PROPOSED EXPANSION OF THE AUTHORIZED ESIZAYO WIND ENERGY FACILITY NEAR LAINGSBURG, CENTRAL KAROO DISTRICT MUNICIPALITY, WESTERN CAPE: PALAEONTOLOGICAL HERITAGE BASIC ASSESSMENT

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EXECUTIVE SUMMARY

BTE Renewables (previously known as Biotherm) is proposing an Expansion of the authorized Esizayo Wind Energy Facility (WEF) near Laingsburg, Central Karoo District Municipality, Western Cape Province, on the following three land parcels: Portion 1 of Leeuwenfontein 71, Remainder of Farm Leeuwenfontein 71 and Portion 2 of Aanstoot 72. The WEF expansion will comprise up to 23 wind turbines generating a total of up to 200 MW and associated infrastructure.

The WEF Expansion project area is underlain by Middle Permian sedimentary bedrocks within the lower part of the Abrahamskraal Formation (Lower Beaufort Group, Karoo Supergroup). Elsewhere this succession has yielded sparse but scientifically-important fossils of the *Eodicynodon* Assemblage Zone. They include lungfish burrows, low diversity invertebrate trace fossils, tetrapod (terrestrial vertebrate) burrows and trackways *plus* exceedingly rare and fragmentary tetrapod skeletal remains (*viz.* fragments of temnospondyl amphibians and therapsids). Well-preserved tetrapod fossils are very sparsely distributed here while well-preserved petrified wood is unknown. The Beaufort Group sedimentary bedrocks are extensively covered by Late Caenozoic superficial sediments (*e.g.* scree, surface gravels, alluvium, skeletal soils, calcretes) that are usually unfossiliferous. Satellite imagery shows that good exposures of potentially fossiliferous bedrocks are not generally found along ridge crests where most key WEF infrastructure (*e.g.* turbines, internal road network) will be sited. The overall palaeontological sensitivity of the project area is rated as low, although the potential for rare fossil sites of high palaeontological interest cannot be entirely discounted.

All of the fossils recorded so far within the Esizayo WEF Expansion project area are of widely-occurring taxa (sphenophyte ferns, lungfish burrows, low diversity invertebrate trace fossils) that are not considered to be of significant scientific or conservation value. None of the fossil sites recorded during the recent 4-day palaeontological site visit lies within the wind turbine footprints 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.

The impact significance of the construction phase of the proposed Esizayo WEF Expansion 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 of low palaeosensitivity overlying most potentially-fossiliferous bedrocks here. This assessment applies equally to all WEF infrastructure layouts under consideration. Significant further impacts during the operational and de-commissioning phases of the WEF are not anticipated. There are therefore no preferences on palaeontological

heritage grounds for any particular layout option. 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 adjoining authorized 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, 2021b). These anticipated levels of change fall within *acceptable* limits.

There are no fatal flaws in the Esizayo WEF Expansion development proposal 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 WEF Expansion. 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 Expansion 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 and deeper (> 1 m) excavations (*e.g.* for new internal roads, pylon footings, wind turbine foundations) 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 resources agency as soon as possible - *i.e.* 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). 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 Expansion project. 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 Heritage Western Cape for the W. Cape);

- The palaeontologist concerned with potential mitigation work will need to submit a Work Plan for approval by Heritage Western Cape (W. 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 palaeontological heritage report (PIA) is to provide an authoritative, reasoned assessment of potential impacts on palaeontological heritage resources posed by the proposed Expansion by BTE Renewables (previously known as Biotherm) of the authorized Esizayo Wind Energy Facility (WEF) near Laingsburg, Central Karoo District Municipality, Western Cape Province on the following three land parcels: Portion 1 of Leeuwenfontein 71, Remainder of Farm Leeuwenfontein 71 and Portion 2 of Aanstoot 72 (Fig. 1). The WEF expansion will comprise up to 23 wind turbines generating a total of up to 200 MW and associated infrastructure (Table 1).

The PIA assessment is based on (1) previous field-based palaeontological heritage assessments of the Esizayo WEF project area by Almond (2016f, 2021b), a recent 4-day site visit to the WEF expansion project area by the author *plus* an experienced field assistant (31 March – 3 April 2022), as well as (3) a desktop review of several releevant palaeontological field surveys within adjoining WEF project areas, most notably those by Almond (2015b), Almond (2015c), Almond (2016b), Almond (2016c) and Almond (2021b).

Recommendations for any necessary palaeontological mitigation or management measures during the construction phase of the WEF expansion are also made for inclusion in the EMPr.

1.2. Objectives of the report

The present PIA report assesses potential impacts on local palaeontological heritage resources due to the construction of the proposed Expansion for the authorised Esizayo WEF. The Esizayo WEF Expansion project area is located in a region of the Great Karoo (Klein-Roggeveld) that is underlain by potentially fossiliferous sedimentary rocks of Late Palaeozoic and younger, Neogene / Late Tertiary or Quaternary, age (See Section 3 of this report). The construction phase of the proposed WEF Expansion will entail extensive surface clearance as well as excavations into the superficial sediment cover and underlying bedrock (*e.g.* wind turbine foundations, new internal roads, underground cables, powerline pylon footings). 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 which 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 have been submitted by Almond (2016f, 2016g, 2021b) as part of the EIA and BA Phases for these developments which are being co-ordinated on behalf of Biotherm Energy (Pty) Ltd (now BTE Renewables) 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, Esizayo WEF and the expanded Eskom Komsberg Substation have also been submitted by the author (Almond 2015c, 2015b, 2016b, 2016c, 2016d, 2016f, 2016g, 2021b).

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 submit a Work Plan for approval by the relevant heritage management authority, *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). 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 map and sheet explanation (*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 Esizayo and Kareebosch WEF grid connections (Almond 2016f, 2016g, 2015c, 2015b, 2016b 2016c and 2021a, 2021b).
4. Additional palaeontological fieldwork focussing on areas of potential palaeontological sensitivity (as identified from satellite imagery) within the broader Esizayo WEF Expansion project area, carried out by the author and an experienced assistant (31 March – 3 April 2022). 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 Expansion are shown in relation to the wind turbine sites under consideration on the satellite image provided in Appendix 1, Figure A1. Please note that these maps do *not* show the entire final project footprint (*e.g.* internal road network) or 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 Expansion 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, 3). However, sufficient bedrock exposures were examined during the course of the recent 4-day site visit to the WEF Expansion project area, backed-up by several recent, field-based PIA studies in this subregion of the Klein-Roggeveld (see References), to assess the palaeontological heritage sensitivity of the main rock units represented within the study area. 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 BTE Renewables (known as BioTherm) is proposing to develop an Expansion of the authorized Esizayo Wind Energy Facility (DEA Ref: 14/12/16/3/3/2/967) near Laingsburg, Central Karoo District Municipality, Western Cape Province on the following three land parcels: Portion 1 of Leeuwenfontein 71, Remainder of Farm Leeuwenfontein 71 and Portion 2 of Aanstoot 72 (Fig. 1). The proposed WEF expansion will comprise up to 23 wind turbines generating a total of up to 200 MW and associated infrastructure. A summary of the main infrastructural components of the proposed WEF expansion is provided in Table 1 below (provided by WSP.

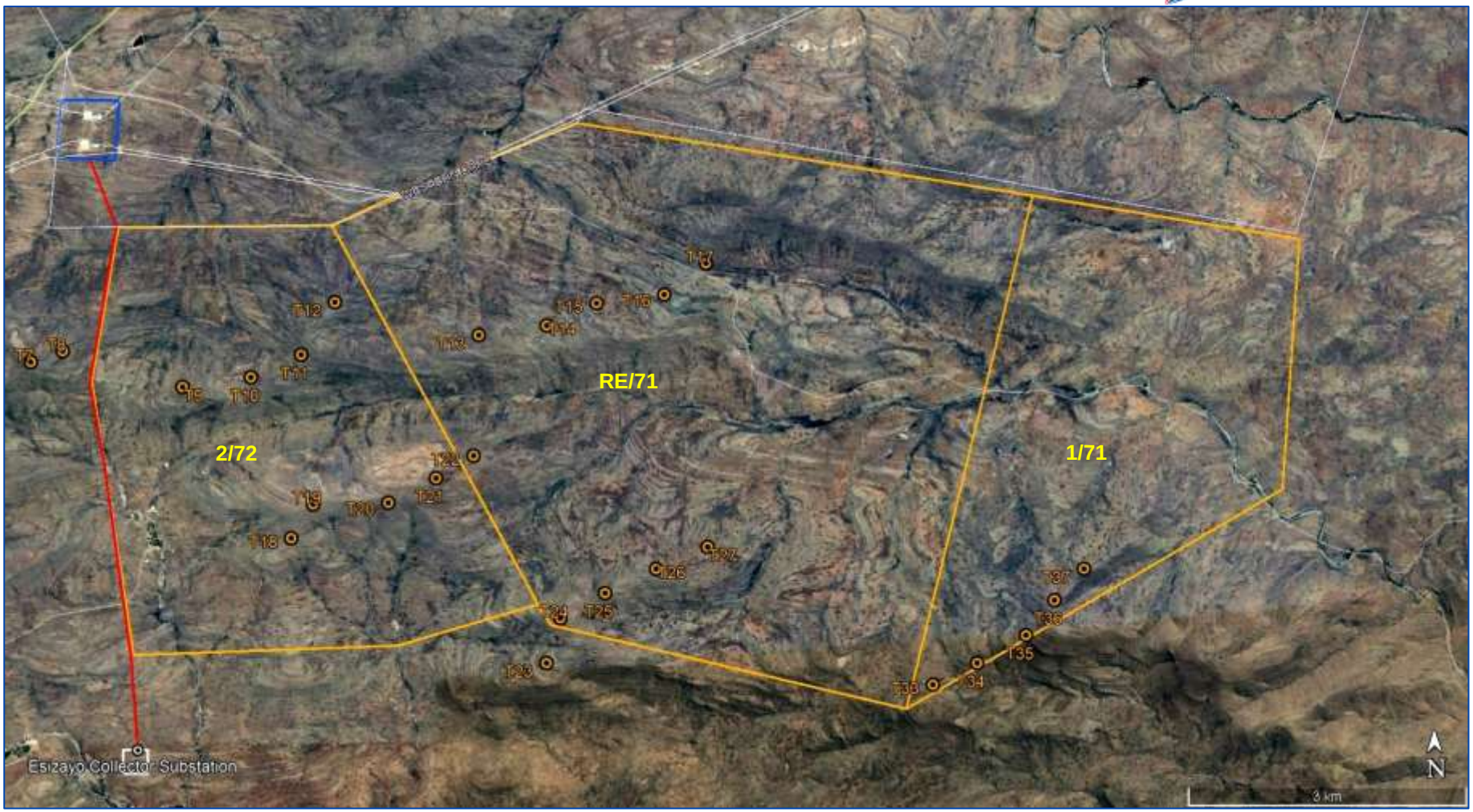

Figure 1: Google Earth© satellite image showing the project area for the proposed Esizayo WEF Expansion (orange polygon) near Laingsburg, Central Karoo District Municipality, Western Cape. The three land parcels involved include Portion 1 of Leeuwenfontein 71, Remainder of Farm Leeuwenfontein 71 and Portion 2 of Aanstoot 72. Also shown are the provisional locations of up to 23 wind turbines (orange numbered circles). Other components of the WEF Expansion footprint (*e.g.* internal road network) have not yet been determined.

Table1: Project description and main infrastructural components of the proposed expansion to the authorized Esizayo WEF near Laingsburg, Western Cape

COMPONENT	DESCRIPTION / DIMENSIONS
Location of the site	Approximately 30km northeast of Laingsburg
Total area of the site	5, 850 ha
Size of buildable area i.e. project infrastructure footprint (only referred layout, inclusive of all associated infrastructure)	Up to 200ha (including turbines, roads and powerlines)
Area occupied by each turbine	Each turbine with a foundation of up to 25m in diameter and up to 4m in depth, compacted hard standing areas of up to 4.5 ha each
Farm Names	Portion 2 of Farm Aanstoot Farm 72 (C04300000000007200002) Portion 1 of Farm Leeuwenfontein 71 (C04300000000007100001) Remainder of Farm Leeuwenfontein 71 (C04300000000007100000)
Export capacity	Up to 200MW
Proposed technology	Wind turbines
Number of Turbines	Up to 23 wind turbines
Turbine Generating Capacity	Up to 10 MW
Hub height from ground level	Up to 150m
Rotor diameter	Up to 200m
Width of internal roads	Up to 9m, (turns will have radius of up to 55m)
Length of internal roads	30km
Power lines	33kV underground cables or overhead powerlines linking groups of wind turbines to onsite 33&132kV substation(s).

3. DESCRIPTION OF THE AFFECTED ENVIRONMENT

The Esizayo WEF Expansion 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*. 1250 m above mean sea level (amsl) in the north of the WEF study area (eastern extension of the Skaapberg ridge on Aanstoot 72). The area is drained by the SE-flowing Roggeveldrivier (itself a tributary of the Buffelsrivier) and its various small tributaries. 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). Small trees and taller shrubs are klargely confined to drainage lines while on satellite images a scattering of dark bush clumps or *heuweltjies* is visible. However, small exposures of Beaufort Group mudrocks (the principal target for palaeontological recording) are visible on satellite imagery along incised stream beds and banks as well as erosion gullies and some steeper hillslopes but rarely along upland ridges where turbines will be situated. Good sections through superficial deposits are found in the steep banks of several water courses, especially on valley floors. Representative views of the topography and scenery within the broader Esizayo WEF Expansion project area relevant to the present study are given in Figures 2 to 10 below.

Figure 2: View southwards across RE/71 near Leeufontein homestead towards an E-W trending ridge on the skyline where several wind turbines will be located, with a small hillslope exposure of grey-green Abrahamskraal Formation mudrocks in the foreground.

Figure 3: View along the gullied northern slopes of the southern turbine ridge on RE/71 showing general lack of bedrock exposure away from the stream gullies, rubbly surface gravels in the foreground and khaki-hued, weathered mudrocks and wackes in the middle ground.

Figure 4: View westwards in the NW sector of Farm 2/72 showing several long, bedding parallel hillslope exposures of grey-green Abrahamskraal Formation mudrocks as well as gently N-dipping beds on the northern limb of the Skaapberg anticline.

Figure 5: Several good hillslope exposures of Abrahamskraal Formation bedrocks are found on the Skaapberg ridge in the NW corner of RE/71 and adjacent portion of Farm 2/72 where the succession dips to the north.

Figure 6: Good stream bed exposure of grey-green Abrahamskraal Formation mudrocks containing boulder-sized diagenetic concretions of rusty-brown ferruginous carbonate, SE sector of RE/71.

Figure 7: Unusually extensive, gullied hillslope exposures of grey-green Abrahamskraal Formation mudrocks in hilly terrain *c*. 1 km NW of Leeufontein homestead, Farm RE/71.

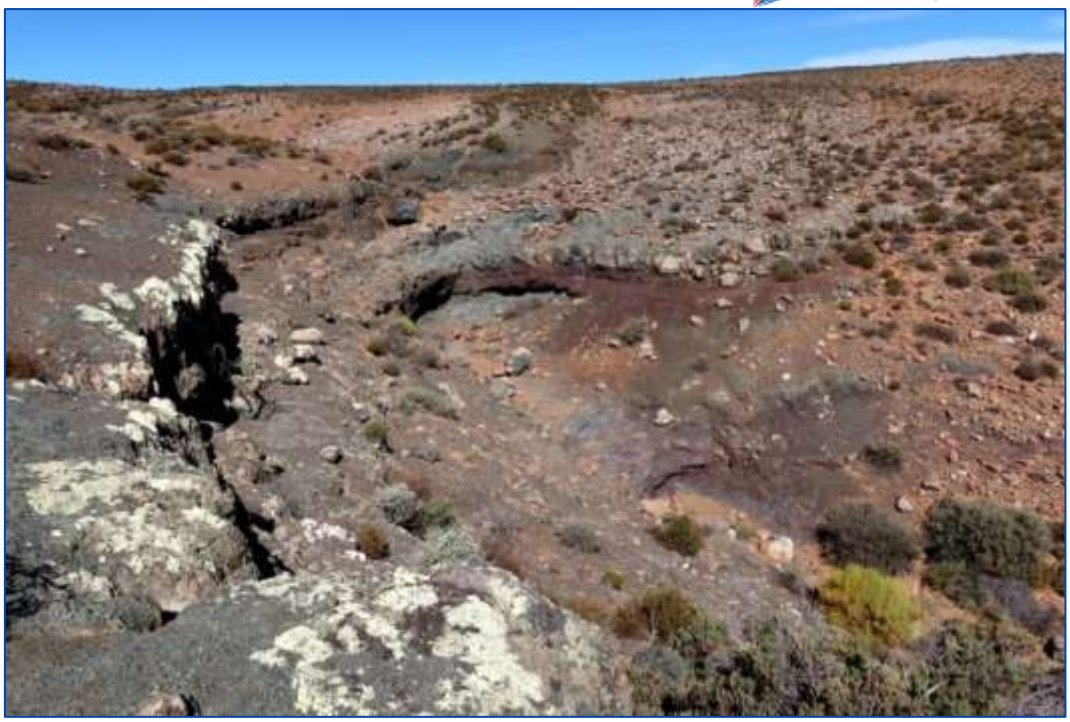

Figure 8: Gullied northern slopes of the southern turbine ridge on Farm 2/72 showing grey-green and purple-brown Abrahamskraal Formation mudrocks and sandstones that are partially mantled by coarse colluvial gravels of concretionary ferruginous carbonate and wacke.

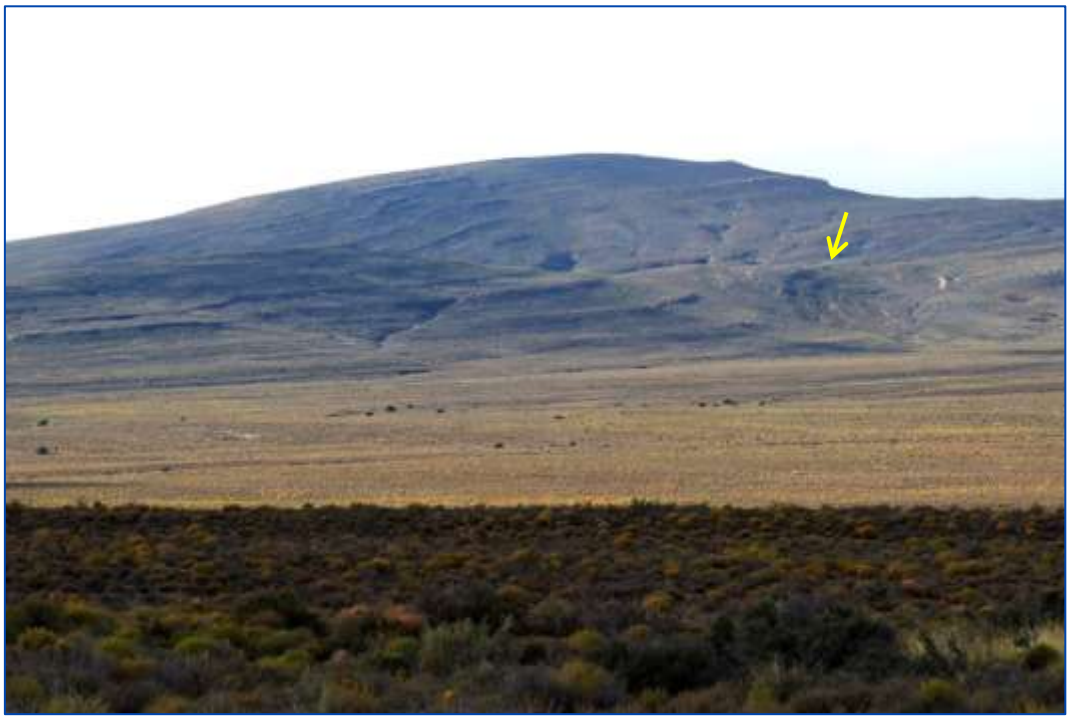

Figure 9: Prominent-weathering package of closely-spaced, lower Abrahamskraal Formation channel sandstones (*possibly* equivalent to the Grootfontein Member) in the SW sector of Farm 1/71, here viewed from the NW. The beds dip gently northwards with local development of small-scale folds (arrow).

Figure 10: South-facing hillslopes on Farm 1/71 with grey-green mudrock exposure in a steep gulley capped by a cliff or *kranz* of resistant-weathering channel wackes dissected by very well-developed E-W trending vertical joints.

3.1. Geological context

The geology of the Esizayo WEF Expansion project area is outlined on the 1: 250 000 geology sheet 3220 Sutherland (Council for Geoscience, Pretoria; Theron 1983, Cole & Vorster 1999) (Figure 11) and illustrated in Figures 12 to 37 below (No further geological data is provided on the more recent 1: 250 000 metallogenic map). Geologically it lies on the gently-folded northern margin of the Permo-Triassic Cape Fold Belt (CFB) and is dominated by bedrocks of the Lower Beaufort Group (Karoo Supergroup) within the Main Karoo Basin (Johnson *et al.* 2006). Gentle folding along west-east trending fold axes of 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). However, some tighter, N-verging folds are evident in places (Fig. 9). While levels of tectonic deformation are usually low with little cleavage development, pockets of cleaved mudrocks are seen locally (including pencil-cleavage is dark, fine-grained facies) as well as narrow zones of quartz veining while many channel wackes show well-developed W-E orientated sets of steep joints (Figs. 19 & 10). 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 might be associated locally with narrow dolerite dykes (unconfirmed).

Illustrated descriptions of the Lower Beaufort Group 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, 2021b). The Klein-Roggeveld region 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 WEF Expansion project area are illustrated in Figures 12 to 37 in this report, together with short explanatory figure legends.

Only one mappable bedrock unit or formation is represented within the study area, namely 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). However, exposure levels of these sedimentary bedrocks are generally very low and mainly confined to occasional stream and erosion gullies (*e.g.* Figs 2 to 9, 12 to 27). Satellite imagery shows that good exposures of potentially fossiliferous bedrocks are generally not found along most ridge crests where most key WEF infrastructure (*e.g.* turbines, internal road network) will be sited. Only the lower portion of the Abrahamskraal Formation succession, close to the lower contact with the Waterford Formation and extending at most a few 100 m above the incoming of reddish mudrocks, is represented within the grid corridor project area. This succession largely corresponds to the **Combrinkskraal Member** *sensu lato* as originally defined but may include the **Combrinkskraal** and **Grootfontein Members**, and perhaps even higher beds, as more recently defined by Day & Rubidge (2014).

A delta platform or distal, well-watered floodplain setting with frequent high water tables is suggested for the lower Abrahamskraal Formation beds by very common upward-coarsening sedimentary packages, gradational and sometimes 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 rarely reddish), laminated to massive mudrocks, frequent well-developed horizons of large, rusty-brown weathering concretions and lenses of diagenetic ferruginous carbonate, fine-scale wave-rippled bedding planes, sandstone-infilled desiccation cracks as well as fossil assemblages dominated by equisetalean ferns and lungfish burrows, with almost no skeletal remain of land-living tetrapods recorded so far (Section 4). Many of the voluminous ferruginous carbonate bodies were probably formed at the palaeo-watertable as groundwater carbonates rather than being of pedogenic or paludal origin. Thus they can be influenced by tectonism as well as climate and so they are not always a good indicator of semi-arid conditions (Prof. R. Smith, pers. comm., 2022). Drier climatic intervals are indicated by occasional well-developed palaeosol horizons of small, grey pedogenic calcrete nodules, sometimes septarian, and the incoming of substantial red beds higher in the succession. Horizons with abundant stellate or clumped gypsum pseudomorphs (“desert roses”) witness intermittent arid climatic episodes with evaporation of water bodies. Near surface mudrocks are often chemically weathered to crumbly, khaki-hued saprolite up to depths of several meters. Heterolithic packages showing interbedding of tabular, thin- to medium-bedded mudrocks and wackes may represent channel margin facies (*e.g.* levees) and are often trace fossil rich. Most channel bodies comprise massive, medium to thick-bedded, well-sorted, fine-grained grey-green wacke with sharp but non-gullied bases. Occasional channel sandstone bodies feature yellowish-weathering, medium-grained, friable, yellowish-hued wackes with tabular cross-sets and sharp erosive bases. Associated basal breccio-conglomerates contain thin sandstone lenses and are dominated by mudrock intraclasts with little or no reworked calcrete clasts or bone / tooth material (Major calcrete-rich breccias are known from the Esizayo WEF project area, however).

Narrow dykes referred to the **Karoo Dolerite Suite** of Early Jurassic age are intruded into the Lower Beaufort Group beds along WNW-ESE trending fracture zones in the Esizayo WEF project area but are not mapped within the Esizayo WEF Expansion project area (A long NW-SE trending dyke does occur only *c*. 250 m to the NE of the latter area, however, as seen on satellite imagery and the 1: 250 000 geological map). Given the narrowness of their thermal aureoles, the dolerites are not of any great palaeontological heritage significance.

Away from the numerous shallow to deeply-incised stream and erosion 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. 28 to 27). 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 Expansion project area. The majority of powerline pylon foundations and internal roads are likely to be excavated into such largely unfossiliferous superficial sediments rather than the underlying Lower Beaufort Group bedrocks.

Eluvial and colluvial gravels are heavily dominated by poorly-sorted, angular to subangular wackes with minor vein quartz in a sandy matrix. These rubbly deposits may reach thicknesses of several meters where they merge with coarse, poorly-sorted alluvium with better rounded clasts along footslopes and valley bottoms. Older alluvial gravels are often well-consolidated and partially cemented by calcrete; some horizon are well-bioturbated (Section 4). Distinctive orange-hued diamictites composed of poorly-sorted, dispersed wacke clasts up to boulder-sized within a consolidated matrix of ferruginised gritty sand may be debris flow deposits, perhaps of Pleistocene age. Bouldery “High Level Gravels” with subrounded wacke clasts perched several meters above the level of present stream beds occur along some drainage lines. Younger alluvium exposed in stream banks is mainly sandy with gravel lenses and stone lines but well-developed, unconsolidated gravel bars are seen along stream beds, as well as more heavily calcretised sediments associated with reedy springs.

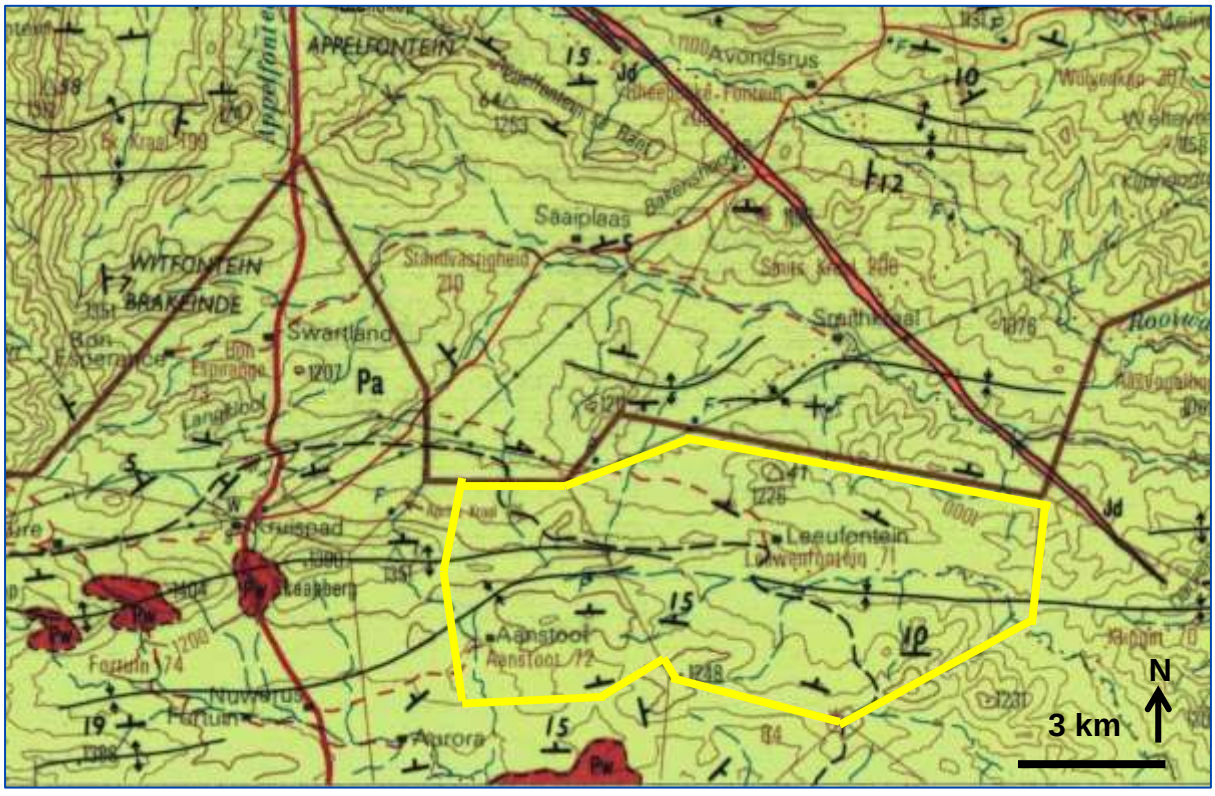

Figure 11: Extract from 1: 250 000 scale geology sheet 3220 Sutherland (Council for Geoscience, Pretoria) showing the location of the Esizayo WEF Expansion project area, *c*. 30 km northwest of Laingsburg, Western Cape Province (yellow polygon). The main mappable rock units represented within the broader region 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 12: Successive tabular, erosive-based channel wackes (the lower one showing large scale cross-sets) of the Abrahamskraal Formation on Farm 1/71.

Figure 13: Thick, tabular-bedded, well-jointed channel wacke exposed in a stream bank on RE/71. The medium-grained wackes are extensively patinated by epilithic lichens which contribute to their surface weathering.

Figure 14: Two cross-cutting, yellowish-weathering channel wackes of the Abrahamskraal Formation exposed in a river bank near the eastern edge of Farm 1/71. A curious heterolithic slump lobe, possibly associated with the incision surface, is seen on the left (arrowed).

Figure 15: Gullied, erosive base of the lenticular channel body seen in the previous illustration (RHS) showing well-developed lenses of mudflake intraclast basal breccias (hammer = 30 cm). No reworked calcrete nodules or fossil bone / tooth material was observed within the breccias here.

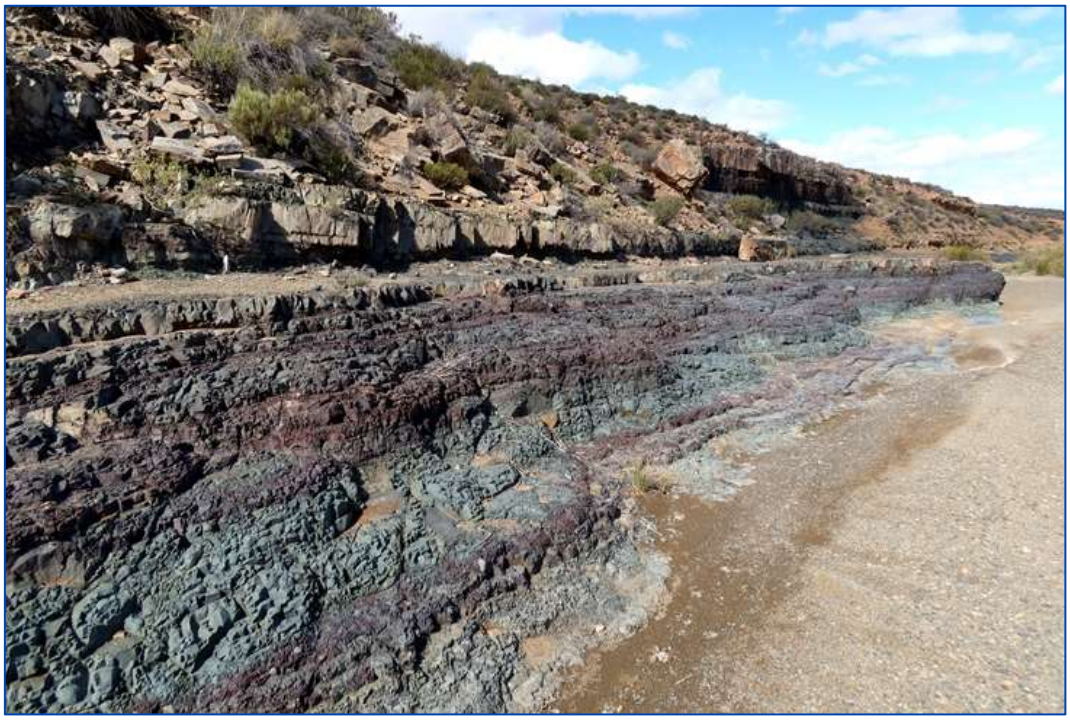

Figure 16: Good riverine exposures of interbedded purple-brown and grey-green Abrahamskraal Formation overbank mudrocks as well as tabular wackes in the eastern sector of Farm 1/71.

Figure 17: Upward-coarsening package of Abrahamskraal mudrocks and wackes seen in the riverine exposure illustrated above. Note the pale, lenticular bodies of pale wacke enclosed in mudrock near the hammer (30 cm long) – possibly foundered or boudinaged pillows.

Figure 18: Upward-coarsening package grading from massive, hackly-weathering, grey-green mudrock at the base into brownish, fine-grained wacke, gulley exposure on Farm 2/72 (hammer = 30 cm).

Figure 19: Grey Abrahamskraal Formation mudrocks showing pervasive steep, splintery tectonic cleavage, gulley exposure on Farm RE/71 (hammer = 30 cm).

Figure 20: Upward-thickening succession of tabular-bedded mudrocks and wackes of the Abrahamskraal Formation, gulley exposure on 2/72.

Figure 21: Heterolithic package of interbedded wackes and mudrocks on RE/71, perhaps deposited in a channel levee setting (hammer = 30 cm). These beds are associated with *Scoyenia* Ichnofacies invertebrate trace fossils and reedy plant stem casts indicative of damp substrates.

Figure 22: Gulley exposure on Farm 2/72 showing an upward-shoaling package from massive to laminated grey mudrocks at the base through thin-bedded siltstones, thin-bedded wackes culminating in medium-bedded tabular wackes at the top.

Figure 23: Successive thin, upward-coarsening packages within the lower Abrahamskraal Formation with a horizon of brownish-weathering carbonate concretions towards the base of the upper cycle, gulley exposure on Farm 2/72 (hammer = 30 cm).

Figure 24: Extensive hillslope exposures of Abrahamskraal Formation mudrocks with well-developed horizons of rusty-brown ferruginous carbonate concretions (patinated with white lichens), NE edge of Farm 2/72.

Figure 25: Thick package of grey-green and purple-brown mudrocks, one of several comparable gulley exposures in the NW sector of Farm RE/71 (See Figure 5).

Figure 26: Detail of exposure shown in the previous illustration showing convex-down lobes of small, rounded load casts of grey-green siltstone or fine wacke suggesting slumping.

Figure 27: Closely spaced, very small-scale wave ripples on a fine-grained wacke bedding plane generated by wind and wave action within a shallow pond, stream gulley on Farm RE/71 (scale = 15 cm).

Figure 28: Dense lobe of coarse, colluvial gravels composed of angular to subrounded wacke clasts – possibly downwasted from a relict periglacial debris flow or boulder stream, Farm RE/71.

Figure 29: Relict outsized boulders or blocks of wacke scattered on gentle hillslopes on Farm RE/71.

Figure 30: A thin surface scatter of downwasted coarse wacke clasts overlying orange-brown sandy soils, seen here on RE/71, typifies gentle lower hillslopes and wide valley floors within large parts of the project area.

Figure 31: Thick prism of well-bedded,gravelly to sandy alluvial deposits exposed along a river bank on Farm 1/71.

Figure 32: Detail of the Late Caenozoic superficial sediments seen in the previous figure, here showing the semi-consolidated, rubbly basal gravels capped by massive, finely gravelly to sandy beds of inundite (flood) or debrite origin (hammer = 30 cm).

Figure 33: Intensely orange-brown hued, well-cemented diamictite bed of poorly-sorted, angular gravel clasts within a gritty sand matrix exposed in a stream bank on RE/71 (hammer = 30 cm). These possible debrites often directly overlie weathered bedrock and may be of Pleistocene age.

Figure 34: Thick, well-bedded older gravelly and younger sandy alluvium exposed along a deeply-incised stream gulley on a valley floor on Farm 2/72 (hammer = 30 cm). The basal gravels are partially consolidated by calcrete.

Figure 35: Thick, partially imbricated, coarse alluvial gravels overlain by orange-brown soils typical of valley floors in the project area, seen here on Farm RE/71 (hammer = 30 cm).

Figure 36: Well-consolidated, well-bedded, pale brown, gravelly to sandy colluvial or sheetwash sediments on a hillslope exposed by gulley erosion, Farm 2/72 (hammer = 30 cm).

Figure 37: Excellent, long panel sections through thick gravely to sandy alluvial deposits exposed in a riverbank on Farm 1/71. Some of the horizons are calcretised and heavily bioturbated (See Figure 44).

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 very sparse fossil sites recorded during the recent palaeontological field study for the Esizayo WEF Expansion project are illustrated in Figures 38 to 44 below and also indicated on the satellite image of the project area in Figure A1.1 (Appendix 1) in relation to the provisional wind turbine layout (*N.B.* Information on other components of the WEF Expansion layout – such as the internal road network, are not currently available). Please note that this is *not* a distribution map 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 WEF. Areas on the map that do not contain known fossil sites are therefore not necessarily fossil-free or palaeontologically-insensitive.

Sparse fossil remains recorded from the lower portion of the Abrahamskraal Formation (Lower Beaufort Group / Adelaide Subgroup) in the previously assessed 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, Almond 2021b). 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 recent PIA reports might have belonged to woody plants, however. Mudrock horizons containing assemblages of vertical subcylindrical casts of lungfish burrows (*Dipnoichnus*) occur at intervals within the lowermost Abrahamskraal Formation beds. Puzzling larger, upward- or downward-tapering, sandstone-infilled structures in the same beds might be biogenic (*e.g.* tree trunk casts) or perhaps pipes or dykes related to sediment dewatering (Almond 2021b).

The fossil assemblages within the lowermost Abrahamskraal Formation beds represented within the Esizayo WEF Expansion project area, pre-dating as well as following the incoming of maroon red bed facies, are provisionally assigned to the Middle Permian *Eodicynodon* Assemblage Zone within which vertebrate skeletal remains are notoriously extremely rare (Rubidge 1995, Smith *et al.* 2012, Rubidge & Day 2020; see also short review in Almond 2021a). 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 (Almond 2021a). No fossil tetrapod skeletal fossils or trace fossils have been recorded from the lower Abrahamskraal Formation in the Esizayo WEF and grid project area (Possible amphibian remains are known from the underlying Waterford Formation here).

The occurrence of (rare) amphibian remains and trackways, common horizons of horsetail fern debris as well as lungfish burrow casts and invertebrate traces of the *Scoyenia* Ichnofacies supports the prevalence of lacustrine and swampy wetland settings on the early Abrahamskraal Formation delta

platform or distal floodplain. As argued above (Section 3), 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.

The commonest fossils and biosedimentary structures recorded within the Esizayo WEF Expansion project area (Figs. 38 to 44) are generally associated with wave rippled palaeosurfaces preserved round the margins of delta plain or floodplain ponds and lakes or water courses. They comprise various microbial mat textures, possible adhesion warts, narrow simple horizontal burrows (possible of undermat-mining insects), cylindrical arthropod scratch burrows of the *Scoyenia* Ichnofacies as well as arrays of vertical stem casts of reedy plants.

The only fossils recorded from the pervasive Late Caenozoic superficial sediments mantling the Karoo Supergroup (Abrahamskraal Formations) bedrocks in the Esizayo WEF Expansion study area consist of spongy, highly porous horizons or bodies of indurated sandy sediment within calcretised, well-consolidated older alluvial deposits (Figs. 37 & 44). These bioturbated horizons may be attributable in part to calcretised plant roots but it is likely that most of the bioturbation structures were generated by burrowing insects such as termites.

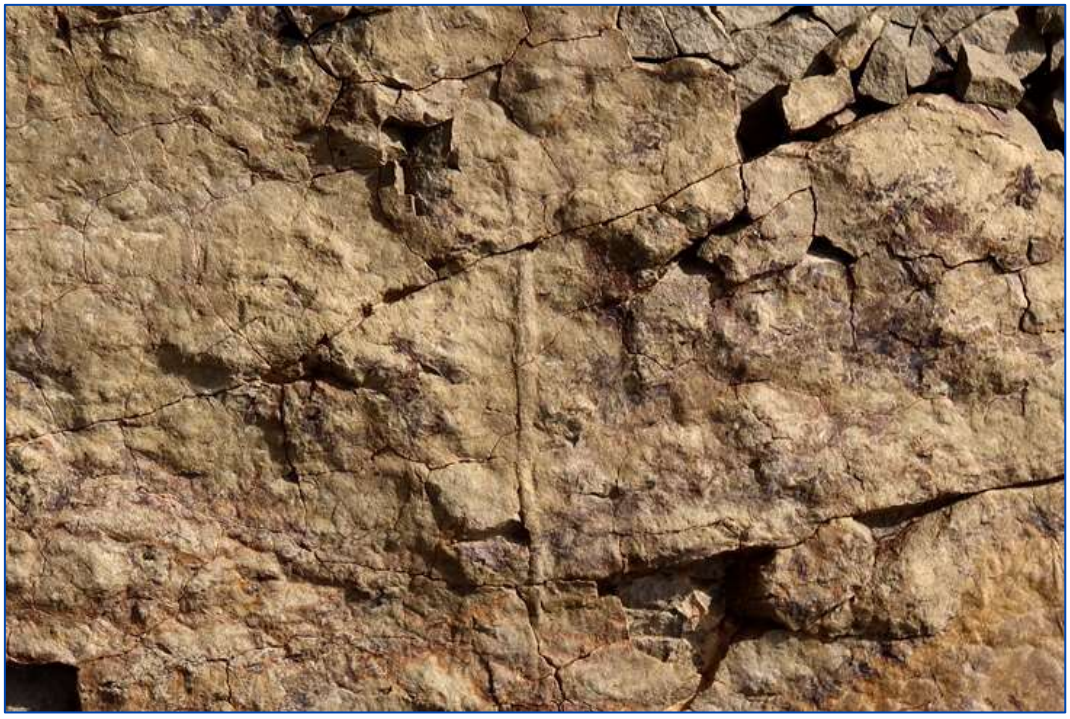

Figure 38: Narrow (*c*. 3 mm) horizontal invertebrate burrow associated with a pustulose and wave rippled palaeosurface on Farm 2/72 (Loc. 431).

Figure 39: Poorly-preserved, water-worn bedding plane assemblages of *Scoyenia* Ichnofacies invertebrate traces which were probably generated in damp substrates by arthropods such as insects (scale in cm and mm), Farm RE/71 (Loc. 494).

Figure 40: Arthropod scratch burrows and cylindrical casts of reedy plant stems (scale in cm and mm) exposed on wacke float blocks near Leeufontein homestead, Farm RE/71 (Loc. 462).

Figure 41: Upward-coarsening, grey-green siltstone to wacke package on Farm 2/72 containing vertical subcylindrical lungfish burrow casts *Dipnoichnus* (see arrow) (hammer = 30 cm) (Loc. 437).

Figure 42: Several prominent-weathering lungfish burrow casts seen almost in plan view, same locality as the previous figure (scale = 15 cm).

Figure 43: Pale weathering, dark grey, sphaeroidal to irregular micritic calcrete concretions such as these seen on Farm 2/72 occur at a few horizons within the Lower Abrahamskraal Formation beds in the project area (scale in cm). They are a primary focus of fossil vertebrate surveys. However, no fossiliferous concretions were recorded during the recent site visit.

Figure 44: Horizons and lenses of calcretised alluvial sands with a distinctive spongy, highly porous fabric have probably been bioturbated by insects such as termites (hammer = 30 cm), riverbank exposure on Farm 1/71 (Loc. 507) See also Figure 37).

4.1. Palaeosensitivity mapping

According to the SAHRIS palaeosensitivity map as well as DFFE Screening Tool maps, areas underlain by Lower Beaufort Group bedrocks are provisionally assigned a High to Very High Palaeosensitivity. However, no vertebrate or vascular plant body fossil remains were recorded during the recent site visit to the Esizayo WEF Expansion project area. All of the fossils observed so far within the project area are of widely-occurring forms that are not considered to be of exceptional scientific or conservation value (see Proposed Field Rating IIIC Local Resource in Appendix 1). None of the known fossil sites lies within the provisional wind turbine footprint (see satellite map Appendix 1, Figure A1.1) and no No-Go or High Sensitivity areas have been identified here in terms of palaeontological heritage. Direct impacts on the known fossil sites are unlikely and no mitigation is recommended in regard to them.

It is concluded that the overall palaeontological sensitivity of the Esizayo WEF Expansion project area is in practice LOW. The provisional High to Very High Palaeosensitivity mapped on the SAHRIS palaeosensitivity map and DFFE Screening Tool for this part of the Klein-Roggeveld is therefore *contested* here. However, the potential for hitherto unrecorded, very rare sites of High Palaeosensitivity (*e.g.* tetrapod skeletal remains and trackways) cannot be completely excluded.

5. ASSESSMENT OF IMPACTS

Given the very uniform underlying geology (and hence expected palaeontological resources) within the Esizayo WEF Expansion project area, this assessment is likely to apply equally to all the alternative layout options 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 WEF expansion will entail extensive surface clearance (notably for internal roads, pylon footings) as well as excavations into the superficial sediment cover and also into the underlying bedrock (*e.g. for* wind turbine foundations). The development may therefore 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 WEF are 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 sources of potential impacts on palaeontological heritage are the construction of new internal access roads and wind turbine foundations, especially in hilly terrain where deep cuttings may be required.

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, although this is known to occur elsewhere in the Sutherland region.

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 WEF Expansion during the construction phase, mainly due to surface clearance and excavation activities. It is noted that surface clearance for lengthy internal roads associated with turbine positions and new powerlines is likely to have the greatest impact on fossil heritage. 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. 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 WEF Expansion 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 Esizayo WEF Expansion project, including all the associated infrastructure. Given the lack of high-sensitivity fossil sites recorded within the Esizayo WEF Expansion project area, there is no preference on palaeontological grounds for any particular layout option under consideration.

Despite low levels of bedrock exposure, 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 previous site visits to the adjoining 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 WEF 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 is likely to 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 (*e.g.* 2016f, 2021b) 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 WEF Expansion project are highlighted by the black circle in Figure 45 (From Almond 2021b).

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, Almond 2021b). 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 lower Abrahamskraal Formation succession.

Cumulative impacts for the Esizayo WEF Expansion 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 development and other regional projects (including the authorized Esizayo WEF) 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 considered to lie within *acceptable* limits.

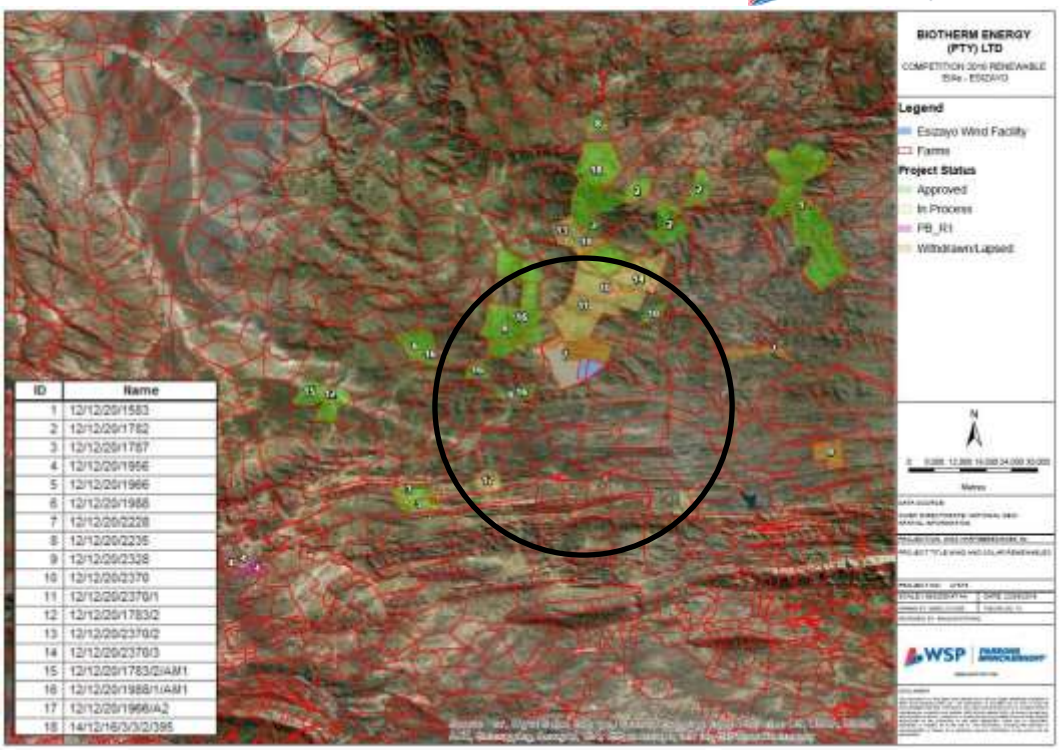

Figure 45: Satellite image showing the large number of proposed WEF facilities in the Klein-Roggeveldberge region between Matjiesfontein and Sutherland. The black circle outlines those projects that lie within a *c.* 30 km radius of the Esizayo WEF Expansion project (*cf* Table 1 below). PIA studies for most of these WEF projects have been conducted by the present author.

Table 2: WEF projects in the vicinity of the Esizayo WEF Expansion project area (DEEA database) ADD ESIZAYO WEF

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 Esizayo WEF Expansion 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 WEF EXpansion (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).

- 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 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 to submit a Work Plan for approval by Heritage Western Cape while 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 WEF 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 Esizayo WEF Expansion and also included as conditions for authorisation of the development.

Table 3: Recommended mitigation and management measures concerning palaeontological heritage for the Esizayo WEF Espansion.

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)	ECO / ESO	Construction	Yes	Define and secure fossil site with security tape. Report finds at earliest opportunity to HWC
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 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 .	Professional palaeontologist	Construction	Yes	Following Phase 2 palaeontological mitigation

7. CONCLUSIONS

In recent years the Middle Permian sedimentary bedrocks within the lower part of the Abrahamskraal Formation (Lower Beaufort group, Karoo Supergroup) in the Klein-Roggeveldberge region of the Great Karoo have yielded sparse but scientifically-important fossils of the *Eodicynodon* Assemblage Zone. They include lungfish burrows, low diversity invertebrate trace fossils as well as tetrapod (terrestrial vertebrate) burrows and trackways *plus* exceedingly rare and fragmentary tetrapod skeletal remains (*viz.* fragments of temnospondyl amphibians and therapsids). Well-preserved tetrapod fossils are very sparsely distributed here while well-preserved petrified wood is unknown. 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. Satellite imagery shows that good exposures of potentially fossiliferous bedrocks are generally not found along upland ridge crests where most key WEF infrastructure (*e.g.* turbines, internal road network) will be sited. The overall palaeontological sensitivity of the project area is rated as low, although the potential for rare fossil sites of high palaeontological interest cannot be entirely discounted.

All of the fossils recorded so far within the Esizayo WEF Expansion project area are of widely-occurring taxa (sphenophyte ferns, lungfish burrows, low diversity invertebrate trace fossils) that are not considered to be of significant scientific or conservation value. None of the fossil sites recorded during the recent 4-day palaeontological site visit lies within the wind turbine footprints 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 Esizayo WEF Expansion 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 of low palaeosensitivity overlying most potentially-fossiliferous bedrocks here. This assessment applies equally to all WEF infrastructure layouts under consideration. Significant further impacts during the operational and de-commissioning phases of the WEF are not anticipated. There are therefore no preferences on palaeontological heritage grounds for any particular layout option. 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 adjoining authorized 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, 2021b). These anticipated levels of change fall within *acceptable* limits.

There are no fatal flaws in the Esizayo WEF Expansion development proposal 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 WEF Expansion. 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 Expansion 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 and deeper (> 1 m) excavations (*e.g.* for new internal roads, pylon footings, wind turbine foundations) 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 resources agency as soon as possible - *i.e.* 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). 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 Expansion project.

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 EXPANSION FOSSIL SITE DATA: APRIL 2022

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 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.

Loc.	GPS data	Comments
431	-32.965624° 20.602436°	Farm 2/72. Lower Abrahamskraal Formation. Rippled sandstone palaeosurface with adhesion warts / microbial mat textures, small-scale horizontal invertebrate burrows (2-3 mm wide) exposed in dam overflow channel. Proposed Field Rating IIIC Local Resource. No mitigation necessary.
438	-32.957713° 20.599944°	Farm 2/72. Lower Abrahamskraal Formation. Laterally persistent horizon of laminated to thin-bedded grey siltstones (beneath thin-bedded siltstone passing up into tabular wacke) containing poorly-preserved subvertical, subcylindrical casts of lungfish burrows (*Dipnoichnus*). Proposed Field Rating IIIC Local Resource. No mitigation necessary.
462	-32.980198° 20.601540°	Farm 2/72. Lower Abrahamskraal Formation. Sandstone float block bedding planes with *Scoyenia* invertebrate traces (including arthropod scratch burrows), cylindrical vertical stem casts of reedy plant stems. Proposed Field Rating IIIC Local Resource. No mitigation necessary.
494	-32.971138° 20.672134°	Farm RE/71. Lower Abrahamskraal Formation. Thinly-bedded, N-dipping grey wackes exposed in stream bed with water-worn assemblages of *Scoyenia* Ichnofacies trace fossils. Proposed Field Rating IIIC Local Resource. No mitigation necessary.
507	-32.959785° 20.708234°	Farm 1/71. Late Caenozoic (probably Pleistocene) alluvium. Riverine cliff section through several meters of older calcretised sandy to gravelly alluvium with heavily bioturbated horizons (possible termite activity or other insects, possible root casts or rhizoliths). Proposed Field Rating IIIC Local Resource. No mitigation necessary.
511	-32.962633° 20.721927°	Farm 1/71. Lower Abrahamskraal Formation. Interbedded purple-brown and grey-green mudrocks with small scale wave rippled palaeosurfaces, probably subcylindrical stem casts of reedy plants stems. Proposed Field Rating IIIC Local Resource. No mitigation necessary.

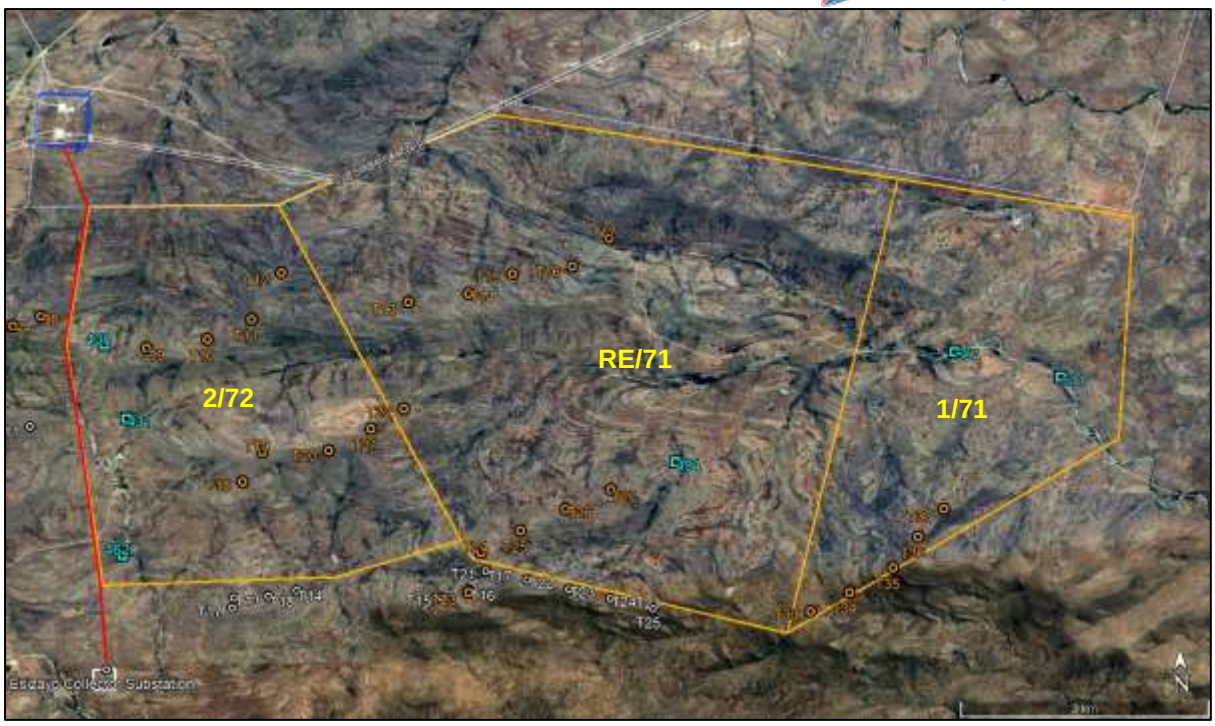

Figure A1.1: Google Earth© satellite image of the Esizayo WEF Expansion project area (orange polygon). Very sparse fossil sites recorded during the recent palaeontological site visit (numbered pale blue squares) are mapped here in relation to the provisional wind turbine layout. None of the known fossil sites lies within the development footprint as far as this is currently defined (*e.g.* no details of internal road network are yet available), Furthermore, none of the recorded fossil sites are of significant scientific or conservation value 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 substantial fossil 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 Expansion between Matjiesfontein and Sutherland</th></tr>
<tr><td>Province & region:</td><td colspan="2">Western Cape (Central Karoo District Municipality)</td></tr>
<tr><td>Responsible Heritage Resources Agency</td><td colspan="2">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).</td></tr>
<tr><td>Rock unit(s)</td><td colspan="2">Abrahamskraal Formation (Lower Beaufort Group, Karoo Supergroup), Late Caenozoic alluvium, colluvium, eluvium, calcretes.</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, invertebrate trace fossil assemblages 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 WEF EXPANSION PROJECT

Table A3.1: Assessment of anticipated impacts on palaeontological heritage resources for the proposed Esizayo WEF Expansion (construction phase). This assessment applies equally to all infrastructure layout 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 Expansion in the context of numerous other WEF developments in the region (construction phase). This assessment applies equally to all infrastructure layout 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**						