PROPOSED 132 KV TRANSMISSION INTEGRATION PROJECT FOR THE AUTHORIZED ESIZAYO WIND ENERGY FACILITY NEAR LAINGSBURG, CENTRAL KAROO DISTRICT MUNICIPALITY, WESTERN CAPE & KAROO HOOGLAND DISTRICT MUNICIPALITY, NORTHERN CAPE: PALAEONTOLOGICAL HERITAGE BASIC ASSESSMENT

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EXECUTIVE SUMMARY

It is planned to connect Biotherm Energy's authorised Esizayo Wind Energy Facility (WEF), situated in the Klein-Roggeveldberge region of the Great Karoo some 30 km to the northwest of Laingsburg, Western Cape, to the national electricity grid. The link will occur *via* the existing Eskom Komsberg Main Transmission Substation, situated to the north of the Esizayo WEF project area on Farm Standvastigheid 210, Northern Cape Province. It will involve the construction of an on-site substation (two sites under consideration) as well as a 132 kV powerline (several route options *per* substation under consideration).

Combined field-based and desktop palaeontological assessments (PIAs) covering most of the potential substation and powerline footprints have already been submitted by Almond (2015b, 2015c, 2016f, 2016g), as well as PIAs for several adjoining WEF project areas. The Klein-Roggeveldberge region is largely underlain by deltaic and continental (fluvial / lacustrine) sediments of the Waterford and Abrahamskraal Formations. These rocks belong respectively to Ecca and Lower Beaufort Groups of the Karoo Supergroup and are of Middle Permian age. The Middle Permian Ecca and Beaufort Group bedrocks in this region have yielded scientifically-important fossils of petrified wood, rich vascular plant and insect assemblages, tetrapod (terrestrial vertebrate) burrows and trackways as well as extremely rare tetrapod skeletal remains (amphibians and therapsids) of the *Eodicynodon* Assemblage Zone. However, well-preserved fossils are very sparsely distributed here.

The great majority of the fossils recorded so far within the Esizayo WEF and grid connection project areas are of widely-occurring taxa (sphenophyte ferns, lungfish burrows, low diversity invertebrate trace fossils) that are not considered to be of exceptional scientific or conservation value. None of the fossil sites recorded during the 2016 and 2021 palaeontological site visits lies within the footprints (or buffer zones) of the 132 kV powerline route options and on-site substation sites under consideration (see satellite map Appendix 1, Figure A1). Direct impacts on these known fossil sites are therefore not anticipated and no mitigation is recommended in regard to them.

The impact significance of the construction phase of the proposed on-site substation and powerline for the Esizayo WEF is assessed as LOW (NEGATIVE) in terms of palaeontological heritage resources. This is a consequence of (1) the paucity of irreplaceable, unique or rare fossil remains within the study area as well as (2) the extensive superficial sediment cover overlying most potentially-fossiliferous bedrocks here. This assessment applies equally to the two substation sites

and various associated powerline corridors under consideration – including the new preferred grid option. Significant further impacts during the operational and de-commissioning phases of the electrical infrastructure are not anticipated. There are therefore no preferences on palaeontological heritage grounds for any particular layout among the various substation and powerline options under consideration. The no-go alternative (*i.e.* no development) will probably have a low (neutral) impact on palaeontological heritage.

Cumulative impacts on palaeontological heritage resources that are anticipated as a result of the numerous renewable energy developments currently proposed or authorised for the Klein-Roggeveldberge region, including the Esizayo WEF and its electrical infrastructure, are anticipated to be MODERATE (NEGATIVE). Their significance would probably fall to LOW (NEGATIVE) *provided that* the proposed monitoring and mitigation recommendations made for all these various projects are followed through (*cf* Almond 2016f). These anticipated levels of change are acceptable.

There are no fatal flaws in the Esizayo WEF grid connection infrastructure development proposals as far as fossil heritage is concerned. *Provided that* the recommendations for palaeontological monitoring and mitigation outlined below (See also Section 6 of this report) are fully implemented, there are no objections on palaeontological heritage grounds to authorisation of the proposed on-site substation and 132 kV powerline. Pending the potential discovery of substantial new fossil remains during construction, specialist palaeontological mitigation is not recommended for this project. The following general recommendations concerning conservation and management of palaeontological heritage resources apply (See tabulated Chance Fossil Finds Protocol in Appendix 2).

The Environmental Control Officer (ECO) / Environmental Site Officer (ESO) responsible for the Esizayo WEF grid connection developments should be made aware of the potential occurrence of scientifically-important fossil remains within the development footprint. During the construction phase all major clearance operations (*e.g.* for new access roads, pylon footings) and deeper (> 1 m) excavations should be monitored for fossil remains on an on-going basis by the ECO / ESO. Should substantial fossil remains - such as vertebrate bones and teeth, or petrified logs of fossil wood - be encountered at surface or exposed during construction, the ECO / ESO should safeguard these, preferably *in situ*. They should then alert the relevant provincial heritage management agency as soon as possible - *i.e.* Heritage Western Cape for the 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) and SAHRA for the Northern Cape (Contact details: Dr Ragna Redelstorff, SAHRA, P.O. Box 4637, Cape Town 8000. Tel: 021 202 8651. Email: rredelstorff@sahra.org.za). This is to ensure that appropriate action (*i.e.* recording, sampling or collection of fossils, recording of relevant geological data) can be taken by a professional palaeontologist at the developer's expense.

These mitigation recommendations should be incorporated into the Environmental Management Programme (EMPr) for the Esizayo WEF on-site substation and powerline projects. Please note that:

- All South African fossil heritage is protected by law (South African Heritage Resources Act, 1999) and fossils cannot be collected, damaged or disturbed without a permit from SAHRA or the relevant Provincial Heritage Resources Agency (in this case SAHRA for the N. Cape and Heritage Western Cape for the W. Cape);

- The palaeontologist concerned with potential mitigation work will need a valid fossil collection permit from Heritage Western Cape (W. Cape) / SAHRA (N. Cape) and any material collected would have to be curated in an approved depository (*e.g.* museum or university collection);

- All palaeontological specialist work should conform to international best practice for palaeontological fieldwork and the study (*e.g.* data recording fossil collection and curation, final report) should adhere as far as possible to the minimum standards for Phase 2 palaeontological studies developed by HWC (2021) and SAHRA (2013).

1. INTRODUCTION

1.1. Scope of Work

The brief for the present Basic Assessment report is to provide an authoritative, reasoned assessment of potential impacts on palaeontological heritage resources posed by the construction of an on-site substation and associated 132 kV powerline connection between the authorised Esizayo Wind Energy Facility (WEF) near Laingsburg, Western Cape, and the national grid *via* the existing Komsberg Main Transmission Substation on Farm Standvastigheid 210 near Sutherland, Northern Cape Province (Fig. 1). The assessment is based on (1) a previous field-based palaeontological heritage assessment of the Esizayo WEF project area by Almond (2016f) supplemented by (2) a recent 2-day palaeontological site visit focussing mainly on the revised grid connection and on-site substation project areas, as well as (3) a desktop review of several recent palaeontological field surveys within adjoining WEF project areas, most notably those by Almond (2015b), Almond (2015c), Almond (2016b), Almond (2016c) and Almond (2021).

Recommendations for any necessary palaeontological mitigation or management measures during the construction phase of the substation and 132 kV powerline are also made.

1.2. Objectives of the report

The present PIA report assesses potential impacts on local palaeontological heritage resources due to the construction of an on-site substation and 132 kV grid connection to the existing Komsberg MTS for the authorised Esizayo WEF. Two on-site substation site options and various powerline route options are considered, including the layout that is already approved as well as an additional, newly proposed powerline route option.

The Esizayo WEF on-site substation and powerline project areas are located in a region that is underlain by potentially fossiliferous sedimentary rocks of Late Palaeozoic and younger, Late Tertiary or Quaternary, age (See Section 3 of this report). The construction phase of the proposed substation, powerline and associated access roads will entail extensive surface clearance as well as excavations into the superficial sediment cover and underlying bedrock. The development may adversely affect legally-protected fossil heritage within the study area by destroying, disturbing or permanently sealing-in fossils preserved at or beneath the surface of the ground that are then no longer available for scientific research or other public good (The planning, operational and de-commissioning phases of the substation and powerline are unlikely to involve further adverse impacts on local palaeontological heritage).

Combined desktop and field-based palaeontological heritage assessments (PIAs) of the Esizayo WEF and grid connection projects were submitted by Almond (2016f, 2016g) as part of the EIA Phase for the WEF development that is being co-ordinated on behalf of Biotherm Energy (Pty) Ltd (Biotherm) by

WSP | Parsons Brinckerhoff, Environment & Energy, Africa (Contact details: Ms Ashlea Strong. WSP | Parsons Brinckerhoff, Environment & Energy, Africa. WSP House, Bryanston Place, 199 Bryanston Drive, Bryanston, 2191, South Africa. Tel: +27 11 361 1392. Mob: +27 82 786 7819. Fax: +27 11 361 1381. E-mail: Ashlea.Strong@WSPGroup.co.za). Comparable palaeontological assessments for the adjoining Karusa WEF, Rietkloof WEF, Brandvalley WEF and the expanded Eskom Komsberg Substation as well as a desktop study for the original Esizayo WEF grid connection have also been submitted by the author (Almond 2015c, 2015b, 2016b, 2016c and 2016g respectively).

1.3. Legislative Framework

The present palaeontological heritage assessment report contributes to the consolidated heritage Basic Assessment for the proposed substation and 132 kV powerline and falls under the South African Heritage Resources Act (Act No. 25 of 1999). It will also inform the Environmental Management Programme (EMP) for these alternative energy projects.

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; and
- 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 Heritage Western Cape, HWC (2021) and the South African Heritage Resources Agency, SAHRA (2013).

1.4. Study approach and methodology

In preparing a palaeontological desktop study the potentially fossiliferous rock units (groups, formations *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 field assessment 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 Western, Eastern and Northern Cape have already been compiled; *e.g.* Almond & Pether 2008a, 2008b and SAHRIS website). The likely impacts of the proposed development on local fossil heritage are 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 significantly the extent of fresh bedrock excavation envisaged. When rock units of moderate to high palaeontological sensitivity are present within the development footprint, a Phase 1 field-based assessment study by a professional palaeontologist is usually warranted to identify any palaeontological hotspots and make specific recommendations for any mitigation or monitoring required before or during the construction phase of the development.

On the basis of the desktop and Phase 1 field assessment studies, the likely impact of the proposed development on local fossil heritage and any need for specialist mitigation are then determined. Adverse palaeontological impacts normally occur during the construction rather than the planning, operational or de-commissioning phases. Phase 2 mitigation by a professional palaeontologist – normally involving the recording and sampling of fossil material and associated geological information (*e.g.* sedimentological data) may be required (a) in the pre-construction phase where important fossils are already exposed at or near the land surface and / or (b) during the construction phase when fresh fossiliferous bedrock has been exposed by excavations. To carry out mitigation, the palaeontologist involved will need to apply for a palaeontological collection permit from the relevant heritage management authorities, *i.e.* SAHRA for the Northern Cape (Contact details: Dr Ragna Redelstorff. Heritage Officer Archaeology, Palaeontology & Meteorites Unit, SAHRA. 111 Harrington Street, Cape Town, 8001. Tel: +27 (0)21 202 8651. Fax: +27 (0)21 202 4509 E-mail:rredelstorff@sahra.org.za) and Heritage Western Cape for the Western Cape (Contact details: Heritage Western Cape. Protea

Assurance Building, Green Market Square, Cape Town 8000. Private Bag X9067, Cape Town 8001. Tel: 086-142 142. Fax: 021-483 9842. Email: hwc@pgwc.gov.za). It should be emphasized that, *providing appropriate mitigation is carried out*, the majority of developments involving bedrock excavation can make a *positive* contribution to our understanding of local palaeontological heritage.

In summary, the approach to a Phase 1 palaeontological heritage study is as follows. Fossil bearing rock units occurring within the broader study area are determined from geological maps and relevant geological sheet explanations as well as satellite images. Known fossil heritage in each rock unit is inventoried from scientific literature, previous palaeontological assessments of the broader study region, and the author's field experience and palaeontological database. Based on this data as well as field examination of representative exposures of all major sedimentary rock units present, the impact significance of the proposed development is assessed in this case using the methodology selected by WSP | Parsons Brinckerhoff, Environment & Energy, Africa. Recommendations for any further palaeontological studies or mitigation considered necessary are specified.

The present combined desktop and field-based PIA study was undertaken in line with the HWC (2016) and SAHRA (2013) Minimum Standards for the palaeontological component of heritage impact assessment. It was largely based on the following sources of information:

1. A brief project outline, maps and kmz files provided by WSP | Parsons Brinckerhoff, Environment & Energy, Africa;
2. Relevant 1: 50 000 and 1: 250 000 scale topographic maps (3220DC Swartland, 3220 Sutherland) as well as corresponding 1: 250 000 scale geological maps and sheet explanations (*e.g.* Theron 1983, Theron *et al.* 1991, Cole & Vorster 1999) as well as Google earth© satellite imagery;
3. Several palaeontological heritage assessment reports by the present author for proposed developments in the Klein-Roggeveldberge region between Sutherland and Matjiesfontein. They include palaeontological assessments for the Esizayo WEF, Esizayo grid connection, Karusa WEF, Rietkloof WEF, Brandvalley WEF, the expanded Eskom Komsberg Substation and the Kareebosch WEF grid connection (Almond 2016f, 2016g, 2015c, 2015b, 2016b 2016c and 2021 respectively).
4. Additional palaeontological fieldwork focussing on areas of potential palaeontological sensitivity (as identified from satellite imagery) within the broader Esizayo WEF grid connection project area, carried out by the author and an experienced assistant (21-22 September 2021). The season during which the site visits were conducted has little influence on the outcome, provided that weather conditions for palaeontological fieldwork are good, as was the case here.
5. The author's previous experience with the formations concerned and their palaeontological heritage (*cf* Almond & Pether 2008a-b and references listed above).

Fossil localities that were recorded during fieldwork for the Esizayo WEF (See Almond 2016f for details) as well as during the more recent site visit focussing on the broader grid connection project area are shown in relation to the powerline corridors and substation sites under consideration on the satellite images provided in Appendix 1, Figure A1. Please note that these maps do *not* show all fossils that are present at surface within the study area. Additional, unrecorded fossil occurrences (the majority) are to be expected in the subsurface, where they may be impacted during the construction phase of the development. Areas on the map that do not contain known fossil sites are therefore not necessarily fossil-free or palaeontologically insensitive.

1.5. Assumptions

Since most fossils are buried beneath the surface, their nature and distribution cannot be directly assessed during field surveys of the development footprint. Palaeontological assessments therefore rely on extrapolating palaeontological sensitivities within the footprint from desktop data and field surveys of well-exposed sedimentary rocks, mostly from sites *outside,* and often well away from, the footprint itself. This approach assumes that the rock exposures seen are representative - in palaeontological terms - of the rock units (formations, members *etc*) that will be impacted by the proposed development.

1.6. Limitations of this study

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

1. 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.

2. 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.

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

4. 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.

5. Absence of a comprehensive computerized database of fossil collections in major RSA institutions which can be consulted for impact studies. A Karoo fossil vertebrate database is now accessible for impact study work.

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

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

b) *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.

In the case of the Esizayo WEF substation and powerline study area near Laingsburg in the Western Cape, preservation of potentially fossiliferous bedrocks is favoured by the semi-arid climate and sparse vegetation. However, bedrock exposure is highly constrained by extensive superficial deposits, especially in areas of low relief, as well as pervasive Karoo *bossieveld* vegetation (Central Mountain Shale Renosterveld, Koedoesberg – Moordenaars Karoo, Tanqua Wash Riviere). Much of the study area is is hilly or mountainous with few access roads, especially in rugged upland areas (*cf* Figs. 2 to 7). However, sufficient bedrock exposures were examined during the course of several previous field studies in the Klein-Roggeveldberge region, including two site visits to the Esizayo WEF project area, to assess the palaeontological heritage sensitivity of the main rock units represented within the study area (See reference list). Confidence levels for this impact assessment are consequently rated as Medium.

1.7. Declaration of independence

I, John E. Almond, declare that I am an independent consultant and have no business, financial, personal or other interest in the proposed development project, application or appeal in respect of which I was appointed other than fair remuneration for work performed in connection with the activity, application or appeal. There are no circumstances that compromise the objectivity of my performing such work.

Dr John E. Almond
(**Palaeontologist**, ***Natura Viva*** **cc)**

2. DESCRIPTION OF THE PROJECT

The company BioTherm Energy (Pty) Ltd (BioTherm) is proposing to develop a wind energy facility (WEF) with a total generation capacity of up to 140 MW, to be known as the Esizayo WEF, on a site located some 30 km to the northwest of Laingsburg, Laingsburg District Municipality, Western Cape. A combined desktop and field-based palaeontological heritage assessment (PIA) for the Esizayo WEF has been submitted previously by Almond (2016f) as part of the EIA for this project. It is planned to connect the Esizayo WEF to the national electricity grid *via* the existing Eskom Komsberg Main Transmission Substation (MTS) situated to the north of the Esizayo WEF project area on Farm Standvastigheid 210, Karoo Hoogland Municipality, Northern Cape Province. A desktop PIA report assessing various grid connection options was submitted by Almond (2016g). The Esizayo WEF was subsequently authorized (DEA Ref: 14/12/16/3/3/2/967) together with a 132 kV grid connection between an on-site substation and the Komsberg MTS (Substation Option 1 and orange line Alternative Route 2 in Fig. 1) (DEA Ref: 14/12/16/3/3/1/1775).

A new preferred 132 kV grid connection between the originally assessed Substation Option 2 and the Komsberg MTS has since been proposed (blue line in Fig. 1). Based on desktop studies as well as a recent two-day palaeontological site visit to the broader Esizayo grid connection project area, the preferred new line is assessed and compared with the previously assessed grid connection route options in this Basic Assessment report.

The proposed 132 kv transmission integration project connecting the authorized Esizayo WEF to the national grid will comprise the following main infrastructural components:

- An Eskom on-site substation (Two site options under consideration, shown in green and red in Fig. 1, with Option 2 (green) being the preferred option).
- A double-circuit 132 kV powerline between the chosen Eskom on-site substation and the Komsberg Main Transmission Substation (See Figures 1 for powerline routes under consideration, showing the 500-m wide corridor assessed here. The new eastern route is now the preferred option, running from substation Option 2 (green) northwards along the boundary between farms Aanstoot 72 and 285 Aurora to the Komsberg MTS is now the preferred option).
- An operations and maintenance (OM) building at each Eskom on-site substation.
- Roads and cables.

Land parcels potentially affected by the proposed transmission integration project, depending on the final route chosen, include the following: Farm 72 (Portion 2) Anstoot, Remainder of Farm 73 Bon Espirange, Portion 1 of Farm 73 Bon Espirange, Remainder of Farm 74 Fortuin, Remainder of Farm 105 Oskop (April's Kraal), Standvastigheid 210 Portion 2 (Komsberg MTS), Remainder of Farm 284 Nuwerus and Remainder of Farm 285 Aurora.

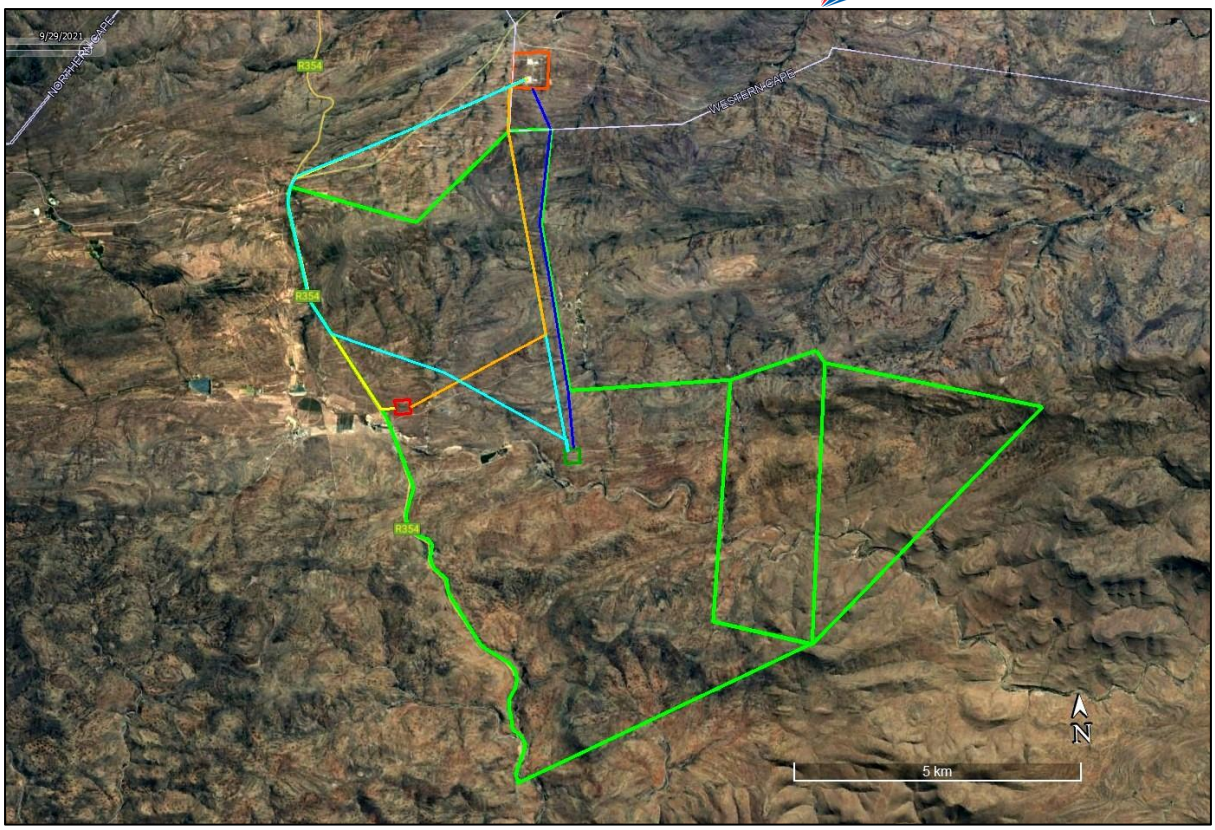

Figure 1: Google Earth© satellite image showing the project area of the authorized Esizayo WEF (green polygon) near Laingsburg, Central Karoo District, Western Cape. Also shown are the alternative sites for the on-site substation (red – Option 1; green – Option 2) as well as various route options for the 132 kV powerline corridor connecting the on-site substation with the existing Komsberg Main Transmission Substation in the Karoo Hoogland District, Northern Cape Province to the north (orange). The originally approved grid connection was from substation Option 1 (red) combined with alternative route 2 (orange line). A new preferred grid connection (dark blue line) running from substation Option 2 (green) northwards along the boundary between farms Aanstoot 72 and 285 Aurora to the Komsberg MTS on Standvastigheid 210 Portion 2 is also considered in this BA report.

3. DESCRIPTION OF THE AFFECTED ENVIRONMENT

The Esizayo WEF powerline project area is situated in semi-arid, hilly to mountainous terrain of the Klein-Roggeveldberge region in the south-western part of the Great Karoo. It lies on the eastern side of the R354 Matjiesfontein to Sutherland tar road and some 30 km northwest of Laingsburg, Western Cape (Fig. 1). West-east trending uplands reach elevations of *c*. 1390 m above mean sea level (amsl) in the north of the WEF study area (Skaapberg ridge). The northern and central portions of the area are drained by the SE-flowing Roggeveldrivier (itself a tributary of the Buffelsrivier) and its various small tributaries. The south-western and southern portions are drained by tributaries of the Wilgerhoutrivier which also eventually drains into the Buffelsrivier near Laingsburg. The level of bedrock exposure in the study region is highly constrained by extensive superficial deposits, especially in areas of low relief, as well as pervasive Karoo *bossieveld* vegetation (Central Mountain Shale Renosterveld, Koedoesberg – Moordenaars Karoo, Tanqua Wash Riviere).

Representative views of the topography and sceney within the broader Esizayo WEF and grid connection project area relevant to the present study are given in Figures 2 to 7 below.

Figure 2: View northwards from the crest of the Skaapberg ridge towards the existing Komsberg MTS on farm Standvastigheid 210 in the middle distance. Bedrock exposure in this region of the Klein-Roggeveldberge is generally very low.

Figure 3: Rare bedrock exposure in the low relief *vlaktes c*. 2 km SW of the Komsberg MTS showing high level of weathering in crumbly mudrock facies near-surface.

Figure 4. View of the northern slopes of the west-east trending Skaapberg anticlinal ridge that runs between the Esizayo WEF project area and the existing Komsberg Substation (April's Kraal 105 and Anstoot 72). Note gentle slopes and lack of bedrocks exposure outside stream gullies.

Figure 5. View eastwards along the crest of the Skaapberg ridge showing mantle of coarse sandstone colluvium, eluvium and sandy soils, Aanstoot 72. Exposure of bedrocks here is limited and their khaki hue suggests that they are weathered near-surface.

Figure 6. View south-eastwards from the crest of Skaapberg ridge across the eastern sector of the Esizayo WEF grid connection project area. Hillslopes and *vlaktes* here are largely mantled by sandstone colluvium (scree, eluvium, gravelly soils) but good, strike-parallel exposures of both wacke and mudrock facies is found along occasional incised stream gullies (middle ground).

Figure 7: Fairly level terrain mantled with eluvial gravels and skeletal soils with occasional low ridges of Abrahamskraal Formation channel sandstone seen within the Substation 2 site on Farm 285 Aurora.

3.1. Geological context

The geology of the Esizayo WEF powerline study area is outlined on the 1: 250 000 geology sheet 3220 Sutherland (Council for Geoscience, Pretoria; Theron 1983, Cole & Vorster 1999) (Figure **) and illustrated in Figures 9 to 26 below. Geologically it lies on the gently-folded northern margin of the Permo-Triassic Cape Fold Belt (CFB) and is dominated by bedrocks of the Karoo Supergroup within the Main Karoo Basin (Johnson *et al.* 2006). Gentle folding along west-east trending fold axes of both uppermost Ecca Group and Lower Beaufort Group bedrocks is apparent within the study area. In general bedding dips are not high, however (15 to 25 degrees on geological map), and levels of tectonic deformation are usually low with little cleavage development. Several WNW-ESE trending fracture systems or faults cutting the Lower Beaufort Group succession can be picked out on satellite images by bush clumps and sharp bedding discontinuities but these are not shown on the geological map. These narrow lines may be associated locally with narrow dolerite dykes.

Only three mappable bedrock units or formations are represented within the study area. These are:

- Sandstone-dominated deltaic sediments of the **Waterford Formation** (**upper Ecca Group**) of Middle Permian age that crop out in the cores of west-east trending anticlines in this region of the Klein-Roggeveldberge (*cf* Rubidge *et al.* 2000, Mason *et al.* 2015). A small outcrop area of Waterford bedrocks is present in the core of the Skaapberg ridge anticline, as seen along the R354 (Figure 9) (Pw dark brown / Pwa orange in Figure 8) while possible Waterford wackes are exposed in a stream bed just west of the Substation 2 site (Fig. 10). Direct impacts on Waterford Formation bedrocks due to the WEF grid connection, if any, are likely to be minimal.

- Fluvial, delta platform and lacustrine mudrocks and sandstones of the **Abrahamskraal Formation** (**Lower Beaufort Group / Adelaide Subgroup**) of Middle Permian age (*cf* Johnson *et al.* 2006, Day and Rubidge 2014, Wilson *et al.* 2014, Cole *et al.* 2016 and references therein). These beds crop out over the great majority of the powerline study area (Pa, pale green in Figure 8). However, exposure levels of these older sedimentary bedrocks are generally very low and mainly confined to occasional stream gullies (*e.g.* Figs 14 to 16), as well as borrow pits along the R354 and *c*. 2 km SW of the Komsberg MTS (Fig. 3). Only the lowermost portion of the Abrahamskraal Formation succession, close to the lower contact with the Waterford Formation and beneath the incoming of reddish mudrocks, is represented within the grid corridor project area.

  A delta platform or distal, well-watered floodplain setting with frequent high water tables is suggested for the lower Abrahamskraal Formation beds by frequent upward-coarsening sedimentary packages, gradational and loaded tabular sandstone bases without gullying or well-developed channel breccio-conglomerates, *possible* pipe- or dyke-like dewatering structures, dark grey or grey-green (but not reddish), laminated to massive mudrocks, frequent horizons of large, rusty-brown concretions and lenses of diagenetic ferruginous carbonate as well as fossil assemblages dominated by equisetalean ferns and lungfish burrows, with no skeletal remain of land-living tetrapods recorded so far (Section 4). Drier climatic intervals are indicated by occasional well-developed horizons of small, grey pedogenic calcrete (palaesols). Horizons with abundant gypsum pseudomorphs (“desert roses”) witness intermittent arid climatic episodes with evaporation of water bodies.

- Narrow dykes of the **Karoo Dolerite Suite** of Early Jurassic age that are intruded into the Lower Beaufort Group beds along WNW-ESE trending fracture zones. They are only mapped

in the southern portion of the Esizayo WEF study area (Jd, red lines in Figure 8) but were also recorded in streambed exposures further north by Almond (2016f). Given the narrowness of their thermal aureoles, the dolerites are not of palaeontological heritage significance.

- Away from the shallow to deeply-incised stream gullies, levels of bedrock exposure in the Klein-Roggeveldberge region are generally very low due to the pervasive mantle of **Late Caenozoic superficial deposits** such as alluvium, colluvium (scree, hillwash), eluvium / surface gravels, pedocretes (*e.g.* calcrete) and skeletal to alluvial sandy soils, as well as karroid *bossieveld* vegetation (Figs. 23 to 26). Most of these superficial deposits are of Late Neogene or Quaternary to Holocene age. They have not been mapped at 1: 250 000 scale within the Esizayo WEF project area. The majority of powerline pylon foundations and access roads are likely to be excavated into such largely unfossiliferous superficial sediments rather than the underlying Lower Beaufort Group bedrocks.

Illustrated descriptions of Waterford Formation, Lower Beaufort Group and Karoo dolerite bedrocks as well as various superficial sediments encountered within the Esizayo WEF, Komsberg MTS and 132 kV grid connection project area have been given by Almond (2016f, 2019g). The area to the north is covered by previous PIA studies for the Komsberg Substation and Karusa WEF by Almond (2015b, 2015c). Further representative exposures of the main rock units represented within the Esizayo grid connection project area are illustrated in Figures 9 to 26 in this report, together with short explanatory figure legends.

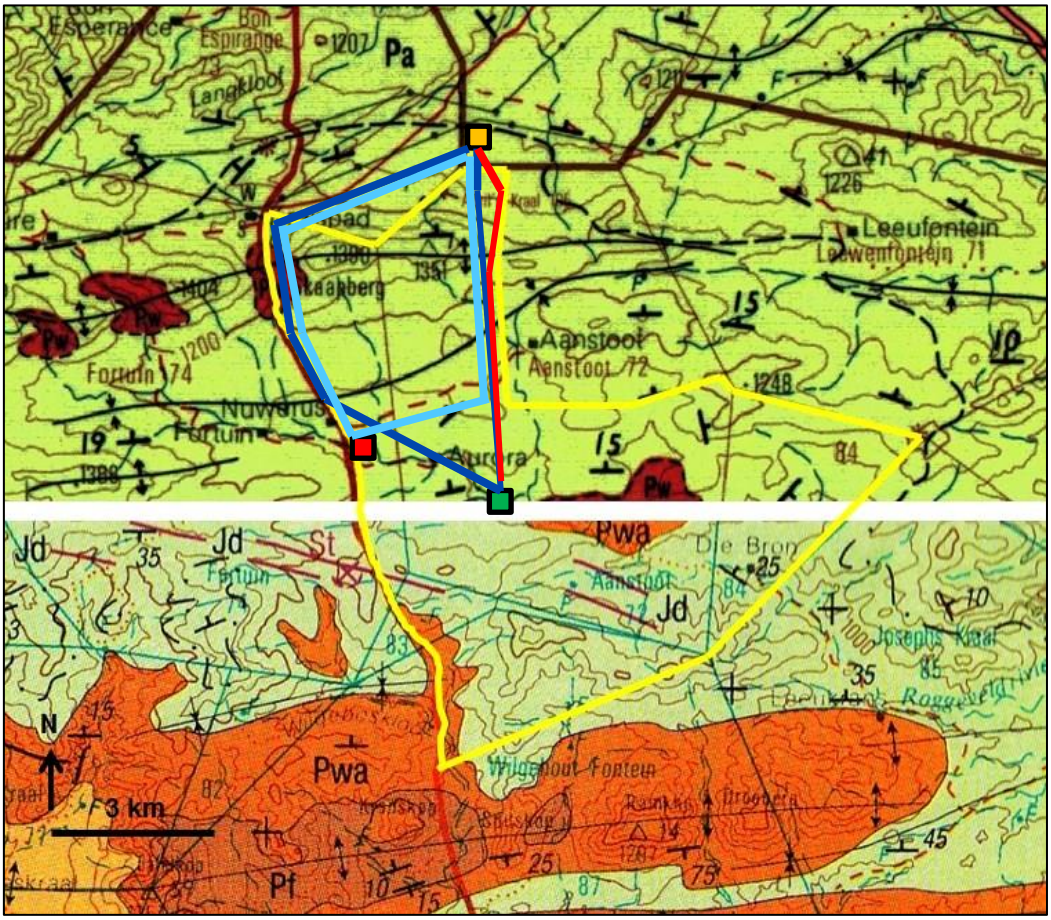

Figure 8: Extracts from adjoining 1: 250 000 scale geology sheets 3320 Ladismith (below) and 3220 Sutherland (above) showing the location of the authorized Esizayo WEF project area, *c.* 30 km northwest of Langsburg, Western Cape Province (yellow polygon) (Abstracted from geological maps published by Council for Geoscience, Pretoria). Site options for the on-site substation are shown in red (Option 1) and green (Option 2). The previously assessed 132 kV powerline corridor route options to the existing Komsberg Main Transmission Substation (orange) are shown somewhat schematically in pale or dark blue while the new preferred grid connection route from substation Option 2 is shown in red (See satellite map Figure 1 for a more accurate grid corridor map).

The main mappable rock units represented within the study area are:

ECCA GROUP	**Waterford Formation (Pwa, orange / Pw, dark brown)**
LOWER BEAUFORT GROUP	**Abrahamskraal Formation (Pa, pale green)**
KAROO DOLERITE SUITE	**Karoo dolerite (Jd, red lines)**

Various Late Caenozoic superficial deposits that are not mapped at 1: 250 000 scale include alluvium, colluvium (scree deposits, hillwash), downwasted surface gravels / eluvium, pedocretes (calcretes) and soils.

Figure 9. Thick package of Waterford Formation delta top wackes exposed in the core of the Skaapberg ridge anticline on the eastern side of the R354, Fortuin 74 (From Almond 2016f). Direct impacts on Waterford Formation bedrocks due to the grid connection are likely to be minimal.

Figure 10: Thick-bedded wackes exposed in a stream bed just west of the Substation 2 site on Farm 285 Aurora. These beds probably belong to the uppermost part of the Waterford Formation, so the Ecca – Beaufort Group (*i.e.* palaeoshoreline of the Ecca Sea) must run close by. If so, the Waterford Formation outcrop area mapped in Figure 2 is underestimated.

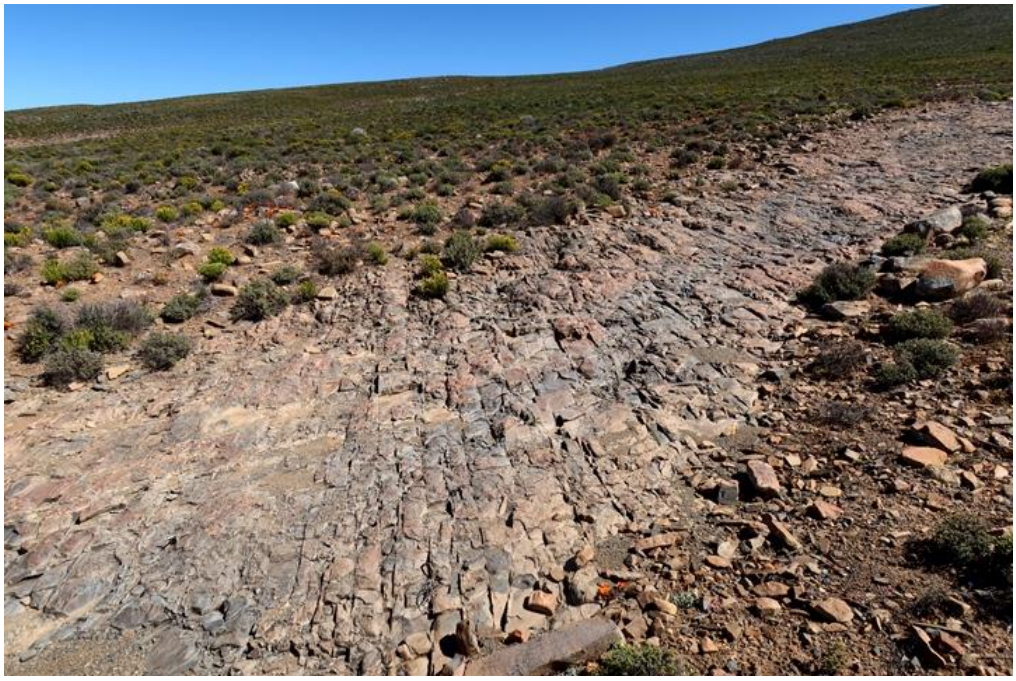

Figure 11: Extensive exposures of the tops of tabular lower Abrahamskraal Formation channel bodies are found along stream gullies on the slopes of the Skaapberg ridge, Farm 285 Aurora. They often show a regular, well-developed NW-SE jointing pattern, as seen here, and are generally unfossiliferous.

Figure 12: Massive, fine-grained channel sandstones (wackes) exposed along the crest of the Skaapberg ridge on Farm 285 Aurora show sphaeroidal corestone weathering and scabby exfoliation. Karstic (solution) weathering processes as well as lichen weathering may have been active here.

Figure 13: Steep stream gulley and waterfall exposure of dark grey overbank mudrocks of the lower Abrahamskraal Formation, southern slopes of the Skaapberg ridge, Aanstoot 72.

Figure 14: Excellent stream gulley exposure of a mudrock-rich package within the lower Abrahamskraal Formation on the southern slopes of the Skaapberg ridge, Farm 285 Aurora. (See also Figure 6 for context). The tabular, medium-bedded wackes are often similar in grain-size and hue to the intervening mudrocks and show gradational lower contacts.

Figure 15: Lower Abrahamskraal Formation exposures along strike to those shown in the previous figure, here showing the development of large, sphaeroidal concretions of ferruginous diagenetic carbonate (arrowed), Farm 285 Aurora (Hammer = 30 cm).

Figure 16: Interbedded packages of grey-green mudrocks and thin, tabular channel sandstones of the lower Abrahamskraal Formation, stream gully on southern slopes of Skaapberg ridge, Farm 285 Aurora. Note evidence of loading of the sandstone base into underlying soupy, water-rich mudrocks (arrow) suggesting high water tables in a delta platform setting.

Figure 17: Irregular, gradational contact between a well-jointed, grey-green channel wacke and underlying grey-green silty mudrocks with occasional ferruginous carbonate concretions (Hammer = 30 cm). This locality lies very low within the Abrahamskraal Formation, close to the contact with the Waterford Formation, Farm 285 Aurora.

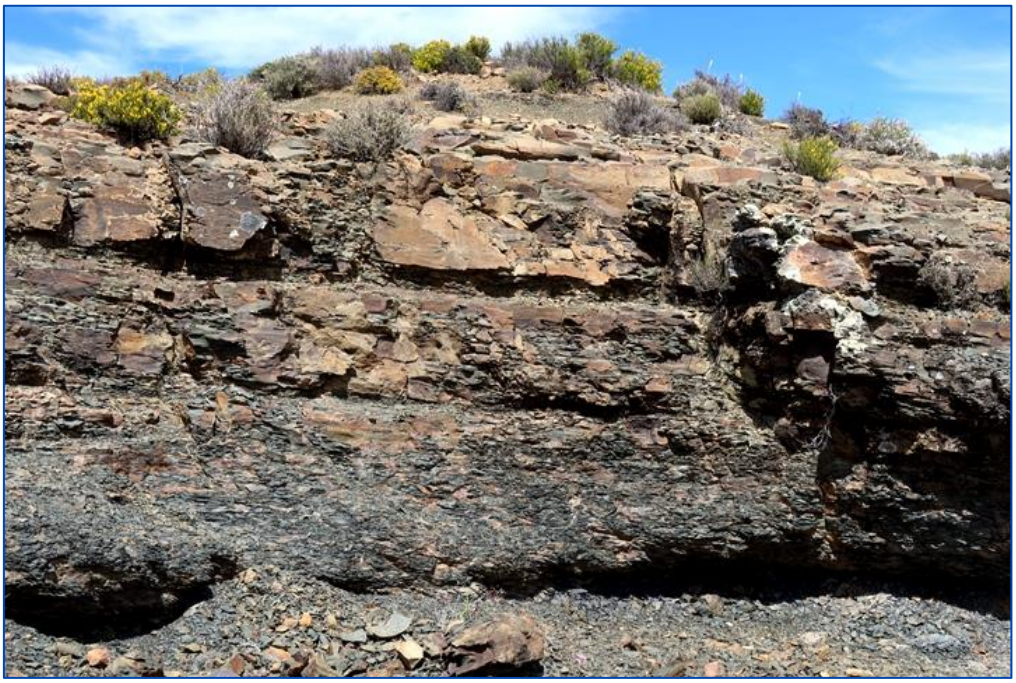

Figure 18: Typical example of an upward-coarsening sediment package within the lower Abrahamskraal Formation, stream gulley exposure on Farm 285 Aurora. Thin-bedded, dark grey-green siltstones at the base grade up into thicker-bedded, sharp-topped, grey-green, fine-grained wackes at the top. This is not a typical fluvial sedimentation pattern and may be related rather to the infilling of interdistributary bays on a delta platform.

Figure 19: A grey-green mudrock package overlying the beds shown in the previous figure contains abundant silicified pseudomorphs of clusters of biconvex gypsum crystals and sphaeroidal "desert roses" with a radial internal crystal structure, indicating drying episodes within ponds and lakes on the delta platform, Farm 285 Aurora (Scale in cm).

Figure 20: Dark blue-grey to grey-green mudrocks of the lowermost Abrahamskraal Formation, here sharply capped by a highly tabular channel sandstone, riverbank near Araura homestead, Farm 285 Aurora.

Figure 21: Stream gulley exposure of the lower Abrahamskraal Formation on Farm 285 Aurora showing high level of weathering in the crumbly, khaki-hued near-surface mudrocks. Fresher, darker siltstones in the stream bed contain moulds of plant stems (Figure 32).

Figure 22: Rare extensive exposure of weathered lower Abrahamskraal Formation mudrocks in the low-relief, gently hilly region *c*. 600 m east of the Substation 1 site, Farm 285 Aurora.

Figure 23: Thick gravelly to sandy alluvium and soils overlying lower Abrahamskraal Formation mudrocks exposed in a deep erosion donga on the southern footslopes of the Skaapberg ridge. Much of the proposed 132 kV powerline corridor at lower elevations would traverse similar poorly-fossiliferous superficial deposits.

Figure 24: Bare sandy patches of alluvial soils with patches of dispersed surface gravels modified by sheetwash, Aanstoot 72.

Figure 25: Sandy alluvium with coarse gravel interbeds, incipiently calcretised towards the base, exposed in a riverbank near Araura homestead, Farm 285 Aurora.

Figure 26: Thick succession of well-sorted, sandy alluvium capped by slightly darker soils, stream gulley section just east of the R354, Farm 285 Aurora (Hammer = 30 cm).

4. PALAEONTOLOGICAL HERITAGE

The Great Karoo is world-famous for its rich record of terrestrial vertebrates and other fossils from the Permian, Triassic and Early Jurassic Periods in Gondwana (Rubidge 1995, MacRae 1999, Rubidge 2005, McCarthy & Rubidge 2005, Smith *et al.* 2012). The fossil record of the Klein-Roggeveld region is very poorly known by Karoo standards but our knowledge has been improved in recent years through several palaeontological impact assessments in the area (See References).

The principal fossil sites recorded during the original field study for the Esizayo WEF are indicated on the satellite image of the project area in Figures A1 and A2 (Appendix 1). The fossil database has been abstracted from Almond (2016f) where the fossil material is illustrated and briefly described, while detailed locality data has been tabulated in the Appendix to that report. Additional new fossil sites recorded during the recent 2-day palaeontological site visit (Figs. 27 to 36) are mapped in Figure A3 (Appendix 1) in relation to the revised scheme of grid connection route options.

Please note that these are *not* distribution maps of *all* fossil occurrences within the project area – most of which are not exposed at the surface – but only a representative sample of the better-preserved fossils encountered during the field assessment. Further, unrecorded fossil occurrences are to be expected elsewhere at the ground surface or in the subsurface (the majority), where they may be impacted during the construction phase of the powerline. Areas on the map that do not contain known fossil sites are therefore not necessarily fossil-free or palaeontologically-insensitive.

The only fossils recorded from the Waterford Formation in the wider Esizayo WEF project area are local concentrations of simple horizontal burrows *plus* disarticulated moulds of bony and / or cartilaginous skeletal elements of probable fish or amphibian affinity (Almond 2016f). Well-preserved silicified wood – including fragments of large logs – as well as low-diversity trace fossil assemblages have been recorded from Waterford beds in the Rietkloof WEF and Brandvalley WEF study areas, just to the southwest and west of the Esizayo WEF study area (Almond 2016b, 2016c). No fossils are known from the Waterford beds along the R354 which outcrop close to the western Esizayo powerline corridor (Figure 9). Direct impacts on fossils within the Waterford Formation bedrocks due to the 132 kV grid connection are likely to be minimal.

Sparse fossil remains recorded from the Abrahamskraal Formation (Lower Beaufort Group / Adelaide Subgroup) in the Esizayo WEF and grid connection study area include low-diversity trace fossil assemblages (invertebrate burrows, casts of reedy plant stems – probably horsetail ferns). Locally abundant striated plant stem, root / rhizome (?) and leaf compressions, casts and moulds are probably attributable, at least to a large extent, to sphenophytes or horsetail ferns (Almond 2016f, this report Figs. 33 & 34). It is notable that no well-preserved petrified wood or terrestrial vertebrate remains have been recorded so far from these lowermost beds of the Abrahamskraal Formation in the Esizayo, Karusa and Komsberg Substation study areas. Some of the moulds of larger plant axes illustrated in the present report might have belonged to woody plants, however (Figs. 31 & 32). Recent fieldwork revealed, in addition, several mudrock horizons containing vertical subcylindrical casts of lungfish burrows (*Dipnoichnus*; Figs. 27 & 28). Puzzling larger, upward- or downward-tapering, sandstone-infilled structures in the same beds (Figs. 29 & 30) might be biogenic (*e.g.* tree trunk casts) or perhaps pipes or dykes related to sediment dewatering.

The fossil assemblages within the lowermost Abrahaskraal Formation beds, pre-dating the incoming of maroon red bed facies, that are represented within the Esizayo WEF and grid connection project area are provisionally assigned to the Middle Permian *Eodicynodon* Assemblage Zone within which vertebrate remains are notoriously rare (Rubidge 1995, Smith *et al.* 2012, Rubidge & Day 2020; see also short review in Almond 2021). It is therefore of scientific interest that very occasional tetrapod

burrows, and even disarticulated cranial and post-cranial skeletal remains, have now been recorded from this stratigraphic level in the Brandvalley WEF study area (Almond 2016c). Fragmentary temnospondyl amphibian skeletal remains have recently been reported from the lowermost Abrahamskraal Formation in the Kareebosch WEF project area some 12 km NW of the present study area (Almond 2021). No fossil tetrapod skeletal fossils or trace fossils have been recorded from the Abrahamskraal Formation in the Esizayo WEF and grid project area (contrast the possible amphibian remains within the underlying Waterford Formation mentioned above).

The occurrence of (rare) amphibian remains and trackways, common horizons of horsetail fern debris as well as lungfish burrow casts supports the prevalence of lacustrine and swampy wetland settings on the early Abrahamskraal delta platform or distal floodplain. As argued above (Section **), the sedimentology of these beds suggests protracted intervals of high water tables with episodes of aridity and desiccation which would have favoured animals, such as lungfish, that were well-adapted for aestivation.

No fossil remains are recorded from the pervasive Late Caenozoic superficial sediments mantling the Karoo Supergroup (Waterford and Abrahamskraal Formations) bedrocks in the broader Esizayo WEF and grid study region, while the minor Karoo dolerite intrusions are unfossiliferous. It is concluded that the overall palaeontological sensitivity of the 132 kV powerline and on-site substation study areas for the Esizayo WEF development is low.

It is noted that the great majority of the fossils observed so far within the Esizayo WEF and grid connection project areas are of widely-occurring forms that are not considered to be of exceptional scientific or conservation value (see Proposed Field Rating in Appendix 1). None of the known fossil sites recorded during the 2016 and 2021 palaeontological site visits lies within the footprints (or buffer zones) of the 132 kV powerline route options and on-site substation sites under consideration (see satellite map Appendix 1, Figure A1.1). Direct impacts on these known fossil sites are therefore not anticipated and no mitigation is recommended in regard to them.

Figure 27: Small, subcylindrical lungfish burrow cast (arrowed) within dark grey mudrocks of probable lacustrine or interdistributary bay origin (Loc. 412, Farm 285 Aurora) (Scale = 15 cm). In this case the burrow cast and matrix are of comparable grain-size and hue, so the burrow is rather cryptic.

Figure 28: Lungfish burrow (*Dipnoichnus*) *c*. 8 cm in diameter preserved as a sandstone cast within grey-green laminated mudrocks (Loc. 420, Farm 285 Aurora) (Scale in cm).

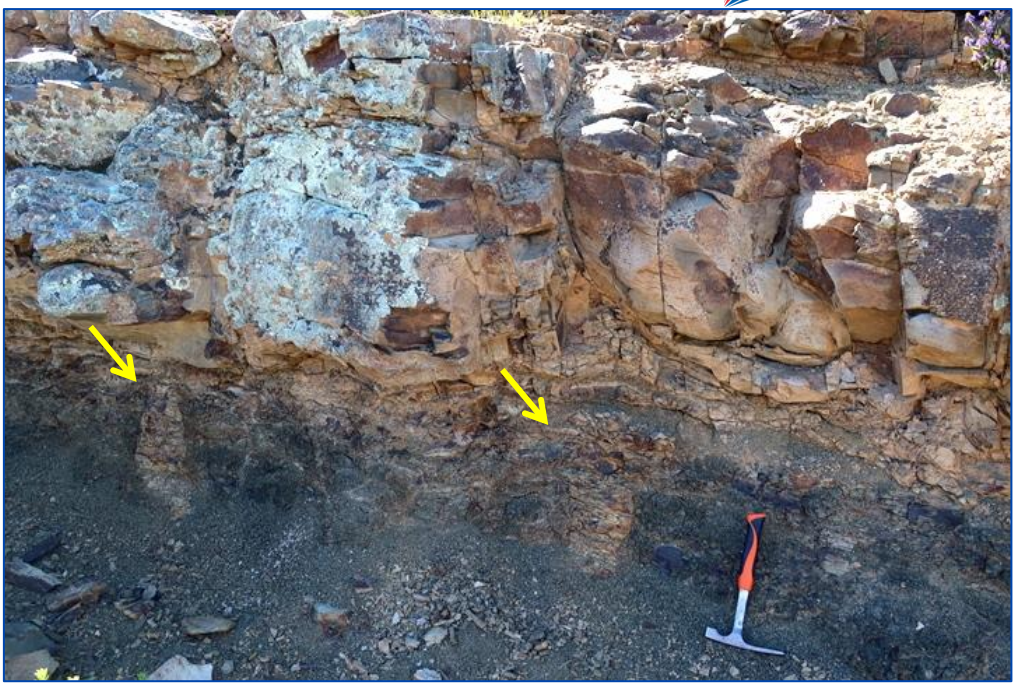

Figure 29: Two substantial, subvertical, downward or upward-tapering sedimentary structures (arrowed) infilled with pale weathered sandstone and penetrating friable, dark grey to grey-green mudrocks of possible lacustrine or interdistributary bay origin (Loc. 421, Farm 285 Aurora) (Hammer = 30 cm). See next figure for more detail.

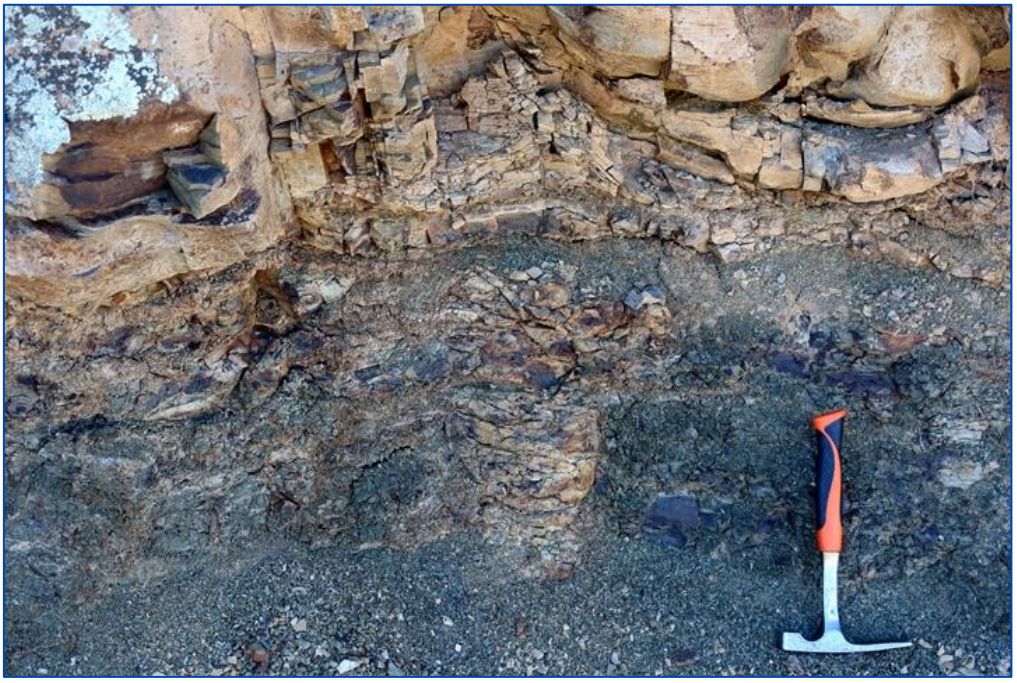

Figure 30: Close-up of one of the vertical sand-infilled structures illustrated above (Hammer = 30 cm). Their geometry is unclear and they are much larger than lungfish burrows found within the same beds. Possible interpretations include casts of large animal burrows or *in situ* tree trunks, or perhaps de-watering structures (*cf* neptunian dykes / pipes).

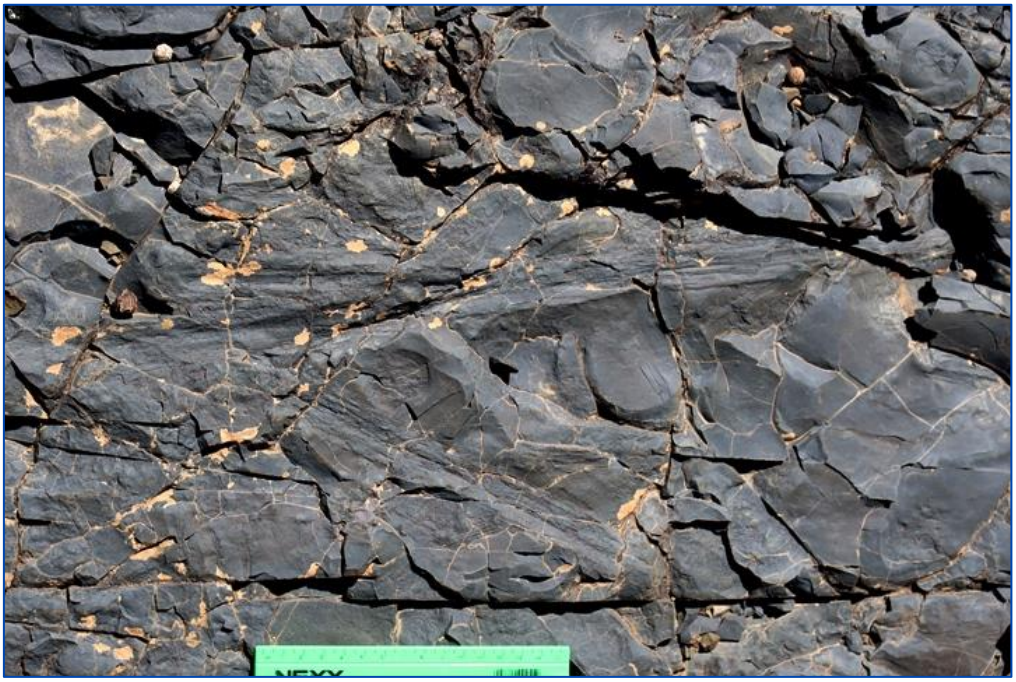

Figure 31: Moulds or impressions of substantial, reworked plant stems embedded in dark grey, hackly-weathering, massive mudrocks (Loc. 424, Farm Aurora 285) (Scale = 15 cm).

Figure 32: Close-up of plant stem moulds within dark grey mudrock showing coarse, irregular longitudinal ridges (Loc. 434, Farm 285 Aurora) (Scale in cm). These may be the moulds of woody plant axes.

Figure 33: Moulds of longitudinally-ridged plant stems within a massive dark grey siltstone – probably large sphenophyte ferns (Loc. 423, Farm 285 Aurora) (Scale in cm).

Figure 34: Close-up of longitudinally-ridged sphenophyte plant stem from same locality as above (Scale in cm and mm).

Figure 35: Friable to hackly-weathering, grey mudrocks containing brownish compressions of plant organs, *possibly* radiating from a central point (RHS) – *perhaps* a plant root or rhizome system (Loc. 422, Farm 285 Aurora) (Scale in cm). Segmented glossopterid or lycopod roots of *Vertebraria* or *Stigmaria* type are not seen here, so these structures may be related to the common sphenophyte ferns.

Figure 36: Close-up of a ferruginous carbonate diagenetic concretion containing fine, mm-scale ferruginous structures that *might* be fossilised plant rootlets or tiny invertebrate burrows (Loc. 344, Farm 285 Aurora). Normally, these rusty-brown concretions are unfossiliferous.

5. ASSESSMENT OF IMPACTS

Given the very uniform underlying geology (and hence expected palaeontological resources), this assessment applies equally to all the on-site substation sites and 132 kV powerline corridors under consideration.

All South African fossil heritage is protected by law (South African Heritage Resources Act, 1999) and fossils may not be collected, damaged or disturbed without a permit from the relevant Provincial Heritage Resources Agency (in this case Heritage Western Cape) (See Section 1.3). The construction phase of the proposed on-site substation and 132 kV powerline will entail extensive surface clearance (notably for access roads, pylon footings) as well as excavations into the superficial sediment cover and possibly also into the underlying bedrock, albeit to a limited extent (*e.g. for* pylon footings). The development may adversely affect potential fossil heritage within the study area by destroying, damaging, disturbing or permanently sealing-in fossils preserved at or beneath the surface of the ground that are then no longer available for scientific research or other public good. The operational and de-commissioning phases of the transmission integration infrastructure are very unlikely to involve further adverse impacts on local palaeontological heritage and are therefore not separately assessed here. Based on experience with WEFs currently under construction, the main source of potential impacts on palaeontological heritage due to grid connection projects is the construction of new access roads, especially in hilly terrain.

5.1. Current impacts on site

Due to slow-acting natural weathering and erosion processes in a semi-arid Karoo setting, where rates of erosion usually exceed rates deposition, fossils already exposed at the ground surface are being gradually destroyed while new, previously buried fossils are being exposed and “prepared out”. Farming activities within the project area have a minimal impact on local palaeontological heritage resources. Fossil collection by qualified palaeontologists or (illegal) amateurs is probably negligible.

5.2. Impact assessment for the construction phase

This assessment (See Table A3.1 in Appendix 3) refers to impacts on fossil heritage preserved at or beneath the ground surface within the footprint of the on-site substation and associated 132 kV powerline during the construction phase, mainly due to surface clearance and excavation activities. It is noted that surface clearance for lengthy access roads associated with new powerlines is likely to have greater impact on fossil heritage than the intermittent, shallow excavations for pylon footings. Such impacts on fossil heritage are *limited to the site* (development footprint) and are generally *direct*, *negative* and of *permanent* effect (*irreversible*). While fossils of some sort (including microfossils, invertebrate trace fossils and plant debris) are of widespread occurrence within the project area, unique or scientifically-important fossils are very scarce indeed here, even where bedrock exposure levels are locally high. Only one highly-sensitive no-go area has been identified within the broader Esizayo WEF study area and this lies well outside the substation and 132 kV powerline development footprint (Site 256 marked in red in map Figure A1.1). It is concluded that impacts on *palaeontological heritage resources of scientific and / or conservation value* are of *low probability* and of *low magnitude* since (1) significant fossil sites are unlikely to be affected and (2) in many cases these impacts can be mitigated through the proposed Chance Fossil Finds Protocol (Appendix 2). The overall impact significance during the construction phase of the substation and powerline infrastructure *without mitigation* is rated as LOW (NEGATIVE) in terms of palaeontological heritage resources. Should the proposed mitigation measures outlined in Section 6 below be fully implemented, the impact significance would remain LOW (NEGATIVE). However, residual negative impacts such as the

inevitable loss of fossil heritage would be partially offset by an improved understanding of Karoo fossil heritage which is considered a *positive* impact.

There are no objections on palaeontological heritage grounds to authorisation of the proposed 132 kV transmission integration project, including the on-site substation, 132 kV powerline and associated infrastructure. Given the paucity of high-sensitivity fossil sites recorded within the Esizayo WEF and grid connection project areas, there is no preference on palaeontological grounds for either one or the other of the two sites for the on-site substation, or for any particular one of the grid connection options under consideration.

Confidence levels for this assessment are rated as *medium*, given the number of palaeontological field studies that have been carried out within the broader Klein-Roggeveldberge study region, including two site visits to the Esizayo WEF and grid connection project area (See References).

The impact assessment for the **No-Go Option** considers future impacts on local fossil heritage that are likely to occur in the absence of powerline development, using the present status of fossil heritage in the area as a baseline. Destruction of near-surface or surface fossil material by natural bedrock weathering and erosion will be partially counterbalanced by on-going exposure of fresh fossil material by erosion. Improvements in our understanding of palaeontology of the area (a possible positive impact) will depend on whether or not field-based academic or impact studies are carried out here, which is inherently unpredictable (There is an on-going research project on the palaeontology of the SW Karoo by Wits University). On balance, the No-Go Option may have a *neutral* impact significance.

5.3. Assessment of cumulative impacts (construction phase)

Cumulative impacts inferred for the various alternative energy developments in the Klein-Roggeveldberge region between Matjiesfontein and Sutherland have been previously assessed by Almond (2016f) on the basis of desktop and field-based palaeontological impact assessment reports for these projects, the great majority of which were submitted by the present author (See references provided below and SAHRIS website). Relevant published palaeontological literature for the region has also been taken into account (*e.g.* Loock *et al.* 1994). This assessment applies only to the construction phases of the WEF developments, since significant additional impacts on palaeontological heritage during the operational and de-commissioning phases are not anticipated. The projects concerned in the earlier cumulative impact analysis by Almond (2016f) lie within a radius of some 50-70 km of the Esizayo WEF project area. WEF projects within a smaller, 30 km radius of the Esizayo grid connection project are highlighted by the black circle in Figure 37 while existing Eskom powerlines in the vicinity of the Esizayo WEF grid connection project area are shown in Figure 38. In the absence of full PIA data for comparable WEF grid connection projects within the 30 km radius circle, a meaningful cumulative impact assessment for the Esizayo grid connection is not feasible.

In all the strictly *relevant* field-based palaeontological studies in the Klein-Roggeveld region the palaeontological sensitivity of the project area and the palaeontological heritage impact significance for the developments concerned has been rated as low. In all cases it was concluded by the author that, despite the undoubted occurrence of scientifically-important fossil remains (notably fossil vertebrates, vertebrate trackways and burrows, petrified wood), the overall impact significance of the proposed developments was low because the probability of significant impacts *on scientifically important, unique or rare fossils* was slight. While fossils do indeed occur within some of the formations present, they tend to be sparse – especially as far as fossil vertebrates are concerned - while the great majority represent common forms that occur widely within the outcrop areas of the

relevant sedimentary rock units, and are hence not of high scientific or conservation significance. Important exceptions include (1) local concentrations of exceptionally well-preserved fossil logs in the Waterford Formation and (2) vertebrate burrows attributed to small therapsids, and possibly also to lungfish (Almond 2016b, Almond 2016c). Well-preserved vertebrate trackways made by temnospondyl amphibians or other, unidentified tetrapods found *c*. 35 km north of the Esizayo WEF project area (Almond 2016e) are not really relevant here because they occur within significantly younger sediments of the Abrahamskraal Formation.

Cumulative impacts for the Esizayo WEF on-site substation and associated 132 kV powerline in the context of comparable alternative energy projects proposed or authorised in the Klein-Roggeveldberge region are assessed in Table A3.2 (See Appendix 3). It is concluded that the cumulative impact significance of the proposed new developments and other regional projects is *LOW* (*NEGATIVE*), provided that the proposed monitoring and mitigation recommendations made for all these various projects are followed through. 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. However, *without* mitigation the magnitude and probability of cumulative (negative, direct) impacts of such a large number of WEFs affecting the same (albeit sparsely) fossiliferous rock successions would be significantly higher. The cumulative impact significance without mitigation is accordingly assessed as *MEDIUM (NEGATIVE)*. These anticipated levels of change are *acceptable*.

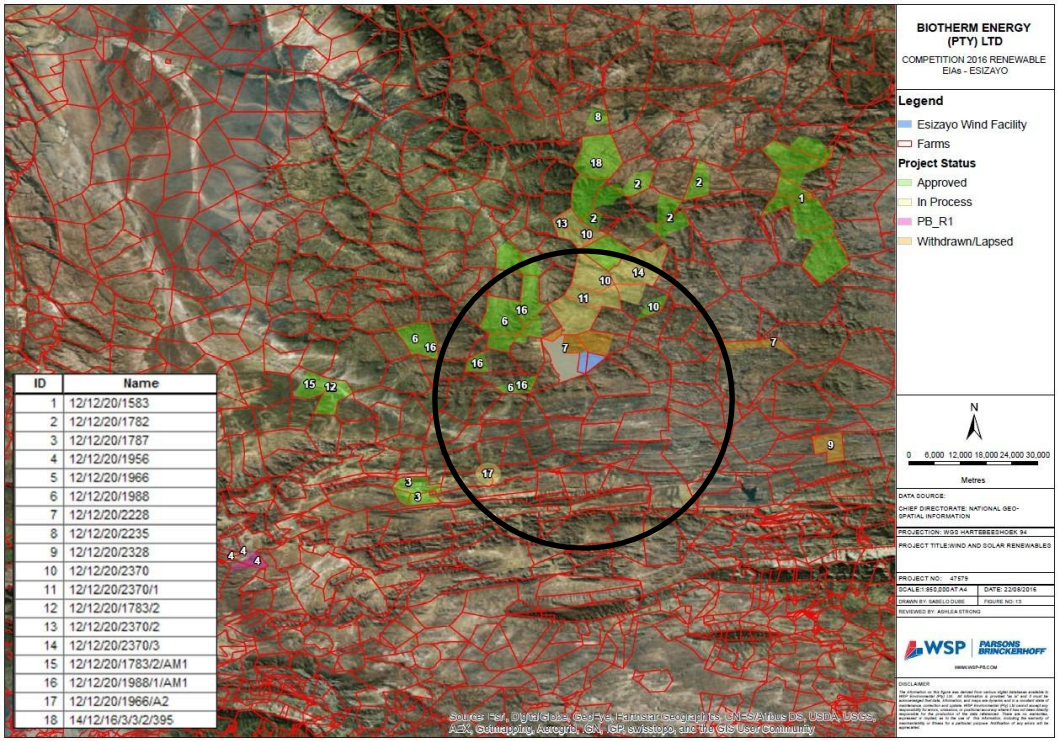

Figure 37: Satellite image showing the large number of proposed WEF facilities in the Klein-Roggeveldberge region between Matjiesfontein and Sutherland. The black circle outlines those projects that lie within a *c.* 30 km radius of the Esizayo WEF project (*cf* Table 1 below). PIA studies for most of these WEF projects have been conducted by the present author.

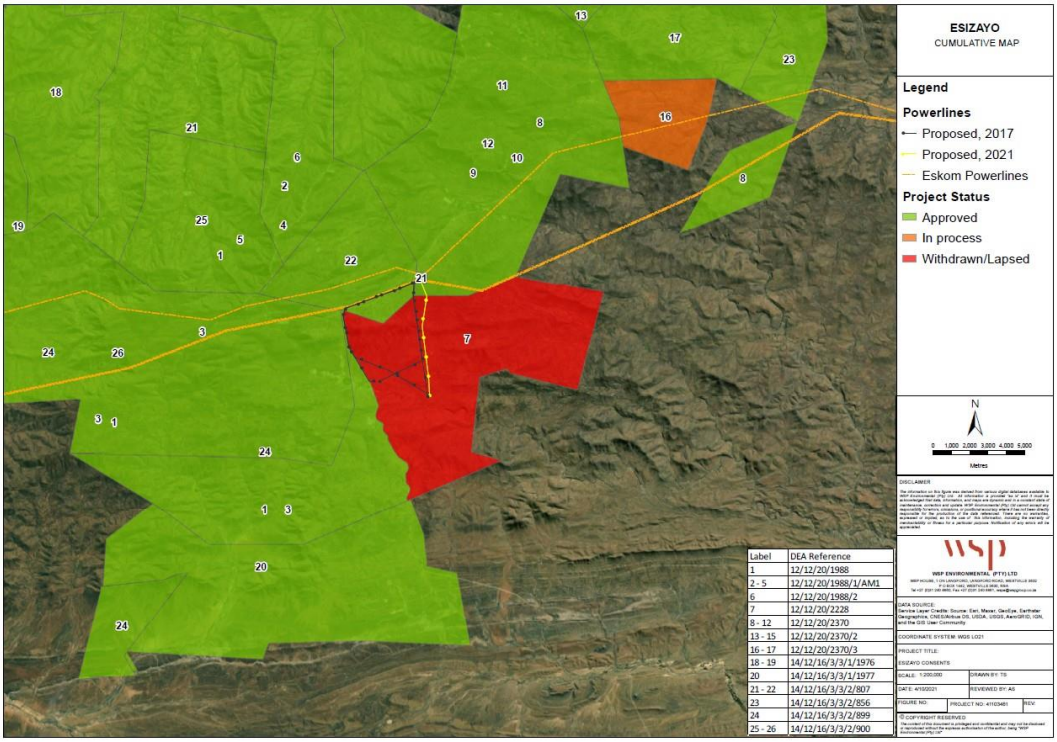

Figure 38: Grid connection options for the Esizayo WEF in the context of Eskom powerlines in the vicinity. Palaeontological data for grid connections to other WEF projects in the region is very limited.

Table 1: WEF projects in the vicinity of the Esizayo WEF and grid connection project area (DEEA database)

DEA_REF	EIA_PROCES	PROJ_TITLE	APPLICANT
12/12/20/1988	Scoping and EIA	Proposed Construction Of The 750 Mw Roggeveld Wind Farm Within The Karoo Hoogland Local Municipality Of The Northern Cape Province And Within The Laingsburg Local Municipality Of The Western Cape Province	G7 Renewable Energies Pty Ltd
12/12/20/1988/1/AM1	Amendment	Proposed Construction Of The 750 Mw Roggeveld Wind Farm Within The Karoo Hoogland Local Municipality Of The Northern Cape Province And Within The Laingsburg Local Municipality Of The Western Cape Province	G7 Renewable Energies Pty Ltd
12/12/20/1988/2	Scoping and EIA	Proposed Construction Of The 140Mw Roggeveld Wind Farm Within The Karoo Hoogland Local Municipality Of The Northern Cape Province And Within The Laingsburg Local Municipality Of The Western Cape Province	G7 Renewable Energies Pty Ltd
12/12/20/2228	Scoping and EIA	Proposed wind energy facility near Komsberg, Western Cape	INCA Komsberg Wind Pty Ltd
12/12/20/2370	Scoping and EIA	Proposed Hidden Valley wind energy facility , Northern cape	To review
12/12/20/2370/2	Scoping and EIA	Proposed Hidden Valley wind energy facility , Northern cape	To review
12/12/20/2370/3	Scoping and EIA	Proposed Hidden Valley wind energy facility , Northern cape	To review
14/12/16/3/3/1/1976	BAR	Proposed development of the 325MW Kudusberg wind Energy facility and associated infrastructure in Western and Northern Cape Provinces	Kudusberg Wind Farm (Pty) Ltd
14/12/16/3/3/1/1977	BAR	Proposed development of the 14MW Rietkloof wind energy facility and associated infrastructure near Matjiesfontein in the Western Cape	Rietkloof Wind Farm (Pty) Ltd
14/12/16/3/3/2/807	Scoping and EIA	The Proposed Karreebosch Wind Farm (Roggeveld Phase 2) and its Associated Infrastructure within the Karoo Hoogland Local Municipality and the Laingsburg Local Municipality in the Northern and Western Cape Provinces	Karreebosch Wind Farm (Pty) Ltd
14/12/16/3/3/2/856	Scoping and EIA	275 Komsberg West Wind Energy facility near Sutherland within the Karoo Hoogland and Laingsburg Local Municipalities in the Northern and Western Cape Provinces.	Komsberg Wind Farms (Pty) Ltd
14/12/16/3/3/2/899	Scoping and EIA	140 MW Rietkloof WE, near Sutherland, NC_WC	Rietkloof Wind Farm (Pty) Ltd
14/12/16/3/3/2/900	Scoping and EIA	147MW Brandvalley wind energy facility North of the town of Matjiesfontein within Karoo Hoogland	Brandvalley Wind Farm (Pty) Ltd.

6. Mitigation and Management Measures

Given the scarcity of scientifically-important, unique fossil heritage recorded within the on-site substation and powerline project area, no further specialist palaeontological studies or mitigation are recommended for this development, pending the potential discovery of significant new fossils before or during the construction phase.

The following general palaeontological mitigation measures apply to the construction phase of the powerline (See Table 2):

- Monitoring of all surface clearance and substantial excavations (>1 m deep) by the ECO / ESO for fossil material (*e.g.* bones, teeth, fossil wood) on an on-going basis during the construction phase.

- Safeguarding of chance fossil finds (preferably *in situ*) during the construction phase by the responsible ECO / ESO, followed by reporting of finds to Heritage Western Cape (HWC) for the Western Cape / SAHRA for the Northern Cape.

- Recording and judicious sampling of significant chance fossil finds by a qualified palaeontologist, together with pertinent contextual data (stratigraphy, sedimentology, taphonomy) (Phase 2 mitigation).

- Curation of fossil material within an approved repository (museum / university fossil collection) and submission of a Phase 2 palaeontological heritage report to HWC / SAHRA by a qualified palaeontologist.

Mitigation of significant chance fossil finds reported by the ECO / ESO would involve the recording, sampling and / or collection of fossil material and associated geological data by a professional palaeontologist during the construction phase of the development (See summarized Chance Fossil Finds Protocol in Appendix 2). The palaeontologist concerned with potential mitigation work (Phase 2) would need a valid fossil collection permit from Heritage Western Cape (W. Cape) or SAHRA (N. Cape) and any material collected would have to be curated in an approved depository (*e.g.* museum or university collection). All palaeontological fieldwork and reporting should meet the minimum standards outlined by HWC (2021) and SAHRA (2013).

Significant further impacts on palaeontological heritage resources are not anticipated during the planning, operational, decommissioning and rehabilitation phases of the substation and grid connection so no further mitigation or management measures in this respect are proposed here.

These monitoring and mitigation requirements should be incorporated into the Environmental Management Programme (EMPr) for the proposed electrical infrastructure and also included as conditions for authorisation of the developments.

Table 2: Recommended mitigation and management measures concerning palaeontological heritage for the Esizayo WEF grid connection.

ACTIVITY	MITIGATION AND MANAGEMENT MEASURE	RESPONSIBLE PERSON	APPLICABLE DEVELOPMENT PHASE	INCLUDE AS CONDITION OF AUTHORISATION	MONITORING REQUIREMENTS
Surface clearance & substantial excavations (> 1 m deep)	Monitoring of all surface clearance and substantial excavations (>1 m deep) for fossil material (*e.g.* bones, teeth, fossil wood)	ECO / ESO	Construction	Yes	Inspect cleared ground and excavations for fossil remains. On-going, throughout construction phase
Surface clearance & substantial excavations (> 1 m deep)	Safeguarding of chance fossil finds (preferably *in situ*), followed by reporting of finds to Heritage Western Cape (HWC) / SAHRA.	ECO / ESO	Construction	Yes	Define and secure fossil site with security tape. Report finds at earliest opportunity to HWC / SAHRA
Surface clearance & substantial excavations (> 1 m deep)	Recording and judicious sampling of significant chance fossil finds by a qualified palaeontologist, together with pertinent contextual data (stratigraphy, sedimentology, taphonomy).	Professional palaeontologist	Construction	Yes	Following consultation over chance fossil finds with HWC / SAHRA and professional palaeontologist
Surface clearance & substantial excavations (> 1 m deep)	Curation of fossil material within an approved repository (museum / university fossil collection). Submission of Phase 2 palaeontological heritage report to HWC / SAHRA.	Professional palaeontologist	Construction	Yes	Following Phase 2 palaeontological mitigation

7. CONCLUSIONS

In recent years the Middle Permian sedimentary bedrocks of the Waterford and Abrahamskraal Formations in the Klein-Roggeveldberge region of the Great Karoo have yielded sparse but scientifically-important fossils of the *Eodicynodon* Assemblage Zone. They include petrified wood, rich vascular plant and insect assemblages, lungfish burrows as well as tetrapod (terrestrial vertebrate) burrows and trackways *plus* exceedingly rare and fragmentary tetrapod skeletal remains. Well-preserved tetrapod fossils are very sparsely distributed here. The Beaufort Group sedimentary bedrocks are extensively covered by Late Caenozoic superficial sediments (*e.g.* scree, surface gravels, alluvium, skeletal soils) that are usually unfossiliferous. The overall palaeontological sensitivity of the study area is rated as low, although the potential for rare fossil sites of high palaeontological interest cannot be entirely discounted.

The great majority of the fossils recorded so far within the Esizayo WEF and grid connection project areas are of widely-occurring taxa (sphenophyte ferns, lungfish burrows, low diversity invertebrate trace fossils) that are not considered to be of exceptional scientific or conservation value. None of the fossil sites recorded during the 2016 and 2021 palaeontological site visits lies within the footprints (or buffer zones) of the 132 kV powerline route options and on-site substation sites under consideration (see satellite map Appendix 1, Figure A1). Direct impacts on these known fossil sites are therefore not anticipated and no mitigation is recommended in regard to them.

The impact significance of the construction phase of the proposed on-site substation and powerline for the Esizayo WEF is assessed as LOW (NEGATIVE) in terms of palaeontological heritage resources. This is a consequence of (1) the paucity of irreplaceable, unique or rare fossil remains within the project area as well as (2) the extensive superficial sediment cover overlying most potentially-fossiliferous bedrocks here. This assessment applies equally to the two substation sites and various associated powerline corridors under consideration - including the new preferred grid option. Significant further impacts during the operational and de-commissioning phases of the electrical infrastructure are not anticipated. There are therefore no preferences on palaeontological heritage grounds for any particular layout among the various substation and powerline options under consideration. The no-go alternative (*i.e.* no development) will probably have a low (neutral) impact on palaeontological heritage.

Cumulative impacts on palaeontological heritage resources that are anticipated as a result of the numerous renewable energy developments currently proposed or authorised for the Klein-Roggeveldberge region, including the Esizayo WEF and its electrical infrastructure, are anticipated to be MODERATE (NEGATIVE). Their significance would probably fall to LOW (NEGATIVE) *provided that* the proposed monitoring and mitigation recommendations made for all these various projects are followed through (*cf* Almond 2016f). These anticipated levels of change are *acceptable*.

There are no fatal flaws in the Esizayo WEF grid connection infrastructure development proposals as far as fossil heritage is concerned. *Provided that* the recommendations for palaeontological monitoring and mitigation outlined below (See also Section 6 of this report) are fully implemented, there are no objections on palaeontological heritage grounds to authorisation of the proposed on-site substation and 132 kV powerline. Pending the potential discovery of substantial new fossil remains during construction, specialist palaeontological mitigation is not recommended for this project. The following general recommendations concerning conservation and management of palaeontological heritage resources apply (See tabulated Chance Fossil Finds Protocol in Appendix 2).

The Environmental Control Officer (ECO) / Environmental Site Officer (ESO) responsible for the Esizayo WEF grid connection developments should be made aware of the potential occurrence of scientifically-important fossil remains within the development footprint. During the construction phase all major clearance operations (*e.g.* for new access roads, pylon footings) and deeper (> 1 m) excavations should be monitored for fossil remains on an on-going basis by the ECO / ESO. Should substantial fossil remains - such as vertebrate bones and teeth, or petrified logs of fossil wood - be encountered at surface or exposed during construction, the ECO / ESO should safeguard these, preferably *in situ*. They should then alert the relevant provincial heritage management agency as soon as possible - *i.e.* Heritage Western Cape for the 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) and SAHRA for the Northern Cape (Contact details: Dr Ragna Redelstorff, SAHRA, P.O. Box 4637, Cape Town 8000. Tel: 021 202 8651. Email: rredelstorff@sahra.org.za). This is to ensure that appropriate action (*i.e.* recording, sampling or collection of fossils, recording of relevant geological data) can be taken by a professional palaeontologist at the developer's expense. These mitigation recommendations should be incorporated into the Environmental Management Programme (EMPr) for the Esizayo WEF on-site substation and powerline projects.

8. ACKNOWLEDGEMENTS

Ms Ashlea Strong of WSP | Parsons Brinckerhoff, Environment & Energy, Africa, Bryanston is thanked for commissioning this study, for providing the necessary background information, and for editorial input. I am, as always, especially grateful to Madelon Tusenius for companionship, for logistical assistance in the field, and – most of all - for finding fossils. Hedi Stummer and Erwin Stummer made significant contributions to the original palaeontological field study for the Esizayo WEF.

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10. SHORT CV OF AUTHOR

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 1: ESIZAYO WEF GRID CONNECTION ADDITIONAL FOSSIL SITE DATA: SEPTEMBER 2021

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

N.B. This palaeontological locality data supplements that provided in the PIA report for the Esizayo WEF submitted by Almond (2016d). Fossil sites recorded during the 2016 site visit as well as the 2021 site visit are plotted on a satellite image of the Esizayo WEF grid connection project area in Figure A1.1. Please note that:

- Locality data for South African fossil sites in *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 field survey. The absence of recorded fossil sites in any area therefore does *not* mean that no fossils are present there.
- The detailed stratigraphic data for each site is provisional and has yet to be confirmed.

Loc.	GPS data	Comments
412	32°57'30.25"S 20°34'47.81"E	Farm 285 Aurora, stream gulley exposure. Small, subcylindrical lungfish burrow casts within dark grey mudrocks of probable lacustrine or interdistributary bay origin. Proposed Field Rating IIIB Local Resource. No mitigation recommended.
420	32°57'58.94"S 20°34'5.34"E	Farm 285 Aurora, stream gulley exposure of Lower Abrahamskraal Fm. Lungfish burrow up to *c*. 8 cm in diameter preserved as a sandstone cast within grey-green laminated mudrocks. Proposed Field Rating IIIB Local Resource. No mitigation recommended.
421	32°57'58.66"S 20°34'5.41"E	Farm 285 Aurora, stream gulley exposure of Lower Abrahamskraal Fm. Problematic sandstone cast sedimentary structures of possible biogenic origin (animal burrows / tree trunk casts) or perhaps generated by dewatering. Proposed Field Rating IIIB Local Resource. No mitigation recommended.
422	32°57'52.05"S 20°34'1.38"E	Farm 285 Aurora, stream gulley exposure of Lower Abrahamskraal Fm. Friable to hackly-weathering, grey mudrocks containing brownish compressions of plant organs, *possibly* a plant root or rhizome system. Proposed Field Rating IIIC Local Resource. No mitigation recommended.
423	32°57'41.36"S 20°33'56.78"E	Farm 285 Aurora, stream gulley exposure of Lower Abrahamskraal Fm. Moulds of longitudinally ridged plant stems (probably sphenophytes) and other scrappy plant debris within massive dark grey siltstone. Proposed Field Rating IIIC Local Resource. No mitigation recommended.
424	32°57'40.50"S 20°33'56.53"E	Farm 285 Aurora, stream gulley exposure of Lower Abrahamskraal Fm. Moulds or impressions of substantial, reworked plant stems embedded in dark grey, hackly-weathering, massive mudrocks. Proposed Field Rating IIIC Local Resource. No mitigation recommended.
425	32°57'36.67"S 20°34'2.37"E	Farm 285 Aurora, stream gulley exposure of Lower Abrahamskraal Fm. Wacke bed top in stream bed with effaced traces of reedy plant stems. Proposed Field Rating IIIC Local Resource. No mitigation recommended.
431	32°57'54.10"S 20°33'34.19"E	Farm 285 Aurora. Horizon of abundant ferruginous carbonate diagenetic concretions within Lower Abrahamskraal Fm containing fine, mm-scale ferruginous structures that *might* be fossilised plant rootlets or tiny invertebrate burrows. Proposed Field Rating IIIC Local Resource. No mitigation recommended.
434	32°58'4.94"S 20°33'47.27"E	Farm 285 Aurora, stream gulley exposure of Lower Abrahamskraal Fm. Plant stem moulds within dark grey mudrock showing coarse, irregular longitudinal ridges - possibly the moulds of woody plant axes. Proposed Field Rating IIIC Local Resource. No mitigation recommended.

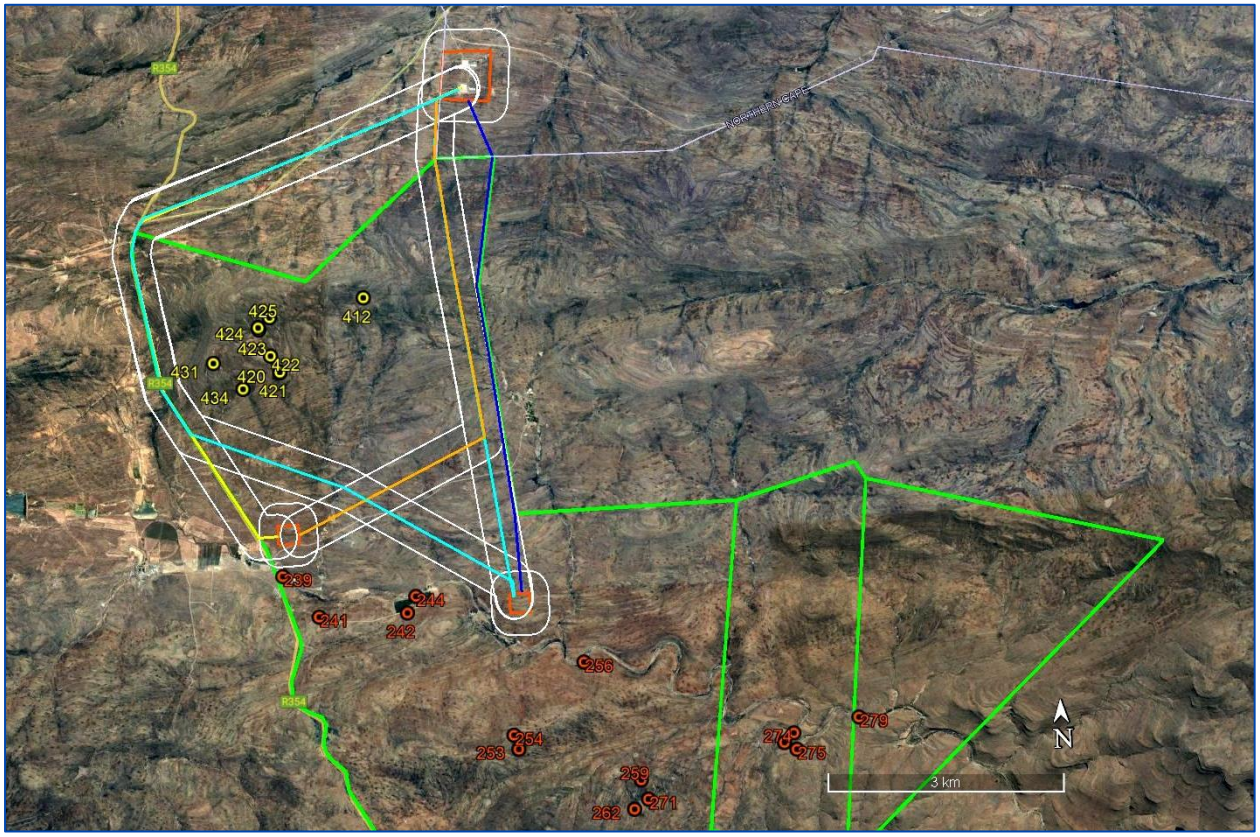

Figure A1.1: Google Earth© satellite image of the Esizayo grid connection project area (See Figure 1 for the various on-site substation and powerline route options). Fossil sites recorded during palaeontological site visits in 2016 and 2021 (numbered red and yellow circles respectively) are mapped here. None of the known fossil sites lies within the grid connection corridor options and therefore no mitigation is recommended with regard to these sites. It is noted that the image does not record *all* potential fossil sites within the project area. Any additional sites which may be found or exposed during the construction phase of the development will be subject to a Chance Fossil Finds Protocol as outlined in Appendix 2.

<table>
<tr><th colspan="3">APPENDIX 2: CHANCE FOSSIL FINDS PROTOCOL: Esizayo WEF grid connection to the Komsberg MTS between Matjiesfontein and Sutherland</th></tr>
<tr><td>Province & region:</td><td colspan="2">Western Cape (Laingsburg Local Municipality) and Northern Cape (Karoo Hoogland Local Municipality)</td></tr>
<tr><td>Responsible Heritage Resources Agency</td><td colspan="2">Heritage Western Cape for the 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)
SAHRA for the Northern Cape (Contact details: South African Heritage Resources Agency. 111 Harrington Street, Cape Town. PO Box 4637, Cape Town 8000, South Africa. Tel : 021 462 4502).</td></tr>
<tr><td>Rock unit(s)</td><td colspan="2">Abrahamskraal Formation (Lower Beaufort Group, Karoo Supergroup), Late Caenozoic alluvium, colluvium, eluvium</td></tr>
<tr><td>Potential fossils</td><td colspan="2">Fossil vertebrate bones, teeth, large burrow casts (lungfish, tetrapods), trackways, petrified wood, plant-rich beds in the Abrahamskraal Fm bedrocks.
Fossil mammal bones, teeth, horncores, freshwater molluscs, plant material, calcretised termitaria in Late Caenozoic alluvium.</td></tr>
<tr><td rowspan="5">ECO 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:
• Accurate geographic location – describe and mark on site map / 1: 50 000 map / satellite image / aerial photo
• Context – describe position of fossils within stratigraphy (rock layering), depth below surface
• 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:
Alert Heritage Resources Agency and project palaeontologist (if any) who will advise on any necessary mitigation
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):
Carefully remove fossils, as far as possible still enclosed within the original sedimentary matrix (e.g. entire block of fossiliferous rock)
Photograph fossils against a plain, level background, with scale
Carefully wrap fossils in several layers of newspaper / tissue paper / plastic bags
Safeguard fossils together with locality and collection data (including collector and date) in a box in a safe place for examination by a palaeontologist
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 Authority. Adhere to best international practice for palaeontological fieldwork and Heritage Resources Agency minimum standards.</td></tr>
</table>

APPENDIX 3: IMPACT ASSESSMENT TABLES FOR THE ESIZAYO 132 KV TRANSMISSION INTEGRATION PROJECT

Table A3.1: Assessment of anticipated impacts on palaeontological heritage resources for the proposed Esizayo WEF on-site substation and associated 132 kV powerline (construction phase). This assessment applies equally to both substation sites as well as the various powerline corridor options under consideration. Further significant impacts in the operational and de-commissioning phases are not anticipated.

Impact number	Aspect	Description	Stage	Character	Ease of Mitigation	Pre-Mitigation							Post-Mitigation						
						(M+	E+	R+	D)x	P=	S	Rating	(M+	E+	R+	D)x	P=	S	Rating
Impact 1:	Palaeontological heritage	Disturbance, damage or destruction of fossils (direct, negative impacts) preserved at or beneath the ground surface within the development footprint , mainly due to surface clearance and excavation activities (e.g. access roads, pylon footings).	Construction	Negative	moderate	2	1	5	5	2	**26**	**N2**	2	1	5	5	2	**26**	**N2**
					Significance	**N2 - Low**							**N2 - Low**						

Table A3.2: Assessment of anticipated cumulative impacts on palaeontological heritage resources for the proposed Esizayo WEF on-site substation and associated 132 kV powerline in the context of numerous other WEF grid connection developments in the region (construction phase). This assessment applies equally to both substation sites as well as the various powerline corridor options under consideration. Further significant impacts in the operational and de-commissioning phases are not anticipated.

Impact number	Receptor	Description	Stage	Character	Ease of Mitigation	Pre-Mitigation							Post-Mitigation						
						(M+	E+	R+	D)x	P=	S		(M+	E+	R+	D)x	P=	S	
Impact 1:	Palaeontological heritage	Disturbance, damage or destruction of fossils (direct, negative impacts) preserved at or beneath the ground surface within the development footprint , mainly due to surface clearance and excavation activities.	Cumulative	Negative	Moderate	3	1	5	5	3	**42**	**N3**	2	1	5	5	2	**26**	**N2**
					Significance	**N3 - Moderate**							**N2 - Low**						