PALAEONTOLOGICAL HERITAGE: DESKTOP & FIELD-BASED BASIC ASSESSMENT

Proposed construction of electrical grid infrastructure to support the authorised Rietrug, Sutherland and Sutherland 2 Wind Energy Facilities, Northern and Western Cape Provinces

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July 2019

EXECUTIVE SUMMARY

South Africa Mainstream Renewable Power Developments (Pty) Ltd (Mainstream) are proposing to build additional electrical grid infrastructure in order to connect the authorised Rietrug, Sutherland and Sutherland 2 Wind Energy Facilities, situated on the Roggeveld Plateau to the southeast of Sutherland, to the national grid. The new infrastructure will comprise a *c*. 40 km – long 132 kV transmission line, a 4 km - long 400 kV transmission line, a Major Transmission Substation (MTS) located on Portion 6 of Hamelkraal 16 (footprint *c*. 25 ha); and a service road.

The electrical grid connection study area extends from the Roggeveld Plateau eastwards into the western Koup region at the foot of the Besemgoedberg Escarpment, *c.* 20 km to the west of Merweville. It is entirely underlain by continental sediments of the Abrahamskraal Formation (Lower Beaufort Group) of Middle Permian age. This fluvial and lacustrine succession is generally assigned a high palaeontological sensitivity due to its rich fossil biota, including pareiasaur reptiles, a wide range of therapsids, fish, amphibians, petrified wood and other remains of the *Glossopteris* Flora as well as trace fossils and microfossils. The Palaeozoic sedimentary bedrocks are extensively covered by Late Caenozoic superficial sediments (*e.g.* scree, gravelly soils) that are usually unfossiliferous.

Fossil material recorded from the Abrahamskraal Formation during a seven-day field-based survey of the broader study region between Sutherland and Merweville includes sparsely-scattered, and often highly-weathered, bones of unidentified robust-bodied tetrapods (probably pareiasaurs and / or dinocephalians) with only one well-articulated post-cranial skeleton. Trace fossils include several tetrapod burrow casts, lungfish burrows and low-diversity invertebrate trace assemblages. An extensive surface scatter of petrified wood blocks, some of which are well-preserved, was located in the western Koup. With the exception of the articulated skeleton and petrified wood scatters which lie well away from the electrical infrastructure footprint, most of these fossil occurrences are of limited palaeontological value. Fossil occurrences within or close to the footprint are of low conservation significance and do not warrant mitigation. The overall palaeontological sensitivity of the electrical grid infrastructure footprint is rated as low.

The impact significance of the construction phase of the proposed electrical grid infrastructure, including the MTS substation, 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 or close to the development footprint as well as (2) the extensive superficial sediment cover

overlying most potentially-fossiliferous bedrocks here. Significant further impacts during the operational and de-commissioning phases of the electrical grid infrastructure are not anticipated. 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 alternative energy or other developments currently proposed or authorised for the Roggeveld Plateau – western Koup region cannot be assessed realistically at this stage. This is mainly because field-based palaeontological assessments for the most relevant wind farm projects - *i.e.* the Sutherland, Sutherland 2, Rietrug and Suurplaat WEFs - have not yet been carried out. This region of the SW Karoo remains very poorly-known palaeontologically, while recent fieldwork for the present WEF electrical infrastructure projects shows that important fossil material, including articulated vertebrate skeletons, tetrapod burrows and well-preserved fossil wood, may occasionally be found here. It is therefore imperative that the pre-construction palaeontological studies for the various relevant Sutherland WEFs are followed through, as required by the South African Heritage Resources Agency (SAHRA) (Case ID 9622, Interim Comment of 5 July 2016).

There are no fatal flaws in the electrical 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 5 of this report) are followed through, there are no objections on palaeontological heritage grounds to authorisation of the proposed MTS substation, 132 kV and 400 kV powerlines and associated service road. Pending the potential discovery of substantial new fossil remains during the construction phase, no specialist palaeontological mitigation is recommended for this project.

The Environmental Control Officer (ECO) responsible for the WEF electrical 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, MTS substation, pylon footings) and deeper (> 1 m) excavations should be monitored for fossil remains on an on-going basis by the ECO. 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 should safeguard these, preferably *in situ*. They should then alert the relevant provincial heritage management authority as soon as possible - *i.e.* Heritage Western Cape for the Western Cape (Contact details: 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) 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, *plus* 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 electrical grid connection project and be included as conditions for its authorization. Please note that:

- All South African fossil heritage is protected by law (South African Heritage Resources Act, Act 25 of 1999) and fossils cannot be collected, damaged or disturbed without a permit from SAHRA (N. Cape) or other relevant Provincial Heritage Resources Agency (*e.g.* Heritage Western Cape for the Western Cape);

- The palaeontologist concerned with potential mitigation work will need a valid fossil collection permit from Heritage Western Cape (HWC) (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 (2016) and SAHRA (2013).

1. INTRODUCTION

1.1. Project Outline and Brief

South Africa Mainstream Renewable Power Developments (Pty) Ltd (Mainstream) are proposing to build additional electrical grid infrastructure in order to connect the authorised Rietrug, Sutherland and Sutherland 2 Wind Energy Facilities - referred to hereafter as the Sutherland WEFs - situated on the Roggeveld Plateau to the southeast of Sutherland, to the national grid. The WEFs and the proposed electrical grid infrastructure fall within the Komsberg Renewable Energy Development Zone (REDZ) and span the boundary between the Western and Northern Cape Provinces (Sutherland and Laingsburg Districts). The grid connection infrastructure will comprise the following main components (See satellite maps Fig. 1 to 3:

- A Major Transmission Substation (MTS) located on Portion 6 of Hamelkraal 16 (footprint *c*. 25 ha);
- A 132 kV overhead transmission line *c*. 41 km in length between the authorised WEF on-site substation on the farm Beeren Valley 150 and the new MTS;
- A 400 kV overheard transmission line *c*. 4 km in length connecting the MTS to an existing W-E Eskom line running to the south of the MTS; and
- Service roads (jeep tracks 4-6 m wide) below the lines, including a short deviation from the line route to avoid a steep slope.

The 132 kV line routing proposed as part of this application has been largely assessed previously as part of the proposed construction of the electrical grid infrastructure for the Sutherland, Sutherland 2 and Rietrug Wind Energy Facilities which were all authorised in 2018. The routing considered in the present report differs only slightly from that considered in previous assessments as Alternative Routing 2 (Almond 2017). The report also assesses a slightly revised location for the MTS as well as an additional short 400 kV connection between the MTS and existing transmission lines to the south to allow for greater flexibility.

The purpose of the present report is to provide a palaeontological heritage Basic Assessment of the proposed additional electrical grid infrastructure for the Sutherland WEF, Sutherland 2 WEF and Rietrug WEF. This report has been commissioned on behalf of the developer by the CSIR – Environmental Management Services, Stellenbosch (Contact details: Ms Surina Laurie, CSIR CSIR – Environmental Management Services. Address: 11 Jan Celliers Street, Stellenbosch. PO Box 320, Stellenbosch, 7599. Tel: 021 888 2561. Cell: 082 468 0962. Fax: 021 888 2693. E-mail: slaurie@csir.co.za). It will contribute to the consolidated Heritage Basic Assessment for the development that is being compiled by Dr Jason Orton (ASHA Consulting (Pty) Ltd. Tel: 021 788 1025. Cell: 083 272 3225. E-mail: jayson@asha-consulting.co.za).

It is noted here that both the original Mainstream Sutherland WEF (now split into the Sutherland, Sutherland 2 and Rietrug WEFs) and the nearby Suurplaat WEF have not yet been subjected to a full, field-based palaeontological heritage assessment. In all cases a pre-construction palaeontological field survey of the land parcels involved was recommended in the pre-scoping desktop assessment (Almond 2010b, 2010c). A pre-construction palaeontological walk-down of the final project footprint of the Sutherland, Sutherland 2 and Rietrug WEFs has now been required by the South African Heritage Resources Agency (SAHRA) (Case ID 9622, Interim Comment of 5 July 2016).

1.2. Legislative context for palaeontological assessment studies

The present combined desktop and field-based palaeontological heritage report contributes to the Heritage Basic Assessment for the proposed electrical grid infrastructure and falls under the South African Heritage Resources Act (Act No. 25 of 1999). It will also inform the Environmental Management Programme (EMPr) for this Project.

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

- geological sites of scientific or cultural importance;
- palaeontological sites; 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 SAHRA (2013).

1.3. Approach to the palaeontological heritage study

The approach to a Phase 1 palaeontological heritage study is briefly as follows. Fossil bearing rock units occurring within the broader study area are determined from geological maps and satellite images. Known fossil heritage in each rock unit is inventoried from scientific literature, previous assessments within 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 in the vicinity of the development footprint as well as further afield, the impact significance of the proposed development is assessed with recommendations for any further studies or mitigation to be incorporated into the EMPr.

1.4. Assumptions & limitations

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 ("mapable") 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 present electrical grid infrastructure study area between Sutherland and Merweville in the Western and Northern Cape, preservation of potentially fossiliferous bedrocks is favoured by the semi-arid climate and sparse vegetation but bedrock exposure is limited by extensive superficial deposits, especially in areas of low relief, as well as pervasive Karoo *bossieveld* vegetation (*e.g.* Roggeveld Shale Renosterveld on the Roggeveld Plateau). However, sufficient bedrock exposures were examined during the course of this study (See Appendix 1) to assess the palaeontological heritage sensitivity of the majority of the study area. Comparatively few academic palaeontological studies or field-based fossil heritage impact studies have been carried out in the region, so any new data from impact studies here are of scientific interest.

Project areas for both the Moyeng Energy (Pty) Ltd Suurplaat WEF as well as the original Mainstream Sutherland WEF have not yet been subjected to a full, field-based palaeontological heritage assessment. In all cases a pre-construction palaeontological field survey of the land parcels involved was recommended in the pre-scoping desktop assessment (Almond 2010b, 2010c). It was therefore not possible to take into consideration palaeontological field data for these large and highly relevant areas for the associated electrical grid infrastructure palaeontological assessment. A pre-construction walk-down of the final WEF development footprints has now been required by SAHRA (Case No. 9622, Interim Comment of 5 July 2016).

1.5. Information sources

The present combined desktop and field-based palaeontological study was largely based on the following sources of information:

1. A detailed project outline supplied by the CSIR– Environmental Management Services as well as a draft HIA compiled by Dr Jason Orton of ASHA.

2. Relevant geological maps and sheet explanations (*e.g.* Theron 1983, 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 Karoo region between Sutherland and Merweville, including a golf course at Sutherland (Almond 2005), the Eskom Gamma – Omega 765 kV transmission line running across the Moordenaars Karoo and Koup region (Almond 2010a) and several alternative energy facilities (Almond 2010b, 2010c, 2011, 2014, 2015a – 2015i, 2016a, 2016b, 2017). These last reports notably include field-based assessments for the separate Gunsfontein WEF (Almond 2015g), pre-scoping desktop assessments for the Mainstream Sutherland WEF (Almond 2010c) and Suurplaat WEF (Almond 2010b) as well as a field-based assessment of the grid connection for the Rietrug WEF (Almond 2017).

4. An initial six-day palaeontological field assessment of the broader Sutherland WEF electrical grid infrastructure study area, including the access road to the north from Sutherland (29 Nov – 2 December 2016 and 1-2 February 2017) by the author and an experienced assistant. This was followed by a one-day field assessment of the revised MTS site and adjoining 132 and 400 kV transmission line routes on Hamelkraal 16 by the same team on 29 June 2019.

5. The author's previous field experience with the formations concerned and their palaeontological heritage (*cf* Almond & Pether 2008 and references listed above).

GPS data for all numbered palaeontological localities mentioned in the text are provided in Appendix 1.

Figure 1 (following page). Google earth© satellite image of the original Rietrug WEF Electrical Grid Infrastructure study area previously assessed by Almond (2017) showing powerline routes Alternative 1 (yellow) and Alternative 2 (red) which were then under consideration. Coloured polygons demarcate relevant land parcels. The present report assesses a 132 kV transmission line route that corresponds closely, but *not* exactly, to Alternative 2, originating at the authorised WEF on-site substation on the farm Beeren Valley 150 (See geological map Figure 19). The proposed new MTS site is located close to but outside the Nuwerust Substation study area previously assessed in 2017. Numbered flags represent recorded fossil sites (See Appendix 1 for GPS data and short descriptions). Note that no palaeontologically significant (high sensitivity) fossil sites were recorded within the 2017 substation site study areas. The majority of the fossil sites recorded during the field assessments are of low palaeontological heritage significance and do not require mitigation and / or lie outside the project footprint. Please refer to the following Figures 2 and 3 for more detailed mapping of fossil sites in the eastern sector of the revised electrical infrastructure project, below the main escarpment, including new sites identified in 2019.

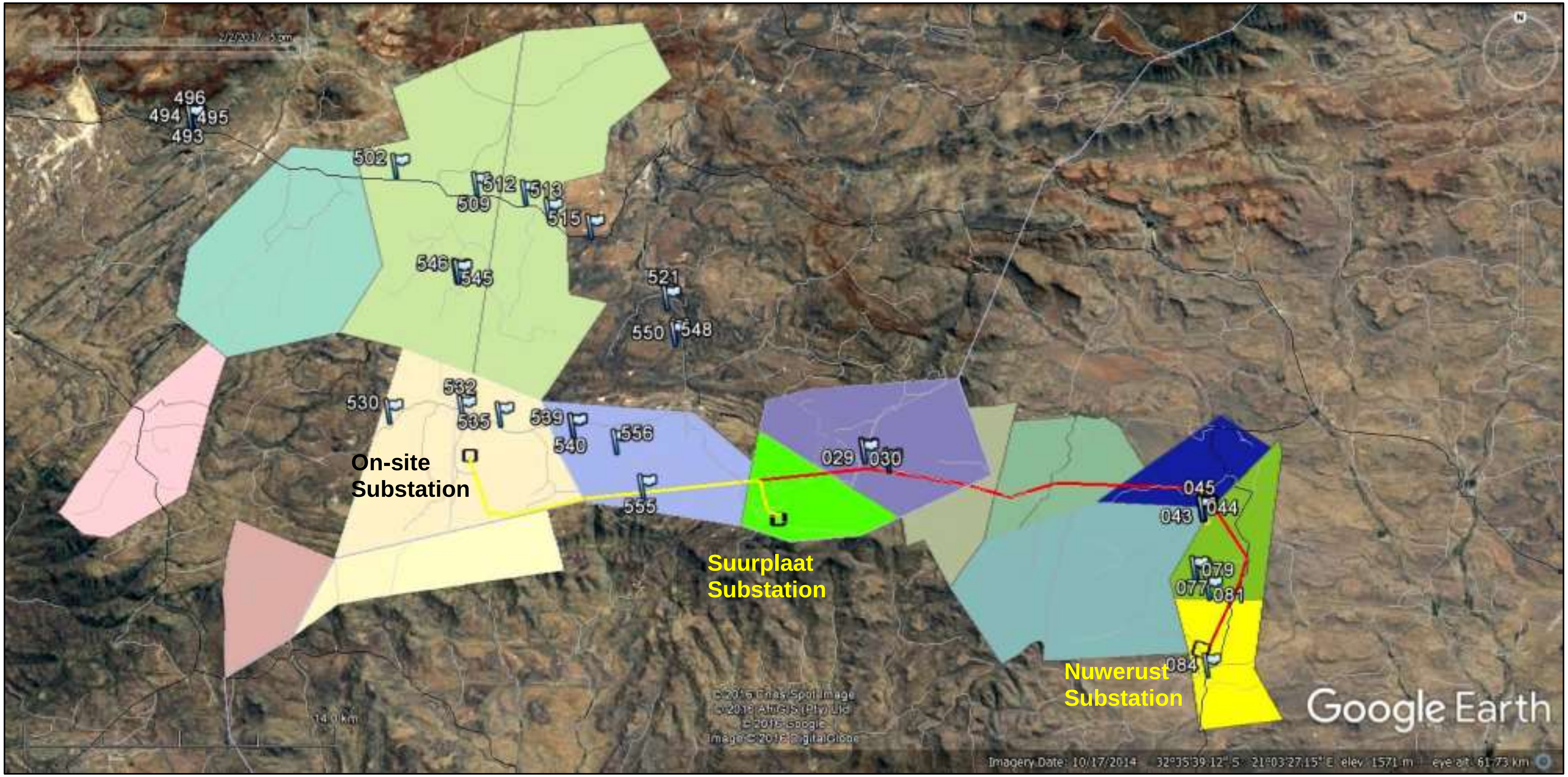
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Figure 2. Google Earth© image of the eastern sector of the revised electrical infrastructure project (Hamel Kraal Farm 16), located in the Great Karoo region some 20 km west of Merweville (N towards the left of the image). Numbered flags represent recorded fossil sites from the previous report by Almond (2017) as well as more recent fieldwork (See Appendix 1 for GPS data and short descriptions). The fossil material comprises poorly-preserved petrified wood, moulds of woody stems, fragmentary tetrapod skeletal remains and invertebrate trace fossils. The majority of the recorded fossil sites are of low palaeontological heritage significance (Proposed Field Rating IIIB or IIIC) and / or lie outside the development footprint. See following figure for more detail of the MTS study area and adjoining transmission lines.

Figure 3. Google Earth© image of the proposed MTS project area (black rectangle) and adjoining 132 kV and 400 kV transmission lines (N towards the left of the image) on Hamel Kraal Farm 16. Numbered flags represent recorded fossil sites from the previous report by Almond (2017) as well as more recent fieldwork (See Appendix 1 for GPS data and short descriptions). The fossil material comprises poorly-preserved petrified wood, moulds of woody stems, fragmentary tetrapod skeletal remains and invertebrate trace fossils. The majority of the recorded fossil sites are of low palaeontological heritage significance (Proposed Field Rating IIIB or IIIC) and / or lie outside the development footprint.

Figure 4. Flat-lying, sandy terrain with no bedrock exposure in the development area for the proposed Sutherland 2 on-site substation, Portion 1 of Tonteldoosfontein Farm 152.

Figure 5. Abrahamskraal Formation bedrocks exposed along a shallow incised drainage line on Gunstfontein 151 with Salpeterkop in the distance to the north.

Figure 6. Flat sandy terrain with sparse surface gravels of sandstone seen in the development area for the proposed Suurplaat On-site Substation, Hartebeeste Fontein Farm 147.

Figure 7. Gently undulating terrain of the Roggeveld Plateau bordering the Suurplaat On-site Substation study area with rocky ridges of Abrahamskraal Formation channel sandstones in the foreground.

Figure 8. Typical rubble-strewn terrain underlain by thick Abrahamskraal Formation channel sandstones on the Roggeveld Plateau, Hartebeeste Fontein Farm 147.

Figure 9. Laterally extensive, tabular channel sandstones of the Moordenaars Member (Abrahamskraal Formation) weathering out as narrow *kranzes* on the slopes of Louwskop, Farm 219.

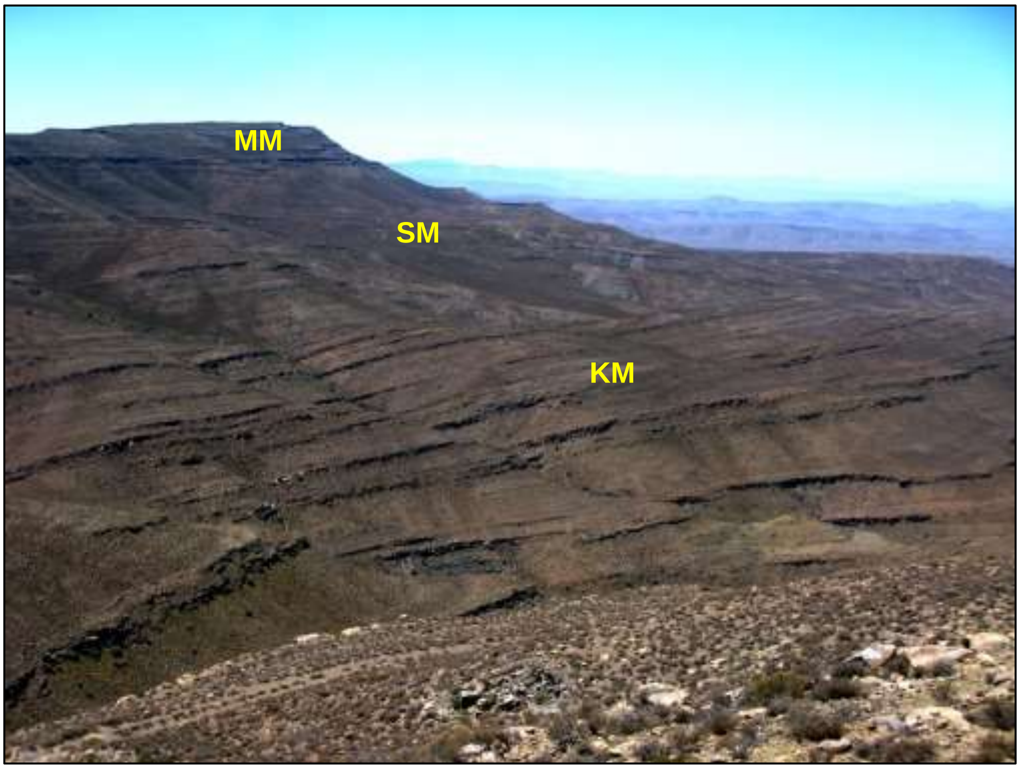

Figure 10. View north-eastwards along the upper part of the Besemgoedberg Escarpment close to Blouval (Farm 219). The sandstone-rich Moordenaars Member (MM, along ridge crest) is separated from the Koornplaats Member (KM, closely-spaced lower sandstones) by a sandstone-poor zone, the Swaerskraal Member (SM).

Figure 11. View southwards from the Langpunt track showing yellowish channel sandstones of the Koornplaats Member overlying the dark grey, mudrock-dominated Leeuvlei Member at the foot of the Besemgoedberg Escarpment near Novavita (Farm 280/RE).

Figure 12. Typical exposure of grey-green overbank mudrocks and yellowish channel sandstones of the Koornplaats Member at Bruwelskop (Hamelkraal Farm 16), western Koup region.

Figure 13. Brownish hills of the Koornplaats Member close to the northern edge of Hamel Kraal Farm 6 with occasional isolated exposures of grey-green mudrocks in the alluvial *vlaktes* in the foreground (Loc. 006).

Figure 14. Bakenkop – site of the proposed MTS on Hamel Kraal Farm 16 – seen from the east with a wide, gravelly alluvial plain in the foreground.

Figure 15. Eastern flanks of Bakenkop close to the MTS site showing typical sandstone-dominated terrain of the Koornplaats Member with large, dark brown *koffieklip* concretions (foreground) and rubbly surface gravels of downwasted yellowish-brown sandstone.

Figure 16. Topographically subdued alluvial *vlaktes* in the southern sector of Hamel Kraal Farm 16 showing patchy exposures of Beaufort Group mudrocks in the foreground and the existing transmission line at the southern termination of the proposed new 400 kV grid connection.

2. GEOLOGICAL CONTEXT

The combined study area for the Sutherland WEF, Sutherland 2 WEF and Rietrug WEF 132 kV and 400 kV transmission lines and associated MTS substation comprises a narrow, west-east trending band of semi-arid Karoo terrain some 35 km long (W-E) and *c*. 15 km wide (N-S), spanning the boundary between the Northern and Western Cape (Figs. 1 to 3). The western ~17 km of the area is situated on the Roggeveld Plateau at elevations of between 1500 and 1600 m amsl. The terrain here is rugged but without major contrasts in elevation, featuring numerous low sandstone ridges but only a few, low *koppies* such as Bakenkop (1560 m amsl.) and Louwskop (1670 ma amsl), rising to its greatest height close to the escarpment edge (Boesmanskop 1715) (Figs. 4 to 9). This western portion of the study area, to the north of the south-facing Komsberg Escarpment, has only a few, minor, northeast-directed drainage lines (*e.g.* Portugalsrivier). Several of these lie along well-defined radial fractures associated with the Late Cretaceous intrusion and uplift of the Sutherland Suite (*e.g.* Salpeterkop volcanic complex) (See NW portion of Fig. 1). The eastern 20 km or so of the study area, from Blouval on Hartebeeste Fontein Farm 147 eastwards to Novavita Farmstead on Farm Rheebokkenfontein 4, descends the steep, east-facing Besemgoedberg Escarpment between Lammerberg and Rooiberg, with a fall of some 600 m in altitude along the Langpunt track. The scenically spectacular escarpment zone features numerous, ridge-like sandstone *kranzes* and is dissected by several deeply-incised *klowe* (stream gorges) (Figs. 4 & 10). To the east of Novavita Farmstead the powerline routes enter the western Koup region to the west of Merweville, characterised by arid, gravelly *vlaktes* and low, stepped *koppies* such as Blikhuiskop (1150 m amsl.), Brandkop (1050 m amsl.), Brewelskop (850 m amsl) and Bakenkop (828 m amsl) (Figs. 12 to 16). This comparatively low-lying region (mainly *c*. 700-750 m amsl) of the Great Karoo *sensu stricto* is drained by numerous intermittent-flowing tributaries of the Dwyka River such as the Juksrivier, Oubergsrivier and Vanwyksrivier. The karroid shrubby vegetation here is noticeably lower and sparser than seen in the less arid Roggeveld Plateau region to the west.

The geology of the Sutherland region is outlined on the 1: 250 000 scale geology sheet 3220 Sutherland (Theron 1983) (Fig. 19) as well as the updated 1: 250 000 Sutherland metallogenic map that includes important new stratigraphic detail for the Lower Beaufort Group succession (Cole & Vorster 1999) (*cf* Fig. 18). The study area is entirely underlain by Middle Permian continental sediments of the **Lower Beaufort Group** (Adelaide Subgroup, Karoo Supergroup), and in particular the **Abrahamskraal Formation** (Pa) at the base of the Lower Beaufort Group succession (Johnson *et al.* 2006 and references cited below). The Beaufort Group sediments here are folded along numerous west-east trending fold axes (narrow black lines on geological map, Fig. 19). In the Sutherland area to the north of the WEF powerline study area the Lower Beaufort Group sediments have been extensively intruded and thermally metamorphosed (baked) by dolerite sills and dykes of the **Karoo Dolerite Suite** of Early Jurassic age (*c*. 182 Ma = million years ago; Duncan & Marsh 2006). These igneous rocks were intruded during an interval of crustal uplift and stretching that preceded the break-up of the supercontinent Gondwana. They show up on satellite images as rusty-brown areas (Fig. 1). No dolerite or younger (Cretaceous) intrusions are mapped within the present study region, however; major dolerite and younger Cretaceous igneous bodies of the **Sutherland Suite** (*e.g.* Salpeterkop) intrude the Lower Beaufort Group some 6 to 12 km to the north. The Palaeozoic bedrocks in the study area are extensively overlain by Late Caenozoic **superficial deposits** such as scree and other slope deposits (colluvium and hillwash), stream alluvium, down-wasted surface gravels, calcretes and various sandy to gravelly soils.

A useful recent overview of the Beaufort Group continental succession has been given by Johnson *et al.* (2006). Almond (2015g) has provided a short account of the Lower Beaufort Group sediments of the Roggeveld plateau to the south of Sutherland that is broadly applicable to the present WEF powerline study area. The Lower Beaufort Group succession here belongs to the **Abrahamskraal Formation**. This is a very thick (*c*. 2.5 km) succession of fluvial deposits laid down in the Main Karoo Basin by meandering rivers on an extensive, low-relief floodplain during the Middle Permian Period, some 266-260 million years ago (Rossouw & De Villiers 1952, Johnson & Keyser 1979, Turner 1981, Theron 1983, Smith 1979, 1980, 1990, 1993a, 1993b, Smith & Keyser 1995a, Loock *et al*., 1994, Cole & Vorster 1999, McCarthy & Rubidge 2005, Johnson *et al*., 2006, Almond 2010a, Day 2013a, Day & Rubidge 2014, Wilson *et al.* 2014). These sediments include (a) lenticular to sheet-like channel sandstones, often associated with thin, impersistent intraformational breccio-conglomerates (larger clasts mainly of reworked mudflakes, calcrete nodules, *plus* sparse rolled bones, teeth, petrified wood), (b) well-bedded to laminated, grey-green, blue-grey to purple-brown floodplain mudrocks with sparse to common pedocrete horizons (calcrete nodules formed in ancient soils), (c) thin, sheet-like crevasse-splay sandstones, as well as more (d) localized playa lake deposits (*e.g.* wave-rippled sandstones, laminated mudrocks, limestones, evaporites). A number of greenish to reddish weathering, silica-rich “chert” horizons are also found. Many of these appear to be secondarily silicified mudrocks or limestones, perhaps associated with playa lakes, but at least some contain reworked volcanic ash (tuffs, tuffites). A wide range of sedimentological and palaeontological observations point to deposition under seasonally arid climates. These include, for example, the abundance of pedogenic calcretes and evaporites (silicified gypsum pseudomorphs or “desert roses”), reddened mudrocks, sun-cracked muds, “flashy” river systems, sun-baked fossil bones, well-developed seasonal growth rings in fossil wood, rarity of fauna, and little evidence for substantial bioturbation or vegetation cover (*e.g.* root casts) on floodplains away from the river banks.

The Abrahamskraal Formation in the SW Karoo has been subdivided by various authors into a series of alternating sandstone- and mudrock-dominated packages, most recently by Day and Rubidge (2014) (Fig. 17). According to the 1: 250 000 metallogenic map of Cole and Vorster (1999) the majority of the WEF powerline study area up on the Roggeveld Plateau near Sutherland is underlain by a thick, channel sandstone-rich package known as the **Moordenaars Member** (Figs. 9 & 10) (Mudrocks of the overlying Kareskraal Member, the youngest subunit of the Abrahamskraal Formation, crop out just to the north of, but not within, the present study area. They are indicated by darker, purple-brown tints on satellite images; Fig. 1). An older package of closely-spaced, yellowish-tinted, tabular channel sandstone bodies exposed on the lower slopes of the Besemgoedberg Escarpment as well as over much of the western Koup region as far as Merweville represents the **Koornplaats Member**. This sandy unit underlies most of the eastern portion of the study area, including the MTS site (Figs. 10 to 15). The thin mudrock-dominated interval between these two sandstone packages - visible, for example, from Blouval and the Langpunt track - belongs to the **Wilgerbos Member** (renamed the **Swaerskraal Member** by Day & Rubidge 2014) (Fig. 10). A thick mudrock package exposed on hillslopes in the south-western corner of Farm Hamelkraal 16 may also belong here. Dark mudrock successions with lenticular sandstone bodies exposed on lower valley slopes near Novavita Farmstead, along the foot of the escarpment, probably belong to the upper part of the **Leeuvlei Member** (Fig. 20).

According to Loock *et al.* (1994 the **Koornplaats Member** of the Abrahamskraal Formation. is characterized by:

- Yellow-weathering sheet-like channel sandstone packages with heavy mineral laminations (up to 2 cm thick) towards the top and basal lag breccio-conglomerates. A prominent, laterally-persistent package of five yellowish fine-grained sandstone units marks the upper part of the member in the Roggeveld – Nuweveld Escarpment area. The sandstones are associated with fossil tetrapod material and reworked plant material, including silicified wood (rarely with exotic extra-basinal pebbles) and *Vertebraria* glossopterid roots. Uranium mineralization may be associated with transported plant material.
- Grey and maroon overbank mudrocks with calcrete horizons, tetrapod fossils.

The **Wilgerbos / Swaerskraal Member** comprises some 120 m of recessive-weathering, grey-green to purple-brown mudrocks with subordinate thin sandstones. Extensive playa lake deposits have been recognized within this unit (Loock *et al.* 1994).

The **Moordenaars Member** is a 300-350 m – thick, sandstone-rich succession of continental fluvial rocks characterized by stacked sheet sandstones with intervening, more recessive-weathering mudrocks (Stear 1980, Le Roux 1985, Loock *et al.* 1994, Cole & Vorster 1999). The prominent, laterally-persistent sandstone ledges generate a distinctive terraced topography on hill slopes in the Sutherland area (Figs. 9 & 26). The sheet sandstones are generally pale-weathering (enhanced by epilithic lichens), fine-grained, and structured by horizontal lamination (flaggy, with primary current lineation) or tabular to trough cross-bedding. The tabular-laminated units often contain numerous dark, very thin, laterally persistent laminae composed of heavy minerals that suggest density sorting during high energy sheet-flow conditions. The lower contacts of the channel sandstones are erosive, with lenticular basal breccias that may infill small-scale erosive gullies. The breccias, which may also occur within the body of the channel sandstone unit, are composed of reworked mudflake intraclasts, small rounded to irregular calcrete glaebules or nodules as well as occasional rolled vertebrate bones, teeth and local concentrations of plant debris. Some of the originally more organic-rich breccias are associated with secondary iron / manganese-rich ('*koffieklip*") and uranium ore mineralization (Cole & Vorster 1999).

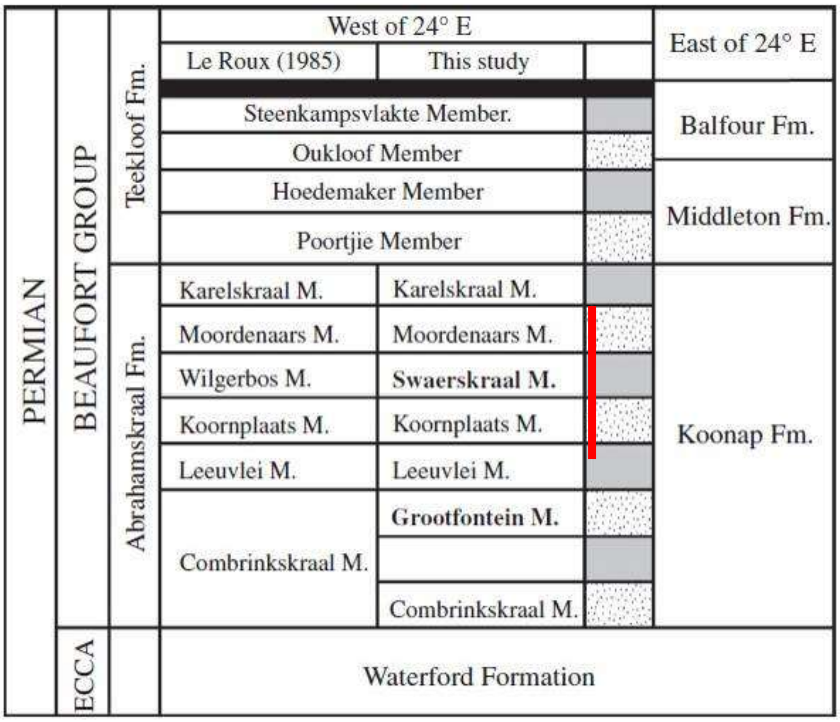

Figure 17. Revised stratigraphic subdivision of the Abrahamskraal Formation of Day and Rubidge (2014). The red bar indicates members that are represented within the electrical infrastructure study area between Sutherland and Merweville. Mudrock-dominated units are indicated in grey and sandstone packages by stippling.

Levels of tectonic deformation of the Lower Beaufort Group bedrocks within the study area are generally low. According to the 1: 250 000 Sutherland sheet map they have been gently folded along east-west or WNW-ESE fold axes (Fig. 19). In the study area the beds are fairly flat-lying with only local development of tectonic cleavage. A series of southwards down-stepping monoclinal folds with W-E trending axes is developed in the escarpment zone, visible for example to the N and NW of Novavita Farmstead.

Representative exposures of Abrahamskraal Formation bedrocks are illustrated below in Figures 20 to 30. Selected unconsolidated superficial deposits overlying these bedrocks are shown in Figures 31 and 33. Although lying outside the brief for the present palaeontological study, two small-scale geological features of geo-scientific interest encountered during the present field study are noted here:

- The unusually extensive occurrence of *koffieklip* (dark brown-patinated, ferruginised sandstone) spanning a dust road on Farm Hamel Kraal 16, situated some 1.5 km southeast of the proposed MTS (Loc. 084, Fig. 23). Elongate lenticular outcrops of black, dolerite-like sandstone blocks extend some 200 m in a NW-SE direction and are possibly related to Mid Permian palaeochannels. A uranium anomaly has not been mapped at this site, and no associated fossil plant material was recorded here (but there are trace fossils; *cf* 61).

- The lenticular cluster of pebble- to cobble-sized exotic clasts ("lonestones") embedded within a succession of fine-grained, purple-brown mudrocks that is recorded on Nooitgedagt 148 (Loc. 540; Fig. 18) includes some of the largest extra-basinal clasts recorded from the Lower Beaufort Group in the SW Karoo (*cf* Almond 2010a, 2015h and refs. therein). The larger clasts appear to be igneous (possibly andesite) and show a modest degree of rounding; the smaller pebbles are well-rounded. It is notable that the megaclasts are associated with crumbly, weathered, dark tillite-like material, suggesting a possible re-exhumed Dwyka Group provenance along the Karoo Basin margin (or alternatively a gritty palaeosol). Plausible explanations as to how such exotic "lonestones" were introduced so far out into the Beaufort Group depository include transport on the roots of floating logs (*cf* Broom 1909) or by floating river ice during winter. In the present case the distal floodplain setting of the conglomeratic lens, far from a river channel, is noteworthy.

Furthermore, it is noted that several uranium anomalies are indicated on the 1: 250 000 Sutherland metallogenic map close to the proposed 132 kV powerline route and on-site substation site. They are situated on the farms Gunstfontein 151 (Anomalies 180, 181) and Beeren Valley 150 (Anomalies 183, 186) (Fig. 18). Co-ordinates for these anomalies are given in the sheet explanation by Cole and Vorster (1999) and in Appendix 1 herein. According to the Mineral and Petroleum Resources Development Act, 2002, the company proposing the wind farm developments on these properties is required to submit a report from the Council for Geoscience on the mineral potential of the development area to the Department of Mineral Resources (Dr Doug Cole, Council for Geoscience, Bellville, pers. comm. 2015). As a precautionary measure, it is suggested that these sites are protected by a 30 m – radius buffer zone during the construction phase. Uranium ore occurrences associated with *koffieklip* are sometimes associated with concentrations of fossil plant material (See discussion and references in Almond 2015g relating to the proposed Gunsfontein WEF).

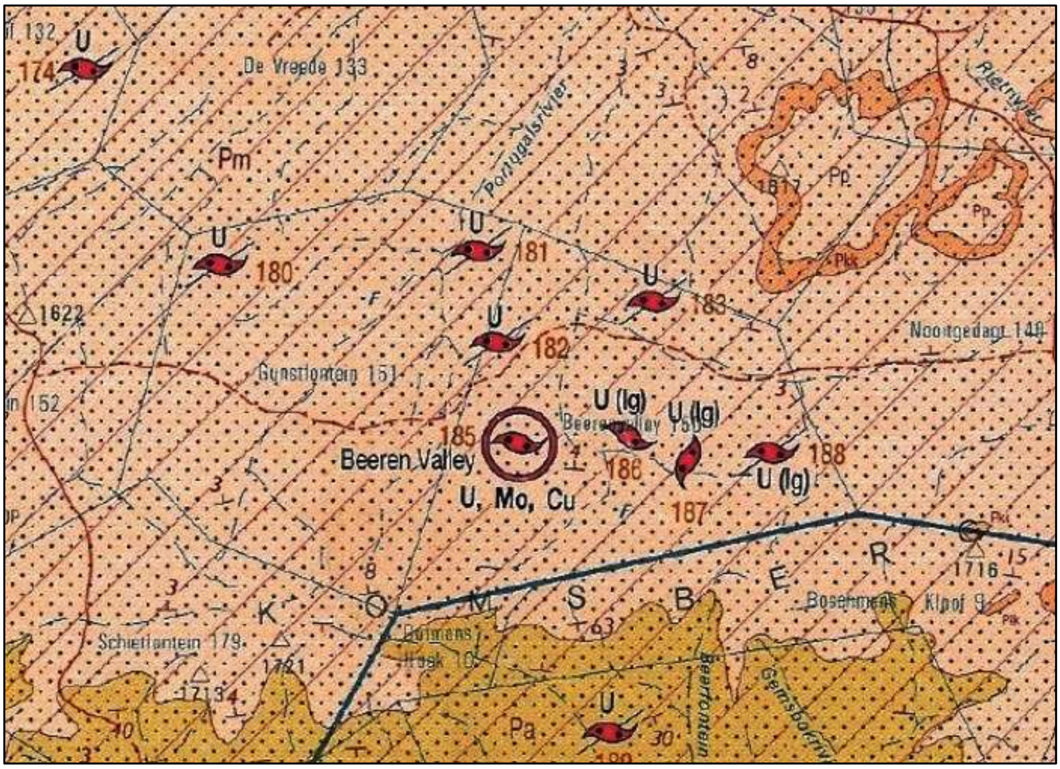

Figure 18. Extract from the 1: 250 000 Sutherland metallogenic map showing several uranium anomalies mapped on the farms Gunsfontein 151 and Beeren Valley 150 (red symbols) (Council for Geoscience, Pretoria). Anomalies 180, 181, 183 and 187 lie close to the proposed electrical grid infrastructure for the Sutherland, Sutherland 2 and Rietrug WEFs (GPS data for these sites is provided by Cole & Vorster 1999). Uranium ore occurrences within *koffieklip* (ferruginous sandstone) may sometimes be associated with fossil plant material, though this was not established during the present field study. As a precautionary measure, it is recommended that these sites are protected by a 30-m radius buffer zone.


WEF on-site substation
132 kV
132 kV
MTS
400 kV
N
c. 10 km

Figure 19 (previous page). Extract from 1: 250 000 geological sheet 3220 Sutherland (Council for Geoscience, Pretoria) showing the *approximate* footprint of the proposed additional Electrical Grid Infrastructure for the Sutherland WEF, Sutherland 2 WEF and Rietrug WEF. The slightly revised 132 kV powerline route (~ 41 km) between the on-site substation for the authorised Sutherland WEF on the farm Beeren Valley 150 (green square) and the proposed new MTS on Portion 6 of Hamelkraal 16 (blue square) is shown in black. The short (~4 km) line shows the proposed additional 400 kV connection between the MTS and existing W-E transmission lines to the south. A short deviation of the access road from the grid connection route *c*. 6.5 km NNE of the MTS is shown in red.

The main geological bedrock units represented in the study region include:

Pa (pale green) = Abrahamskraal Formation (Lower Beaufort Group)
Pte (dark green) = Teekloof Formation (Lower Beaufort Group)
Jd (red) = Karoo Dolerite Suite

***N.B.* Late Caenozoic superficial deposits that are not mapped at 1: 250 000 scale also occur here, including alluvium, colluvium, surface gravels, soils and calcrete.**

Figure 20. Lenticular channel sandstones incised into dark grey mudrocks of the Leeuvlei Member at the base of the escarpment to the west of Novavita Farmstead.

Figure 21. Well-developed ferruginised basal channel breccia within the Koornplaats Member, Bruwelskop, Hamel Kraal Farm 16 (Loc. 079) (Hammer = 30 cm). Such breccias are composed mainly of mudflakes and calcrete nodules but may also contain fossil wood, teeth and bones (*cf* Figs. 40, 56, 57 and 60).

Figure 22. Close-up of basal channel breccia in the Koornplaats Member, Hamel Kraal Farm 16 (Loc. 004) containing reworked calcrete nodules and mudfalkes in a ferruginised sandy matrix (Scale in cm).

Figure 23. Unusually thick and extensive *koffieklip* lens (sandstone secondarily mineralised with iron and manganese minerals) within a channel sandstone of the Koornplaats Member, *c*. 1.5 km SE of the proposed Main Transmission Substation.

Figure 24. Thick package of grey-green and purple-brown overbank mudrocks within the Koornplaats Member on the eastern flanks of Bakenkop, just south of the MTS site, Hamel Kraal Farm 16 (Loc. 019).

Figure 25. Wave-rippled upper surface of a Koornplaats Member crevasse-splay sandstone on Hamel Kraal Farm 16 (Loc. 025). The surface is associated with abundant invertebrate trace fossils (Fig. 62).

Figure 26. Package of closely-spaced, sheet-like channel sandstones of the Moordenaars Member building the upper edge of the Besemgoedberg Escarpment near Blouval, Farm 219.

Figure 27. Gentle hillslope exposure of purple-brown overbank siltstones within the upper part of the Moordenaars Member, Nooitgedagt Farm 148 (Loc. 540).

Figure 28. Exceptional concentration of pebble- to cobble-sized exotic clasts within fine-grained mudrocks of the Mordenaars Member, Nooitgedagt 148 (Loc. 540. See previous figure). These are among the largest clasts recorded within the Lower Beaufort Group in the SW Karoo, possibly transported by floating tree roots.

Figure 29. Excellent stream gulley exposures of blue-grey overbank mudrocks of the Moordenaars Member on Nooitgedagt Farm 148. Tabular packages of thin-bedded mudrocks were deposited on the distal floodplain, perhaps within playa lakes.

Figure 30. Well-developed palaeosol horizon marked by dense pale grey pedogenic calcrete concretions, Moordenaars Member, Tonteldoosfontein Farm 152 (Hammer = 30 cm). Such horizons are a primary focus for recording vertebrate fossil remains.

Figure 31. Downwasted Abrahamskraal Formation sandstones forming rubbly surface gravels south of Bruwelskop, Hamel Kraal 16 (Loc. 081).

Figure 32. Coarse stream gravels capped by sandy to silty alluvium exposed in the banks of the Brandleegte River west of Hamelkraal homestead.

Figure 33. Surface gravels dominated by coffee-brown ferruginous carbonate concretions weathering out of Koornplaats Member mudrocks, Hamel Kraal Farm 16 (Loc. 026).

3. PALAEONTOLOGICAL HERITAGE

The fossil record of the principal sedimentary rock units represented within the WEF electrical grid infrastructure and MTS study region has been reviewed in previous palaeontological assessment reports for the region by Almond (2010b, 2010c, 2011, 2015g, 2017). In this section of the Basic Assessment report only a short summary of earlier finds is given, plus a brief illustrated account of new fossil records made during the recent field-based assessment of the study area.

3.1. Fossil biotas of the Lower Beaufort Group (Adelaide Subgroup)

The overall palaeontological sensitivity of the Beaufort Group sediments is high to very high (Almond & Pether 2008, SAHRIS website). These continental sediments have yielded one of the richest fossil records of land-dwelling plants and animals of Permo-Triassic age anywhere in the world (MacRae 1999, Rubidge 2005, McCarthy & Rubidge 2005, Smith *et al.* 2012). Bones and teeth of Late Permian tetrapods have been collected in the western Great Karoo region since at least the 1820s and this area remains a major focus of palaeontological research in South Africa.

A chronological series of mappable fossil biozones or assemblage zones (AZ), defined mainly on their characteristic tetrapod faunas, has been established for the Main Karoo Basin of South Africa (Rubidge 1995, 2005, Van der Walt *et al.* 2010). Maps showing the distribution of the Beaufort Group assemblage zones within the Main Karoo Basin have been provided by Keyser and Smith (1979, Fig. 25 herein) and Rubidge (1995, 2005). A recently updated version is now available (Nicolas 2007, Van der Walt *et al.* 2010). The assemblage zone represented within the present study area is the Middle Permian ***Tapinocephalus* Assemblage Zone** (Theron 1983, Rubidge 1995).

The main categories of fossils recorded within the *Tapinocephalus* fossil biozone (Keyser & Smith 1977-78, Anderson & Anderson 1985, Smith & Keyser 1995a, MacRae 1999, Rubidge 2005, Nicolas 2007, Almond 2010a, Smith *et al.* 2012, Day 2013a, Day 2013b, Day *et al.* 2015b) include:

- isolated petrified bones as well as rare articulated skeletons of tetrapods (*i.e.* air-breathing terrestrial vertebrates) such as true **reptiles** (notably large herbivorous pareiasaurs like *Bradysaurus*, small insectivorous millerettids), rare pelycosaurs, and diverse **therapsids** or "mammal-like reptiles" (*e.g.* numerous genera of large-bodied dinocephalians, herbivorous dicynodonts, flesh-eating biarmosuchians, gorgonopsians and therocephalians) (Fig. 35);

- aquatic vertebrates such as large **temnospondyl amphibians** (*Rhinesuchus*, usually disarticulated), and **palaeoniscoid bony fish** (*Atherstonia*, *Namaichthys*, often represented by scattered scales rather than intact fish);

- freshwater **bivalves** (*Palaeomutela*);

- **trace fossils** such as worm, arthropod and tetrapod burrows and trackways, coprolites (fossil droppings) and plant stem or root casts;
- **vascular plant remains** (usually sparse and fragmentary), including leaves, twigs, roots and petrified woods ("*Dadoxylon*") of the *Glossopteris* Flora, especially glossopterid trees and arthrophytes (horsetail ferns).

In general, tetrapod fossil assemblages in the *Tapinocephalus* Assemblage Zone are dominated by a wide range of dinocephalian genera and small therocephalians *plus* pareiasaurs while relatively few dicynodonts can be expected (Day & Rubidge 2010, Jirah & Rubidge 2010 and references. therein). Vertebrate fossils in this zone are generally much rarer than seen in younger assemblage zones of the Lower Beaufort Group, with almost no fossils to be found in the lowermost beds (Loock *et al.* 1994) (Fig. 36).

Despite their comparative rarity, there has been a long history of productive fossil collection from the *Tapinocephalus* Assemblage Zone in the western and central Great Karoo area, as summarized by Rossouw and De Villiers (1952), Boonstra (1969) and Day (2013b). Numerous fossil sites recorded in the region are marked on the published 1: 250 000 Sutherland geology sheet 3220 (Fig. 19) but none of these sites lies within the present project footprint. According to the vertebrate fossil distribution map of Keyser and Smith (1977-78; Fig. 34) there is a paucity of known sites within the present study area. Vertebrate fossils found in the Sutherland sheet area are also listed by Kitching (1977) as well as Theron (1983). They include forms such as the pareiasaur *Bradysaurus*, tapinocephalid and titanosuchid dinocephalians *plus* rarer dicynodonts, gorgonopsians and therocephalians (*e.g.* pristerognathids, *Lycosuchus*) as well as land plant remains (*e.g.* arthrophyte stems and leaves). Numerous fossil sites were recorded along the eastern edge of the Moordenaarskaroo in the key biostratigraphic study of the Abrahamskraal Formation by Loock *et al.* (1994). A palaeontological heritage study was carried out by the author within the Abrahamskraal Formation of the Moordenaarskaroo and Koup regions to the south and southeast of the present study area (Almond 2010a). This fieldwork yielded locally abundant dinocephalian and other therapsid skeletal remains, large, cylindrical vertical burrows or plant stem casts, *Scoyenia* ichnofacies trace fossil assemblages and sphenophytes (horsetail ferns) associated with probable playa lake deposits, as well as locally abundant petrified wood. An earlier palaeontological field assessment of Mordenaars Member rocks on the outskirts of Sutherland by Almond (2005) yielded only transported plant remains (arthrophytes including *Phyllotheca*, glossopterid and other, more strap-shaped leaves, possible wood tool marks), sparse trace fossil assemblages of the damp-ground *Scoyenia* ichnofacies, and rare fragments of rolled bone. Reworked silicified wood from surface gravels, scattered, fragmentary plant remains associated with channel sandstones and rare disarticulated bones were reported by Almond (2011) from a Moordenaars Member study site *c*. 11 km south of Sutherland.

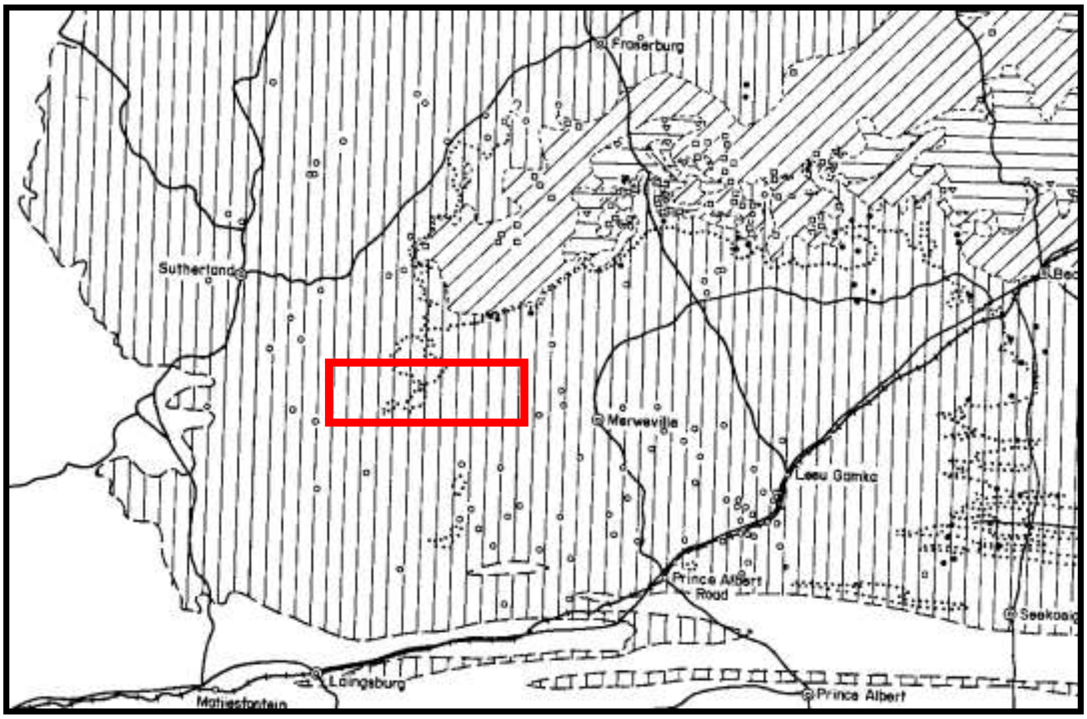

Figure 34. Distribution of vertebrate fossil localities within the Lower Beaufort Group in the south-western Karoo region (Map abstracted from Keyser & Smith 1977-78). Outcrop areas with a vertical lined ornament are assigned to the Middle Permian *Tapinocephalus* Assemblage Zone. Note the paucity of vertebrate fossil records from the lower part of the Abrahamskraal Formation in the WEF electrical grid infrastructure study area between Sutherland and Merweville (red rectangle). This probably reflects palaeontological neglect more than an absence of fossil material.

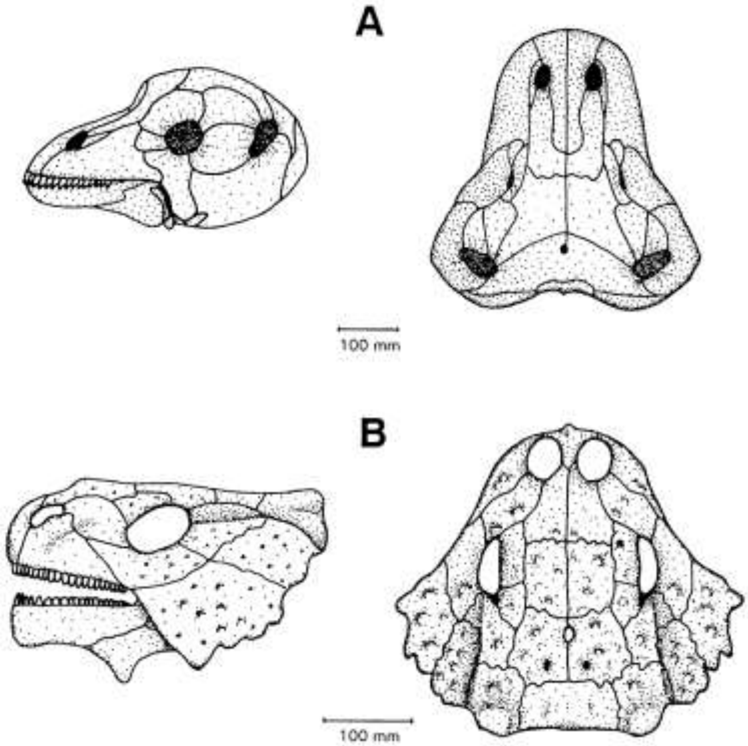

Figure 35. Skulls of two key large-bodied tetrapods of the *Tapinocephalus* Assemblage Zone: A – the dinocephalian therapsid *Tapinocephalus*; B – the pareiasaur *Bradysaurus* (From Smith & Keyser 1995b).

A recent palaeontological field assessment of the Gunstfontein WEF study area (Almond 2015g), situated just to the west of the present WEF electrical infrastructure study area, yielded the following records of fossil material from the Abrahamskraal Formation bedrocks. All these records are from the Moordenaars Member on the Roggeveld Plateau and are representative of the categories and preservation styles of expected and observed fossil material within the present study area:

- Rare transported fossil bone fragments and probable disarticulated bony fish scales preserved within ferruginised basal channel breccias;
- Low diversity trace fossil assemblages of the *Scoyenia* ichnofacies on sandstone sole surfaces as well as treptichnid-like serial probe burrows associated with high energy sheet-laminated sandstone facies;
- Sandstone casts of reedy plant stems – probably sphenophytes ("horsetails") – within crevasse splay sandstones;
- Ferruginised or slightly dark-hued impressions of non-woody plant material, including occasional well-preserved, tongue-shaped glossopterid leaves showing midribs as well as indeterminate leaf and stem fragments, preserved within dark brown, impure sandstone facies;
- Local concentrations of indeterminate woody plant material preserved as ferruginised moulds in channel sandstones, often associated with basal breccio-conglomerates and / or *koffieklip*;

- Sparse to locally common, poorly- to well-preserved blocks of silicified wood, including portions of sizeable logs, occurring among surface sandstone rubble, downwasted surface gravels and sheetwash gravels. Much of this material has a pale yellowish to creamy, cherty, vuggy appearance with no obvious preservation of the original woody fabric and may represent wood that was silicified at a late stage of decomposition. However, some of the petrified wood fragments do show well-preserved xylem cells. While the petrified wood blocks recorded during the present study have not been observed *in situ*, it is inferred that they have been reworked from nearby channel sandstone bodies.

Fossil records made during the recent field assessment for the WEF electrical grid infrastructure projects are tabulated with brief notes in the Appendix 1. The sites are indicated with reference to the proposed powerline routes on the Google earth© satellite map in Figures 1 to 3. The fossils found belong for the most part to the same categories as those listed above for the adjoining Gunsfontein WEF study area. For the purposes of the present palaeontological heritage basic assessment study, the following additional points should suffice here.

Disarticulated fossil bones, mainly of large-bodied tetrapods such as pareiasaurs and dinocephalians, are found widely, but usually very sparsely, at surface within the Abrahamskraal Formation outcrop area. Some of the material has clearly weathered out of basal channel breccio-conglomerates where it may be associated with reworked fossil wood (Figs. 37 & 54). Most of the specimens observed are fragmentary, highly weathered, secondarily ferruginised and, in some cases, rounded by transport (Figs. 48 & 55). Sun-cracked surface textures are commonly seen. Without associated skull material they are difficult to identify and for the most part of limited scientific value; the very thick skull roof fragment seen in Figure 59 can be ascribed to a tapinocephalid dinocephalian. The notable scatter of robust post-cranial bones observed within sandstone scree on Portugals Rivier 218 (Figs. 41 to 43) may belong to one or more individuals. The partially embedded, articulated post-cranial skeleton of a large tetrapod at Loc. 535 (Beeren Valley Farm 150) (Figs. 38 & 39) is of heritage conservation significance but will not be impacted by the present electrical infrastructure project.

Basal channel breccias in the Koornplaats and Moordenaars Members may be locally rich in transported woody plant material (often preserved as ferruginized moulds; Fig. 60) as well as reworked tetrapod remains. The latter include disarticulated, rounded bones and isolated teeth (Figs. 56 and 57), most of which are unidentifiable. The extensive scatters of petrified logs (mostly, but not all, poorly-preserved) seen at surface on Hamel Kraal Farm 16 (Locs. 041-074, 015, 024; Figs. 49 to 53) and the scarce associated bone fragments have probably weathered out of a local channel sandstone within the Koornplaats Member. Nearby *koffiklip* lenses contain occasional reworked bone (Fig. 55). The largest fossil scatter lies 500 m southwest of the 132 kV powerline route and should not be directly impacted by the proposed development (Fig. 63).

Probable sandstone casts of tetrapod burrows were observed at several localities, but in several cases their interpretation as such is equivocal (*cf* Fig. 47). The best examples include a concentration of several gently inclined, subcylindrical tetrapod burrow casts (*c*. 15 cm wide) embedded in maroon overbank mudrocks that were observed within the

Karelskraal Member on Nooitgedagt 148 (Loc. 521). One of these burrows shows well-developed scratch marks on the ventrolateral surface (Fig. 37). These are among the youngest recorded tetrapod burrows within the Abrahamskraal Formation. They may well have been constructed by dicynodonts. Note that this stratigraphic horizon does not crop out within the 132 kV powerline study area itself. Other vertebrate traces of interest are dense arrays of subcylindrical sandstone casts of lungfish aestivation burrows (Loc. 512, Portugals Rivier 218) (Fig. 45). Similar vertical burrow assemblages have been recorded elsewhere in the SW Karoo at several localities and horizons within the Abrahamskraal Formation (*cf* Almond 2010a, Odendaal & Loock 2015).

The oblique, small-scale invertebrate burrow observed at Loc. 509 (Portugals Rivier 218; Fig. 44) is unusual in that the trace maker – possibly some sort of crustacean – had to burrow through a coarse, gravelly substrate. Other small-scale trace fossils observed include stem casts of reedy plants within sandstone beds and occasional low-diversity assemblages of straight to curving, cylindrical invertebrate burrows exposed at the surface or within channel sandstone bodies (Figs. 46 and 61); many of the latter can be assigned to the *Scoyenia* ichnofacies and are associated with wave-rippled crevasse splay sandstone bed tops (Figs. 25 & 62).

Occurrences of sandstone-hosted uranium ore bodies picked up by aerial surveys of the Sutherland sheet area are often associated with fossil plant material and *koffieklip* (Almond 2015g). Decomposition of rotting plant material embedded within channel sandstones often played a key role in the precipitation of uranium minerals (See detailed discussion in Cole & Vorster 1999, Cole & Wipplinger 2001). It is therefore possible that the uranium anomalies mapped close to the present WEF electrical grid infrastructure study area may be associated with fossil plants, though this particular point was *not* addressed during recent fieldwork. On palaeontological as well as economic geological and general geoscientific grounds it is therefore recommended that a 30 m - radius buffer zone be recognised around previously-identified uranium anomalies close to the powerline corridor that are mapped in Fig. 18 (GPS data for numbered anomalies are provided by Cole & Vorster 1999 and also given in Appendix 1).

3.2. Fossils within the superficial deposits

The diverse superficial deposits within the South African interior have been comparatively neglected in palaeontological terms. However, sediments associated with ancient drainage systems, springs and pans in particular may occasionally contain important fossil biotas, notably the bones, teeth and horn cores of mammals as well as remains of reptiles like tortoises (*e.g.* Skead 1980, Klein 1984b, Brink, J.S. 1987, Bousman *et al.* 1988, Bender & Brink 1992, Brink *et al*. 1995, MacRae 1999, Meadows & Watkeys 1999, Churchill *et al*. 2000, Partridge & Scott 2000, Brink & Rossouw 2000, Rossouw 2006). Other late Caenozoic fossil biotas that may occur within these superficial deposits include non-marine molluscs (bivalves, gastropods), ostrich egg shells, trace fossils (*e.g.* calcretised termitaria, coprolites, invertebrate burrows, rhizocretions), and plant material such as peats or palynomorphs (pollens) in organic-rich alluvial horizons (Scott 2000) and diatoms in pan sediments. In Quaternary deposits, fossil remains may be associated with human artefacts such as stone tools and are also of archaeological interest (*e.g.* Smith 1999 and references therein).

Ancient solution hollows within extensive calcrete hardpans may have acted as animal traps in the past. As with coastal and interior limestones, they might occasionally contain mammalian bones and teeth (perhaps associated with hyaena dens) or invertebrate remains such as snail shells.

Apart from the reworked Beaufort Group petrified wood and bones within alluvial and colluvial gravels described earlier, no fossils were observed within the various Late Caenozoic superficial deposits represented within the WEF electrical grid infrastructure study area during the recent field studies.

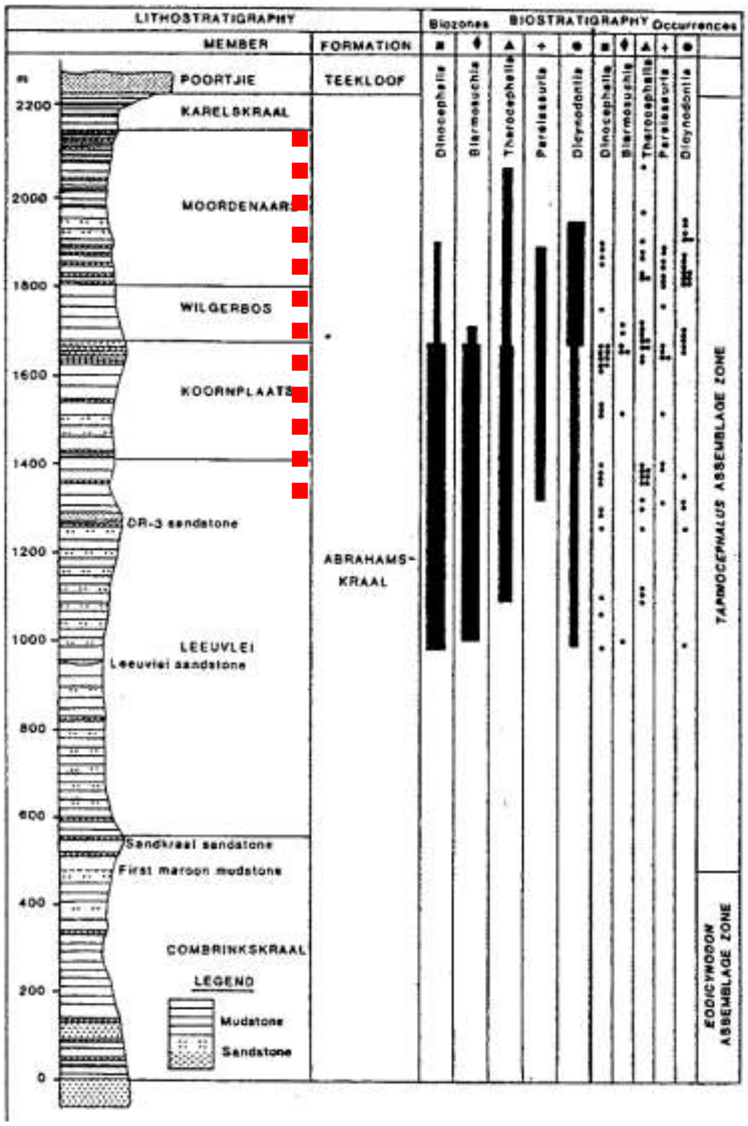

Figure 36. Chart showing the subdivision of the Abrahamskraal Formation in the western Karoo region with the stratigraphic distribution of the major fossil vertebrate groups (Loock *et al*. 1994). The WEF electrical grid infrastructure project area on the Roggeveld Plateau is largely underlain by sediments of the Moordenaars Member. Lower stratigraphic intervals are represented within the Besemgoedberg Escarpment zone and the low-lying Koup region to the east, including the MTS project area on Hamel Kraal Farm 16 (See red dotted line).

Figure 37. Gently-inclined, curved tetrapod burrow cast within the Kareslkraal Member (Scale *c*. 15 cm long), one of several in the area. Nooitgedagt 148 (Loc. 521). This is one of the youngest tetrapod burrows recorded from the Abrahamskraal Formation.

Figure 38. Partially-embedded, well-articulated postcranial skeleton of a large tetrapod, Beeren Valley 150 (Loc. 535) (Scale is *c*. 15 cm long). This specimen is of conservation value but lies well outside the present project footprint.

Figure 39. Detail of the articulated skeleton seen in the preceding figure showing the attachment of several ribs along the backbone.

Figure 40. Sizeable disarticulated bone, preserved in part as a mould, embedded within a calcrete-rich breccia at the base of a channel sandstone, Moordenaars Member, Portugalsrivier 218 (Loc. 509) (Scale in cm and mm).

Figure 41. Several highly-weathered, secondarily ferruginised pieces of tetrapod bone found among surface float, Portugals Rivier 218 (Loc. 545) (Scale in cm). The limb bone on the left shows superficial sun-cracking due to protracted pre-burial exposure.

Figure 42. Sandstone scree on Portugals Rivier 218 with numerous dispersed fossil bones that may have weathered out of the channel sandstone above. Several fossil bones have been collected together in one spot (arrow) (Loc. 546).

Figure 43. Close-up of large tetrapod bones (pareiasaur and / or dinocephalian) shown in the previous figure (Loc. 546) (Scale *c*. 15 cm long). They may belong to one or more individuals but are difficult to identify without associated cranial material.

Figure 44. Fossiliferous basal channel breccia penetrated by an inclined invertebrate burrow – possibly crustacean, Moordenaars Member, Portugalsrivier 218 (Loc. 509) (Scale in cm).

Figure 45. Road cutting through interbedded thin sandstones and overbank mudrocks of the Moordenaars Member showing several cylindrical lungfish burrow casts up to 10 cm in diameter (arrowed), Portugals Rivier 218 (Loc. 512).

Figure 46. Upper surface of a Moordenaars Member channel sandstone with ill-defined horizontal burrows, Beeren Valley 150 (Loc. 530) (Scale is 15 cm long).

Figure 47. Two closely-spaced, anomalous, sandstone-infilled structures (arrowed) embedded within overbank mudrocks – possibly tetrapod burrows, Moordenaars Member, Nooitgedagt 148 (Loc.555) (Hammer = 30 cm).

Figure 48. Isolated block of dense bone in surface float, probably from the Swaerskraal Member, Farm 219 (Loc. 030). Specimen is *c*. 8 cm in longest dimension.

Figure 49. Extensive surface scatter of sizeable blocks of petrified wood weathering out from the Koornplaats Member, Hamel Kraal Farm 16 (Loc. 041). This site is of conservation significance (See also satellite image in Fig. 49).

Figure 50. Block of well-preserved silicified log showing woody fabric and knots, Hamel Kraal Farm 16 (Same locality as preceding figure) (Scale in cm and mm).

Figure 51. Partially embedded, secondarily-ferruginised petrified log that is breaking up *in situ*, Hamel Kraal Farm 16 (Same locality as Fig. 40) (Scale is 15 cm long).

Figure 52. Blocks of poorly-preserved silicified wood dispersed among surface gravels on Hamel Kraal Farm 16 (Loc. 015) (Scale = 15 cm). This material has probably been reworked from Koornplaats Member channel sandstones in the region.

Figure 53. Close-up of typical block of petrified wood (*c*. 15 cm across) from the Koornplaats Member outcrop area showing abundant cavities and poor preservation of woody fabric. The wood may have been extensively decomposed before diagenetic silicification.

Figure 54. Sizeable blocks of spongy fossil bone occurring as float in the vicinity of the petrified wood surface scatter seen in Fig. 40, Hamel Kraal 16 (Loc. 042) (Scale in cm and mm).

Figure 55. Rounded, reworked bone fragment embedded within ferruginised channel sandstone (*koffieklip*), Hamel Kraal Farm 16 (close to Loc. 041) (Bone is *c*. 1.5 cm wide).

Figure 56. Fragment of a large tusk (*c*. 2.5 cm across, circular in cross-section) – probably therapsid - that has weathered out of a basal channel breccia in the Koornplaats Member, Bruwelskop, Hamel Kraal Farm 16 (Loc. 079).

Figure 57. Fragmentary postcranial tetrapod bones weathering out of a Koornplaats Member basal channel breccia on Hamel Kraal Farm 16 (Loc. 005) (Scale in cm).

Figure 58. Weathered and reworked postcranial bone fragments of one or more large-bodied tetrapods found among surface gravels close to the 132 kV transmission line route on Hamel Kraal Farm 16 (Loc. 024) (Scale in cm).

Figure 59. Fragment of the highly-thickened bony cranium of a tapinocephalid dinocephalian found among float, Hamel Kraal Farm 16 (Loc. 027) (Scale in cm).

Figure 60. Ferruginised mould of transported woody debris preserved within a channel breccia, Koornplaats Member, Bruwelskop, Hamel Kraal Farm 16 (Loc. 079) (Scale in cm and mm).

Figure 61. Blocks of dark-patinated channel sandstone (*koffieklip*) showing prominent-weathering intrastratal horizontal burrows, Hamel Kraal Farm 16 (Loc. 084) (Hammer = 30 cm). These rocks show a superficial resemblance to dolerite.

Figure 62. Abundant low-diversity invertebrate trace fossils and sandy desiccation crack infills associated with a wave-rippled crevasse splay sandstone surface, Hamel Kraal Farm 16 (Loc. 25) (*cf* Fig. **) (Scale in cm).

4. ASSESSMENT OF IMPACTS

Given the rather uniform geology and sparse, largely unpredictable distribution of recorded or anticipated palaeontological resources within the Sutherland WEF electrical grid infrastructure and MTS substation study areas (Section 3), this impact assessment applies equally to entire electrical infrastructure footprint (Figs. 1 to 3).

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 Agencies (in this case Heritage Western Cape and SAHRA) (See Section 1.2). The construction phase of the proposed substation, 132 kV powerline and 400 kV powerline will entail extensive surface clearance (notably for service roads, pylon footings, laydown areas, MTS substation) as well as excavations into the superficial sediment cover and underlying bedrocks (*e.g. for* pylon footings, service roads). 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 planning, operational and de-commissioning phases of the electrical grid infrastructure are very unlikely to involve further adverse impacts on local palaeontological heritage and are therefore not separately assessed here.

4.1. Impact assessment for the construction phase

This assessment (See Table 1) refers to impacts on fossil heritage preserved at or beneath the ground surface within the footprint of the proposed MTS substation and associated 132 kV and 400 kV powerlines during the construction phase, mainly due to surface clearance and excavation activities. It is noted that surface clearance for lengthy service roads associated with new powerlines is likely to have greater impact on fossil heritage than the intermittent, shallow excavations for small pylon footings. Such impacts on fossil heritage are *site specific* (limited to the development footprint) and are generally *direct*, *negative* and of *permanent* duration (non-reversible). 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 (conservation-worthy) fossils* are very scarce and unpredictably distributed here, even where bedrock exposure levels are locally high. Only one highly-sensitive "no-go" area was identified within the electrical grid infrastructure study area and this lies outside the proposed development footprint (Figure 63). It is concluded that impacts on scientifically important palaeontological heritage resources are *unlikely* and of *slight consequence* since (1) significant fossil sites are unlikely to be affected, given the small development footprint and rarity of scientifically-important fossils and (2) in many cases these impacts can be mitigated. The overall impact significance during the construction phase of the substation and powerline infrastructure, including the powerline service road, *without mitigation* is rated as LOW in terms of palaeontological heritage resources. Should the proposed mitigation measures outlined in Section 5 below be fully implemented, the impact significance would be very low. 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 electrical grid infrastructure and MTS substation developments. Confidence levels for this assessment are rated as only *medium*. This is due to the necessarily superficial coverage of the recent field assessment and the absence of field-based palaeontological assessments for the relevant WEF projects.

The impact assessment for the **No-Go Option** considers future impacts on local fossil heritage that are likely to occur in the absence of the WEF powerline and MTS substation 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).

Table 1: Assessment of anticipated direct impacts on palaeontological heritage resources for the proposed Sutherland WEF electrical grid infrastructure, including the MTS substation, 132 kV and 400 kV powerlines as well as the associated service road (construction phase).

Aspect/Activity	**Surface clearance & bedrock excavations during construction phase**
Type of impact	Direct (negative)
Potential Impact	Disturbance / damage or destruction of fossils at or beneath the ground surface
Impact Significance (Pre-Mitigation)	LOW
Mitigation Required	1. Safeguarding of any chance fossil finds (preferably *in situ*) during the construction phase by the responsible ECO, followed by reporting of finds to Heritage Western Cape / SAHRA. 2. Recording and judicious sampling of significant chance fossil finds by a qualified palaeontologist 3. Curation of fossil material within an approved repository (museum / university fossil collection) and 4. Submission of a Phase 2 palaeontological heritage report to HWC / SAHRA by a qualified palaeontologist.
Impact Significance (Post-Mitigation)	VERY LOW

4.2. Assessment of cumulative impacts (construction phase)

In the current absence of field-based palaeontological heritage assessments for the relevant Sutherland, Sutherland 2 and Rietrug WEFs (These studies have been requested in the pre-construction phase by SAHRA, Interim Comment of 5 July 2016; Case ID 9622) as well as the separate Moyeng Energy Suurplaat WEF, it is not yet feasible to meaningfully assess cumulative palaeontological impacts for the associated electrical grid infrastructure. Among available palaeontological impact studies for other developments proposed for the region, the most relevant are those on the Roggeveld Plateau for Jakhals Valley solar project (Almond 2011) and the Gunsfontein WEF (Almond 2015g), both located to the south of Sutherland and west of the present study area. The Gamma-Omega 765 kV powerline study by Almond (2012a) considers fossil heritage in the Koup region to the west of Merweville. There are numerous further WEF projects proposed for the Klein-Roggeveld region, below the great escarpment and south of the present study area, but for the most part these concern rocks and fossil assemblages that are older than those encountered in the present study area; exceptions include the Maralla East and Maralla West WEFs (Almond 2015h, 2015i) as well as the Komsberg West and Komsberg East WEFs (Almond 2015j, 2015k).

In all the strictly *relevant* field-based palaeontological studies in the Klein-Roggeveld and Roggeveld Plateau regions 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 rock units concerned. It is concluded that – pending the outcome of outstanding palaeontological field-based studies for the Moyeng Energy Suurplaat WEF and original Mainstream Sutherland WEF (now split into the Sutherland, Sutherland 2 and Rietrug WEFs) - the cumulative impact significance of the proposed new MTS substation and associated electrical grid infrastructure developments in the context of other regional projects is likely to be *low* (*negative*). This is the case *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 of cumulative (negative, direct) impacts of such a large number of WEFs and associated powerlines affecting the same (albeit sparsely) fossiliferous rock successions would be significantly higher and probable. The cumulative impact significance without mitigation is accordingly assessed provisionally as *medium* (Table 2).

Table 2: Cumulative impacts on palaeontological heritage: summary assessment table (construction phase)

Aspect/Activity	**Surface clearance & bedrock excavations during construction phase**
Type of impact	Direct (negative)
Potential Impact	Disturbance / damage or destruction of fossils at or beneath the ground surface
Impact Significance (Pre-Mitigation)	MEDIUM
Mitigation Required	1. Safeguarding of any chance fossil finds (preferably *in situ*) during the construction phase by the responsible ECO, followed by reporting of finds to Heritage Western Cape / SAHRA. 2. Recording and judicious sampling of significant chance fossil finds by a qualified palaeontologist 3. Curation of fossil material within an approved repository (museum / university fossil collection) and 4. Submission of a Phase 2 palaeontological heritage report to HWC / SAHRA by a qualified palaeontologist.
Impact Significance (Post-Mitigation)	LOW

5. MITIGATION AND MANAGEMENT MEASURES

Given the scarcity of scientifically-important, unique fossil heritage recorded within the electrical grid connection and MTS study area, no further specialist palaeontological studies or mitigation are recommended here, pending the potential discovery of significant new fossils before or during the construction phase.

The following specific and general palaeontological mitigation measures apply to the *construction phase* of the electrical infrastructure development (See Table 3):

- Monitoring of all surface clearance and substantial excavations (>1 m deep) by the ECO 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, followed by reporting of finds to Heritage Western Cape / SAHRA.

- 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 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 Appendix 2). The palaeontologist concerned with potential mitigation work (Phase 2) would need a valid fossil collection permit from the relevant heritage management authority, *i.e.* 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 (2016) and SAHRA (2013).

Significant further impacts on palaeontological heritage resources are not anticipated during the operational, decommissioning and rehabilitation phases of the proposed Sutherland WEF Electrical Grid Infrastructure, so no further mitigation or management measures in this respect are proposed here.

These monitoring and mitigation requirements should be incorporated into the EMPr for the proposed MTS substation and electrical grid infrastructure project and also included as conditions for authorisation of the development.

Figure 63. Google earth satellite image of part of Farm Hamel Kraal 16 showing the location of an extensive surface scatter of petrified wood *plus* occasional bone fragments either side of a farm track (Locs. 041- 074). The yellow polygon outlines a *c*. 30-m wide peripheral buffer zone around the fossil scatter. The black line *c*. 500 m to the northeast shows the 132 kV transmission line route.

Table 3: Management Plan for the Construction Phase (Including pre- and post-construction activities): Palaeontological Heritage

Impact	Mitigation/Management Objectives	Mitigation/Management Actions	Monitoring		
			Methodology	*Frequency*	*Responsibility*
A. CONSTRUCTION PHASE					
A.1. PALAEONTOLOGICAL HRITAGE IMPACTS					
Disturbance, damage or destruction of fossils preserved at or below the ground surface during construction activities - especially ground clearance (e.g. for service roads) and substantial excavations (e.g. pylon footings)	Protection of known sensitive fossil sites from disturbance. Safeguarding, recording and sampling of significant new chance fossil finds. Improved palaeontological database for the SW Karoo region.	1. Safeguarding of any chance fossil finds (preferably *in situ*) during the construction phase by the responsible ECO, followed by reporting of finds to Heritage Western Cape / SAHRA. 2. Recording and judicious sampling of significant chance fossil finds by a qualified palaeontologist, together with pertinent contextual data (stratigraphy, sedimentology, taphonomy) (Phase 2 mitigation). 3. 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.	Monitoring of all surface clearance and substantial excavations (>1 m deep) for fossil material (*e.g.* bones, teeth, fossil wood). Reporting of significant chance fossil finds to the relevant heritage management authority (HWC / SAHRA) and permit application.	On-going during construction Following fossil finds	ECO ECO and qualified Palaeontologist (appointed by the Project Developer)

6. ACKNOWLEDGEMENTS

Ms Rohaida Abed as well as Ms Surina Laurie of the CSIR – Environmental Management Services offices in Durban and Stellenbosch are both thanked for providing a constant, and sometimes overwhelming, stream of background information for this project as well as for managing the various stages of the fieldwork and report preparation. I am grateful to Dr Jayson Orton of ASHA Consulting (Pty) Ltd, Cape Town, for advice on heritage management issues during the course of project and for incorporating the palaeontological data into a meaningful Heritage Impact Assessment. Logistical back-up as well as assistance in the field *plus* companionship from Ms Madelon Tusenius is, as ever, very much appreciated.

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QUALIFICATIONS & EXPERIENCE OF THE 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 in Germany, and has carried out palaeontological research in Europe, North America, the Middle East as well as North and South Africa. 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 palaeontological impact assessments for developments and conservation areas in the Western, Eastern and Northern Cape, Limpopo, Northwest, Gauteng and the Free State under the aegis of his Cape Town-based company *Natura Viva* cc. He has served as a long-standing 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).

Specialist Declaration

I, Dr John Edward Almond, as the appointed independent specialist, in terms of the 2014 EIA Regulations, hereby declare that I:

- I act as the independent specialist in this application;
- I perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant;
- regard the information contained in this report as it relates to my specialist input/study to be true and correct, and do not have and will not have any financial interest in the undertaking of the activity, other than remuneration for work performed in terms of the NEMA, the Environmental Impact Assessment Regulations, 2014 and any specific environmental management Act;
- I declare that there are no circumstances that may compromise my objectivity in performing such work;
- I have expertise in conducting the specialist report relevant to this application, including knowledge of the Act, Regulations and any guidelines that have relevance to the proposed activity;
- I will comply with the Act, Regulations and all other applicable legislation;
- I have no, and will not engage in, conflicting interests in the undertaking of the activity;
- I have no vested interest in the proposed activity proceeding;
- I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing - any decision to be taken with respect to the application by the competent authority; and the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
- I have ensured that information containing all relevant facts in respect of the specialist input/study was distributed or made available to interested and affected parties and the public and that participation by interested and affected parties was facilitated in such a manner that all interested and affected parties were provided with a reasonable opportunity to participate and to provide comments on the specialist input/study;
- I have ensured that the comments of all interested and affected parties on the specialist input/study were considered, recorded and submitted to the competent authority in respect of the application;
- all the particulars furnished by me in this specialist input/study are true and correct; and
- I realise that a false declaration is an offence in terms of regulation 48 and is punishable in terms of section 24F of the Act.

Name of Specialist: Dr John Edward Almond

John E. Almond

Signature of the specialist:

Date: 18 July 2019

APPENDIX 1: SUTHERLAND WEF ELECTRICAL GRID INFRASTRUCTURE FOSSIL SITES & SELECTED GEO-SITES

All GPS readings were taken in the field using a hand-held Garmin GPSmap 60CSx instrument. The datum used is WGS 84. Land parcel names used in the table refer to those shown on the relevant 1: 50 000 topographical maps published by the Chief Directorate: National Geo-spatial Information, Mowbray. Fossil localities that were recorded during fieldwork are shown in relation to relevant major components of the proposed development footprint on the satellite image provided in Figure 1. Please note that this map does *not* show all fossils that are present at surface within the study area, and additional, unrecorded fossil occurrences (the majority) are to be expected at the surface or 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.

N.B. Fossil locality data is not for general release to the public (e.g. through publication on open access websites) for conservation reasons.

Loc. No.	GPS data	Comments
NEW FOSSIL SITES FROM SUTHERLAND ROAD & POWERLINE PROJECT Nov 2016- Feb 2017, June 2019		
001	S32° 38' 22.0" E21° 16' 01.9"	Farm De Molen. Small hillslope exposures (probably Koornplaats Member) of grey-green overbank mudrocks, fine-grained channel sandstones close to access road deviation. Metre-scale upward-coarsening packages capped by thin-bedded siltstones. Occasional horizons of small, pale grey palaeocalcrete concretions (well-developed palaesols).
002	S32° 38' 39.7" E21° 16' 02.2"	Farm Hamel Kraal. Sheetwash gravel-covered *vlaktes* and low exposures of crumbly, grey-green and purple-brown overbank mudrocks in foothills of low escarpment. Weathering-out horizons of irregular-shaped calcrete concretions. Local mantle of well-rounded corestones of downwasted, brownish, fine-grained channel sandstone.
003	S32° 38' 42.3" E21° 16' 03.1"	Farm Hamel Kraal. Streambed exposure of fine-grained crevasse-splay sandstone with upper bedding plane showing abundant small-scale invertebrate burrows (c. 5 mm diam.) – probably including *Scoyenia* – as well as stem casts of reedy plants (possibly equisetalean ferns), microbial mat textures. Probable Koornplaats Member. Proposed Field Rating IIIC.
004	S32° 38' 59.2" E21° 16' 30.5"	Farm Hamel Kraal. Crumbly, yellowish-brown, thin-bedded / flaggy to cross-bedded channel sandstones of the Koornplaats Member associated with well-developed lenses (50-100 cm thick) of well-cemented, rusty-brown weathering basal channel breccio-conglomerates. These predominantly of subrounded reworked calcrete clasts, ferruginous mudflakes.
005	S32° 39' 00.1" E21° 16' 30.4"	Farm Hamel Kraal. Fragments of post-cranial bones weathering-out of breccias in the Koornplaats Member which are also associated with rusty-brown ferruginous moulds of transported woody plant axes. Proposed Field Rating IIIC.
006	S32° 38' 59.0" E21° 16' 22.7"	Farm Hamel Kraal. Low hill exposures of crumbly, grey-green and purple-brown Koornplaats Member mudrocks capped by thin sandstones and basal breccias.
007	S32° 39' 00.1" E21° 16' 18.8"	Farm Hamel Kraal. Sheetwash gravels with occasional reworked blocks of vuggy silicified wood showing poorly-developed xylem structure – perhaps a result of pre-diagenetic decomposition. Proposed Field Rating IIIC.
009	S32° 39' 19.2" E21° 16' 45.0"	Farm Hamel Kraal. Greyish-patinated, blocky-weathering, medium-grained channel sandstone (probably Koornplaats Member but atypical, if so) weathering out as ridge in *veld*.
010	S32° 39' 42.6" E21° 16' 48.1"	Farm Hamel Kraal. Low scarp of Koornplaats Member grey-green and purple-brown overbank mudrocks with calcrete pedocretes, intervals of tabular, thin-bedded sandstones, succession capped by crumbly, flaggy, yellowish-brown sandstones. Local development of ferruginised basal channel breccias. Colluvial gravels of sandstone mantle most hillslopes.
011	S32° 40' 03.9" E21° 16' 44.3"	Farm Hamel Kraal. Footslopes of low hills of Koornplaats Member mudrocks with weathered-out, angular to subrounded clasts ferruginous carbonate concretions (*koffieklip*).

012	S32° 40' 06.2" E21° 16' 38.8"	Farm Hamel Kraal. Low hilly exposures of Koornplaats Member grey-green and purple-brown, massive to thin-bedded mudrocks with horizons of ferruginous carbonate / *kofffieklip*, pale grey-brown calcrete concretions. Scree slopes of well-rounded corestones of fine-grained channel sandstone.
013	S32° 40' 37.0" E21° 16' 32.7"	Farm Hamel Kraal. Low sandstone-capped scarp with good views southwestwards into grid connection study area. Extensive alluvial *vlaktes* traversed by shallow ephemeral streams and mantled by alluvial gravels.
014	S32° 40' 53.7" E21° 16' 25.2"	Farm Hamel Kraal. Road cutting exposure through medium-bedded, grey-green to purple-brown mudrocks of the Koornplaats Member with occasional horizons of pedogenic calcrete nodules.
015	S32° 41' 55.5" E21° 16' 09.4"	Farm Hamel Kraal. Surface gravels with local concentration of blocks of poorly-preserved, silicified and partially ferruginised wood, some showing recognisable woody fabric, others not (possibly due to pre-diagenetic decomposition). Proposed Field Rating IIIC.
016	S32° 41' 57.0" E21° 15' 43.5"	Farm Hamel Kraal. Alluvial *vlaktes* and low bedrock exposures east of MTS site traversed by shallow ephemeral streams with poorly-consolidated, alluvial gravels and sands. Lenses of *koffieklip* within mudrocks. Patches of sheetwash gravels with occasional reworked blocks of poorly-preserved silicified wood, fine-grained sandstone stone artefacts, calcrete concretions, vein quartz *etc*. Proposed Field Rating IIIC.
017	S32° 41' 56.2" E21° 15' 34.4"	Farm Hamel Kraal. Sparse blocks of poorly-preserved silicified wood in surface gravels. Apron of coarse sandstone colluvial gravels in foothills of Bakenkop. Proposed Field Rating IIIC.
018	S32° 41' 59.6" E21° 15' 25.3"	Farm Hamel Kraal. Sparse blocks of poorly-preserved silicified wood in surface gravels. Proposed Field Rating IIIC.
019	S32° 42' 00.9" E21° 15' 22.4"	Farm Hamel Kraal. Small, low hillslope exposures crumbly grey-green and purple-brown mudrocks of the Koornplaats Member. Apron of coarse, blocky, fine-grained sandstone colluvial gravels in foothills and slopes of Bakenkop. Several; packages of thin- to medium-bedded, crumbly, yellowish-brown channel sandstones, locally with erosive bases, basal channel breccio-conglomerates and *koffieklip* concretions, capping mudrock packages. Upland areas of MTS site dominated by Koornplaats channel sandstones as well as downwasted surface gravels of sandstone, *koffieklip* and vein quartz.
020	S32° 41' 55.8" E21° 15' 11.3"	Farm Hamel Kraal. Surface gravels with locally abundant angular clasts of vein quartz, some showing mineral lineation surfaces / slickensides.
021	S32° 41' 58.4" E21° 15' 11.4"	Farm Hamel Kraal. Upland viewpoint across MTS study area dominated by Koornplaats Member channel sandstones and sandstone colluvial rubble. Occasional small hillslope exposures of grey-green overbank mudrocks, crevasse-splay sandstones, especially on lower foot-slopes of Bakenkop..
022	S32° 41' 51.3" E21° 15' 25.0"	Farm Hamel Kraal. Alluvial gravels and sands on eastern foot of Bakenkop with sparse blocks of poorly-preserved petrified wood. Proposed Field Rating IIIC.
023	S32° 41' 51.6" E21° 15' 36.0"	Farm Hamel Kraal. Surface gravels east of MTS site with sparse blocks of silicified wood. Proposed Field Rating IIIC.
024	S32° 41' 51.8" E21° 15' 38.7"	Farm Hamel Kraal. Sheetwash surface gravels of sandstone, vein quartz with local concentrations of poorly-preserved, weathered and disarticulated postcranial bones of sizeable tetrapod(s) - possibly dinocephalian or pareisaur – as well as blocks of poorly-preserved petrified wood. Proposed Field Rating IIIC.
025	S32° 41' 53.1" E21° 16' 09.1"	Farm Hamel Kraal. Low hill capped by rusty-brown *koffieklip* breccias. Streambed exposure of wave-rippled sandstone palaeosurface with small-scale, low-diversity ichnoassemblages (epichnial furrows, narrow sinuous burrows), sandstone-infilled desiccation cracks. Proposed Field Rating IIIC.
026	S32° 43' 10.4" E21° 15' 33.2"	Farm Hamel Kraal. Low *koppies* of Koornplaats Member sandstones and mudrocks. Extensive *koffieklip* gravels on footslopes.
027	S32° 43' 09.3" E21° 15' 31.0"	Farm Hamel Kraal. Float block fragment of very thick bony skull roof of a tapinocephalid dinocephalian. Weathering-out calcrete palaeosols. Proposed Field Rating IIIC.
028	S32° 43' 56.2" E21° 15' 32.4"	Farm Hamel Kraal. Thick package of crumbly grey-green to purple-brown mudrocks – either within Koornplaats Member or possibly the overlying Swaerskraal Member.
493	S32° 29' 27.2" E20° 46' 38.0"	Farm Matjesfontein 92. Partial thin-boned skull roof, scapula and unidentified, worn postcranial bones in surface float (probably dinocephalian, possibly tapinocephalid). Note historical *Tapinocephalus* Assemblage Zone fossil locality marked around here on 1: 250 000 geology map Sutherland 3220. Proposed Field Rating IIIC.
494	S32° 29' 26.3" E20° 46' 38.5"	Farm Matjesfontein 92. End of very robust limb bone (dinocephalian / pareiasaur) – partially embedded in soil. Proposed Field Rating IIIC.

495	S32° 29' 29.2" E20° 46' 41.1"	Farm Matjesfontein 92. Highly weathered, worn postcranial bone fragment in float. Proposed Field Rating IIIC.
496	S32° 29' 29.8" E20° 46' 41.4"	Farm Matjesfontein 92. Cluster of several highly weathered, worn postcranial bone fragments in float. Proposed Field Rating IIIC.
502	S32° 30' 38.3" E20° 52' 28.5"	Farm Portugals Rivier 218. Dykes of well-exposed ferruginised pyroclastic breccia of the Sutherland Suite.
509	S32° 31' 04.4" E20° 54' 47.2"	Farm Portugals Rivier 218. Well-developed channel breccias containing several disarticulated and worn tetrapod postcranial bone fragments. Ferruginised oblique burrow (*c.* 5.5 cm wide) excavated through breccia bed. Proposed Field Rating IIIC.
512	S32° 31' 16.4" E20° 56' 11.0"	Farm Portugals Rivier 218. Horizon with numerous subvertical lungfish burrow casts excavated into maroon overbank mudrocks exposed in cutting on southern side of dust road. Proposed Field Rating IIIB.
513	S32° 31' 42.6" E20° 56' 51.9"	Farm Portugals Rivier 218. Blocks of greyish-purple wacke with assemblage of narrow vertical sand-infilled cylinders – probably casts of reedy plant stems (*e.g.* sphenophytes or “horsetails”). Proposed Field Rating IIIC.
515	S32° 32' 06.1" E20° 58' 03.4"	Farm Annex Bakoven 135/1. Flaggy sandstone blocks with plant stem casts, small invertebrate traces of the *Scoyenia* ichnofacies. Proposed Field Rating IIIC.
521	S32° 33' 48.5" E21° 00' 14.1"	Farm Nooigedagt 148. Karelskraal Member. Several large, gently inclined, subcylindrical tetrapod burrow casts (*c*. 15 cm wide) of sandstone embedded in maroon overbank mudrocks. The best example shows well-developed scratch marks on the ventrolateral surface. These are among the youngest recorded tetrapod burrows within the Abrahamskraal Formation and were possibly constructed by dicynodonts. Proposed Field Rating IIIB.
530	S32° 36' 32.6" E20° 52' 19.0"	Farm Beeren Valley 150. Bioturbated swaley channel sandstone palaeosurface with poorly-preserved horizontal burrows and other ill-defined traces. Proposed Field Rating IIIC.
532	S32° 36' 27.6" E20° 54' 24.5"	Farm Beeren Valley 150. Two isolated pieces of highly-weathered postcranial bones in surface float. Proposed Field Rating IIIC.
535	S32° 36' 36.9" E20° 55' 29.2"	Farm Beeren Valley 150. Articulated partial postcranial skeleton of a large tetrapod embedded in grey-green overbank mudrocks. This specimen is conservation-worthy and should be protected by a buffer zone of 30 m radius. Proposed Field Rating IIIB.
539	S32° 36' 53.5" E20° 57' 34.1"	Farm Nooigedagt 148. Disarticulated limb bone of large tetrapod embedded in maroon mudrocks, showing sun-dried surface texture. Proposed Field Rating IIIC.
540	S32° 36' 53.6" E20° 57' 33.9"	Farm Nooigedagt 148. Fragment of long bone in surface float. Discrete cluster of several pebble- to cobble-sized exotic clasts (“lonestones”) embedded within maroon overbank mudrocks. The larger cobbles are of a greenish-grey igneous rock (possibly andesite) and are subrounded. They are among the largest exotic clasts recorded from the Lower Beaufort Group in the SW Karoo. The conglomeratic lens also contains weathered, dark-grey tillite-like material, suggesting a Dwyka Group provenance for the pebbles which may have been brought into the Mid Permian Karoo Basin by floating tree roots or ice floes.
545	S32° 33' 10.2" E20° 54' 13.0"	Farm Portugals Rivier 218. Several highly weathered postcranial bones in surface float, showing sun-cracked surface textures. Proposed Field Rating IIIB.
546	S32° 33' 11.2" E20° 54' 16.1"	Farm Portugals Rivier 218. Scatter of numerous disarticulated, weathered bones of a large tetrapod (dinocephalian / pareiasaur) among sandstone scree. Proposed Field Rating IIIB.
548	S32° 34' 35.1" E21° 00' 29.7"	Farm Nooigedagt 148. Kareskraal Member. *Possible* vertebrate burrow casts (*c*. 30 cm wide). Requires confirmation. Proposed Field Rating IIIC.
550	S32° 34' 40.0" E21° 00' 27.4"	Farm Nooigedagt 148. Partial disarticulated skull of small tetrapod with a boat-shaped lower jaw (probably dicynodont) embedded in pedocrete horizon. Proposed Field Rating IIIC.
555	S32° 38' 21.2" E20° 59' 33.7"	Farm Nooigedagt 148. Possible sandstone cast of vertebrate burrow (*c*. 15 cm wide) within maroon overbank mudrocks (requires confirmation). Proposed Field Rating IIIC.
556	S32° 37' 16.3" E20° 58' 47.9"	Farm Nooigedagt 148. Two highly-weathered post-cranial bones of a large tetrapod in surface float. Proposed Field Rating IIIC.
029	S32° 37' 27.8" E21° 05' 52.4"	Farm 219, escarpment edge nr Blouval. Several small bone fragments (possibly amphibian based on rugose surface texture) within mudflake-rich conglomerate horizon (sandstone float block). Proposed Field Rating IIIC.
030	S32° 37' 29.7" E21° 05' 53.3"	Farm 219, escarpment edge nr Blouval. Extensive hillslope and gulley exposure of blue-green, grey-green and purple-brown Abrahamskraal Fm mudrocks, thin crevasse splay sandstones. Well-developed palaeocalcrete pedogenic horizons

		(sl. ferruginised). Gypsum pseudomorphs and unidentified bone fragment in float. Proposed Field Rating IIIC.
031	S32° 37' 42.7" E21° 06' 34.7"	Farm 219, upper escarpment zone (Langpunt track). Hillslope exposure of grey-green mudrocks and flaggy sandstones – probably of Koornplaats Member. Isolated rolled bone fragment within thin mudflake breccia.
041	S32° 38' 51.9" E21° 15' 42.1"	Hamel Kraal 16, extensive surface scatter of large blocks of silicified wood and rare blocks of spongy bone on either side of farm track. Probably weathered out from base of local yellowish-brown channel sandstones (Koornplaats Member, Abrahamskraal Fm). and locally associated with *koffieklip* ferruginous carbonate concretionary lenses containing occasional rolled bone fragments. Wood preservation often poor, ferruginized, vuggy (possibly partially rotted before petrification) but some material shows well-preserved woody fabric (prominent seasonal growth lines). This site is conservation-worthy and should be protected by a 50-m wide buffer zone. Proposed Field Rating IIIB.
042	S32° 38' 53.7" E21° 15' 42.4"	Hamel Kraal 16, float blocks of robust fossil bone just south of fossil wood surface scatter. Proposed Field Rating IIIB.
043	S32° 38' 53.2" E21° 15' 41.3"	Petrified wood block within surface scatter on Hamel Kraal 16. Proposed Field Rating IIIB.
044	S32° 38' 52.2" E21° 15' 41.3"	Petrified wood block within surface scatter on Hamel Kraal 16. Proposed Field Rating IIIB.
045	S32° 38' 52.3" E21° 15' 41.4"	Petrified wood block within surface scatter on Hamel Kraal 16. Proposed Field Rating IIIB.
046	S32° 38' 52.3" E21° 15' 41.5"	Petrified wood block within surface scatter on Hamel Kraal 16. Proposed Field Rating IIIB.
047	S32° 38' 52.3" E21° 15' 41.5"	Petrified wood block within surface scatter on Hamel Kraal 16. Proposed Field Rating IIIB.
048	S32° 38' 52.2" E21° 15' 41.6"	Petrified wood block within surface scatter on Hamel Kraal 16. Proposed Field Rating IIIB.
049	S32° 38' 52.1" E21° 15' 41.7"	Petrified wood block within surface scatter on Hamel Kraal 16. Proposed Field Rating IIIB.
050	S32° 38' 51.9" E21° 15' 41.7"	Petrified wood block within surface scatter on Hamel Kraal 16. Proposed Field Rating IIIB.
051	S32° 38' 51.9" E21° 15' 41.7"	Petrified wood block within surface scatter on Hamel Kraal 16. Proposed Field Rating IIIB.
052	S32° 38' 51.8" E21° 15' 41.6"	Petrified wood block within surface scatter on Hamel Kraal 16. Proposed Field Rating IIIB.
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057	S32° 38' 52.2" E21° 15' 42.1"	Petrified wood block within surface scatter on Hamel Kraal 16. Proposed Field Rating IIIB.
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061	S32° 38' 52.0" E21° 15' 42.3"	Petrified wood block within surface scatter on Hamel Kraal 16. Proposed Field Rating IIIB.
062	S32° 38' 52.0" E21° 15' 42.4"	Petrified wood block within surface scatter on Hamel Kraal 16. Proposed Field Rating IIIB.
063	S32° 38' 51.9" E21° 15' 42.5"	Petrified wood block within surface scatter on Hamel Kraal 16. Proposed Field Rating IIIB.
064	S32° 38' 51.8" E21° 15' 42.6"	Petrified wood block within surface scatter on Hamel Kraal 16. Proposed Field Rating IIIB.
065	S32° 38' 51.8" E21° 15' 42.6"	Petrified wood block within surface scatter on Hamel Kraal 16. Proposed Field Rating IIIB.
066	S32° 38' 52.2" E21° 15' 43.5"	Petrified wood block within surface scatter on Hamel Kraal 16. Proposed Field Rating IIIB.
067	S32° 38' 52.7"	Petrified wood block within surface scatter on Hamel Kraal 16. Proposed Field

	E21° 15' 43.4"	Rating IIIB.
068	S32° 38' 52.7" E21° 15' 43.3"	Petrified wood block within surface scatter on Hamel Kraal 16. Proposed Field Rating IIIB.
069	S32° 38' 52.6" E21° 15' 43.1"	Petrified wood block within surface scatter on Hamel Kraal 16. Proposed Field Rating IIIB.
070	S32° 38' 52.6" E21° 15' 43.1"	Petrified wood block within surface scatter on Hamel Kraal 16. Proposed Field Rating IIIB.
071	S32° 38' 52.5" E21° 15' 43.1"	Petrified wood block within surface scatter on Hamel Kraal 16. Proposed Field Rating IIIB.
072	S32° 38' 52.3" E21° 15' 42.8"	Petrified wood block within surface scatter on Hamel Kraal 16. Proposed Field Rating IIIB.
073	S32° 38' 52.3" E21° 15' 42.7"	Petrified wood block within surface scatter on Hamel Kraal 16. Proposed Field Rating IIIB.
074	S32° 38' 52.3" E21° 15' 42.6"	Petrified wood block within surface scatter on Hamel Kraal 16. Proposed Field Rating IIIB.
077	S32° 40' 19.8" E21° 15' 28.6"	Hamel Kraal 16, N side of Brewelskop. Tabular, flat-laminated sandstones with cylindrical casts of plant stems (probably sphenophytes / horsetails). Proposed Field Rating IIIC.
079	S32° 40' 23.1" E21° 15' 33.1"	Hamel Kraal 16, N side of Brewelskop. Well-developed (*c*. 50 cm) basal channel breccia packed with reworked calcrete nodules as well as abundant rusty-brown, ferruginized moulds of transported woody plant debris. Plant debris layers or lenses also present within overlying flaggy channel sandstones. Isolated large therapsid tusk (*c*. 25 mm diam.) in float has probably weathered out from basal breccias, or possibly from calcrete palaeosol within underlying mudocks. Proposed Field Rating IIIC.
081	S32° 40' 48.4" E21° 15' 53.6"	Hamel Kraal 16, south of Brewelskop. Isolated rounded bone fragment (*c*. 5 cm across) in float. Proposed Field Rating IIIC.
084	S32° 42' 41.8" E21° 15' 51.5"	Hamel Kraal 16. Unusually extensive development of lens of brown-weathering, ferruginous-patinated greyish channel sandstones either side of dust road and *c*. 1 km SE of proposed Eskom Nuwerust Substation. Dolerite-like sandstone corestones locally show fine internal lamination as well as low-diversity assemblages of prominent-weathering, intrastratal, subcylindrical invertebrate burrows (*c*. 1 cm wide). Proposed Field Rating IIIC.

Uranium anomalies on 1: 250 000 sheet Sutherland

Data abstracted from Cole & Vorster (1999) (See Fig. 18 in text).

U Anomaly	Farm	Co-ordinates
180	Gunstfontein 151	32 35 20 S, 20 48 01 E
181	Gunstfontein 151	32 35 07 S, 20 51 55 E
183	Beerenvalley 150	32 35 59 S, 20 55 29 E
187	Beerenvalley 150	32 37 48 S, 20 55 08 E 32 37 43 S, 20 54 50 S

<table>
<tr><td colspan="3">CHANCE FOSSIL FINDS PROCEDURE: Electrical grid infrastructure to support the authorised Rietrug, Sutherland and Sutherland 2 Wind Energy Facilities, Northern and Western Cape Provinces</td></tr>
<tr><td>Province & region:</td><td colspan="2">Northern Cape, Sutherland & Laingsburg Districts</td></tr>
<tr><td>Responsible Heritage Resources Agency</td><td colspan="2">SAHRA, 111 Harrington Street, Cape Town. PO Box 4637, Cape Town 8000, South Africa.
Phone: +27 (0)21 462 4502. Fax: +27 (0)21 462 4509. Web: www.sahra.org.za
HWC, 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</td></tr>
<tr><td>Rock unit(s)</td><td colspan="2">Abrahamskraal Formation (Lower Beaufort Group, Karoo Supergroup)
Late Caenozoic alluvium along water courses and calcrete hardpans</td></tr>
<tr><td>Potential fossils</td><td colspan="2">Petrified wood and other plant remains, skeletal remains of tetrapods (e.g. therapsids), trace fossils of invertebrates and vertebrate burrows in Abrahamskraal Formation bedrocks . Bones, teeth and horn cores of mammals, freshwater molluscs, calcretised termitaria and other trace fossils in older 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 Authority 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 Authority</td></tr>
<tr><td>Specialist palaeontologist</td><td colspan="2">Record, describe and judiciously sample fossil remains together with relevant contextual data (stratigraphy / sedimentology / taphonomy). Ensure that fossils are curated in an approved repository (e.g. museum / university / Council for Geoscience collection) together with full collection data. Submit Palaeontological Mitigation report to Heritage Resources Agency. Adhere to best international practice for palaeontological fieldwork and Heritage Resources Authority minimum standards.</td></tr>
</table>