PALAEONTOLOGICAL HERITAGE REPORT: DESKTOP ASSESSMENT

PROPOSED EXPANSION OF THE AUTHORISED PROTEA SOLAR POWER PLANT ON THE REMAINING EXTENT OF THE FARM HARTSBOOM NO. 734, NALEDI LOCAL MUNICIPALITY, NORTH WEST PROVINCE

Dr John E. Almond
***Natura Viva* cc**
PO Box 12410 Mill Street
CAPE TOWN 8010, RSA
naturaviva@universe.co.za

April 2021

EXECUTIVE SUMMARY

Protea Solar Power Plant (RF) (Pty) Ltd is proposing to develop a photovoltaic solar facility and associated infrastructure, including a battery storage facility, on the Remaining Extent of the Farm Hartsboom No. 734, Naledi Local Municipality, North West Province. Proposed expansions of the currently authorized 115 MW solar facility, which is subject to a new Basic Assessment Process, will have an additional installed capacity of up to 30 MW and a total additional footprint of approximately 70 hectares (including supporting infrastructure on site). Connection to the National Grid will be *via* a *c*. 9 km long 132 kV powerline to the existing Mookodi Substation which has already been assessed by the author (Almond 2016g). The grid connection is therefore not re-assessed or considered as part of this report.

The solar plant project area is underlain near-surface or at depth by Permo-Carboniferous glacial deposits of the Dwyka Group (Karoo Supergroup). Stromatolitic carbonate bedrocks of the Transvaal Group are not mapped here. The flat-lying solar power plant project area is entirely mantled by Neogene (Late Tertiary) to Holocene superficial sediments including alluvial gravels, sandy soils and calcrete hardpans that are generally of low to very low palaeosensitivity.

It is concluded that the palaeontological sensitivity of the small additional project area - including the solar power plant and all associated infrastructure – is Low to Very Low. Potential impacts during the construction phase are assessed as being of Low (Negative) significance without mitigation and Low (Negative) significance following potential mitigation triggered by the Chance Fossil Finds Procedure which is to be implemented by the ECO during the Construction Phase. The anticipated cumulative impact of the proposed or authorised solar power plant developments in the Vryburg region - including the proposed expanded area of the Protea Solar Power Plant - is assessed as Medium Negative (without mitigation), potentially falling to Low Negative (with full mitigation), given their comparatively small footprints compared with the extensive outcrop areas of the fossiliferous rock units concerned. The No-Go Option would probably have a neutral impact significance.

There are no fatal flaws associated with the proposed expanded solar power plant project from a palaeontological heritage viewpoint. There are no objections to authorization of the

development, provided that the recommended mitigation measures (summarized in Tables 4 and 5) are incorporated into the EMPr for this project and fully implemented.

The ECO responsible for the construction phase of the project should be aware of the potential for important new fossil finds and the necessity to conserve them for possible professional mitigation. The ECO should monitor all site clearance and substantial excavations for fossil remains on an on-going basis during the construction phase (See Chance Fossil Finds Procedure outlined in Appendix 2). Recommended mitigation of chance fossil finds involves safeguarding of the fossils (preferably *in situ*) by the responsible ECO and reporting of finds to SAHRA (Contact details: 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). Where appropriate, judicious sampling and recording of fossil material and associated geological data by a qualified palaeontologist, appointed by the developer, may be necessary, under a Fossil Collection Permit issued by the relevant heritage resources authority (SAHRA). Any fossil material collected should be curated within an approved repository (museum / university fossil collection) by a qualified palaeontologist.

1. PROJECT DESCRIPTION & BRIEF

The company Protea Solar Power Plant (RF) (Pty) Ltd is proposing to develop a photovoltaic solar facility and associated infrastructure, including a battery storage facility, on the Remaining Extent of the Farm Hartsboom No. 734, situated some 13 km south of the town of Vryburg in the Naledi Local Municipality, North West Province (Figs. 1 & 2). Proposed expansions of the currently authorized 115 MW solar facility (DFFE Reference: 14/12/16/3/3/2/914) will have an additional installed capacity of up to 30 MW and a total additional footprint of approximately 70 hectares (including supporting infrastructure on site). The expansion of the solar power plant is assessed within this desktop study. Connection to the National Grid will be *via* a 9 km long 132 kV powerline connecting to the existing Mookodi Substation which has already been assessed by the author (Almond 2016g). According to the Project Description Document prepared by Environamics Environmental Consultants (19 March 2021) the proposed additions to the renewable energy development will comprise the following key components:

- **PV Panel Array** - To produce up to 30MW, the proposed facility will require numerous linked cells placed behind a protective glass sheet to form a panel. Multiple panels will be required to form the solar PV arrays which will comprise the PV facility. The PV panels will be tilted at a northern angle in order to capture the most sun, or using one-axis tracker structures to follow the sun to increase the Yield.
- **Wiring to Inverters** - Sections of the PV array will be wired to inverters. The inverter is a pulse width mode inverter that converts direct current (DC) electricity to alternating current (AC) electricity at grid frequency.
- **Fencing** - For health, safety and security reasons, the facility will be required to be fenced off from the surrounding farm. Fencing with a height of 2.5 meters will be used.
- **Roads** – Access will be obtained *via* the authorized access point leading from the N18 National Road. An internal site road network will also be required to provide access to the solar field and associated infrastructure. The access and internal roads will be constructed within a 25-meter corridor.

Further technical details for the project are outlined in Table 1 below (likewise abstracted from the Project Description Document prepared by Environamics Environmental Consultants).

According to the Environmental Screening Report prepared for the proposed solar facility by Environamics the project area is of Medium Palaeosensitivity (Fig. 4) while the field-based palaeontological assessment for the original Protea Solar Power Plant (Almond 2016g) assigned a Low Sensitivity to the project area. The present desktop palaeontological heritage assessment has accordingly been commissioned on behalf of the proponent by the responsible independent EAP, Environamics Environmental Consultants, Potchefstroom (Contact details: Christia van Dyk. Environamics Environmental Consultants, 14 Kingfisher Street, Tuscany Ridge Estate, Potchefstroom, 2531. Telephone: 086 762 8336 (f); 083 450; 0406 (Cell). Electronic Mail: christia@environamics.co.za). This report will contribute to the Basic Assessment Process for the proposed development, including the overarching Heritage Impact Assessment as well as the Environmental Management Programme (EMPr) for the proposed expansion to the authorized solar plant development.

Table 1: Technical details for the proposed additions to the authorised Solar Power Plant

Component	Description / dimensions
Height of PV panels	6 meters
Area of PV Array	70 hectares
Number of inverters required	Minimum 10
Area occupied by inverter / transformer stations	Central inverters+ LV/MV trafo: 20 m^2
Area occupied by both permanent and construction laydown areas	Permanent Laydown Area: 70 Hectares
Length of internal roads	Approximately 3 km
Width of internal roads	Between 6 & 12 meters
Height of fencing	Approximately 2.5 meters

1.1. Brief for the palaeontological study

1.1.1. General requirements

Specialists' reports must be aligned with Appendix 6 of GNR326 published under sections 24(5), and 44 of the National Environmental Management Act, 1998 (Act No. 107 of 1998), as amended and whereby the following are to be included:

- The details of-
    - the specialist who prepared the report; and
    - the expertise of that specialist to compile a specialist report including a curriculum vitae;
- A declaration that the specialist is independent in a form as may be specified by the competent authority;
- An indication of the scope of, and the purpose for which, the report was prepared;
    - An indication of the quality and age of base data used for the specialist report;

    - A description of existing impacts on the site, cumulative impacts of the proposed development and levels of acceptable change;
- The duration, date and season of the site investigation and the relevance of the season to the outcome of the assessment;
- A description of the methodology adopted in preparing the report or carrying out the specialised process inclusive of equipment and modelling used;
- Details of an assessment of the specific identified sensitivity of the site related to the proposed activity or activities and its associated structures and infrastructure, inclusive of a site plan identifying site alternatives;
- An identification of any areas to be avoided, including buffers;
- A map superimposing the activity including the associated structures and infrastructure on the environmental sensitivities of the site including areas to be avoided, including buffers;
- A description of any assumptions made and any uncertainties or gaps in knowledge;
- A description of the findings and potential implications of such findings on the impact of the proposed activity, or activities;
- Any mitigation measures for inclusion in the EMPr;
- Any conditions for inclusion in the environmental authorisation;
- Any monitoring requirements for inclusion in the EMPr or environmental authorisation;
- A reasoned opinion-
    - whether the proposed activity, activities or portions thereof should be authorised;
        - regarding the acceptability of the proposed activity or activities; and
    - if the opinion is that the proposed activity, activities or portions thereof should be authorised, any avoidance, management and mitigation measures that should be included in the EMPr, and where applicable, the closure plan;
- A description of any consultation process that was undertaken during the course of preparing the specialist report;
- A summary and copies of any comments received during any consultation process and where applicable all responses thereto; and
- Any other information requested by the competent authority.

In addition to the above, specialists are expected to:

- Identify any issue or aspect that needs to be assessed and provide expert opinion on any issue in their field of expertise that they deem necessary in order to avoid potential detrimental impacts;
- Assess the degree and extent of all identified impacts (including cumulative impacts) that the preferred project activity and its proposed alternatives, including that of the no-go alternative, may have;
- Identify and list all legislation and permit requirements that are relevant to the development proposal in context of the study;
- Reference all sources of information and literature consulted; and
- Include an executive summary to the report.

1.1.2. Terms of reference for the paleontological heritage assessment

The scope of work for the palaeontological assessment study will consist of:

- A desktop investigation of the area, in which all geological maps, published scientific literature, previous paleontological impact studies in the same region and the author's field of experience (consultation with professional colleagues as well as examination of institutional fossil collections and data) should be studied and used.
- Based on the outcome of the screening report, the need for a field assessment must be determined. The desktop investigation must be supplemented with a field assessment if required.
- Assess the potential impacts, based on a supplied methodology.
- Describe mitigation measures to address impacts during the construction, operation and decommissioning stages.
- Describe cumulative impacts of the project on paleontological resources in both the local study area regional study area and the proponent's plans to manage those effects.
- Supply the client with geo-referenced GIS shape files of any sensitive areas.

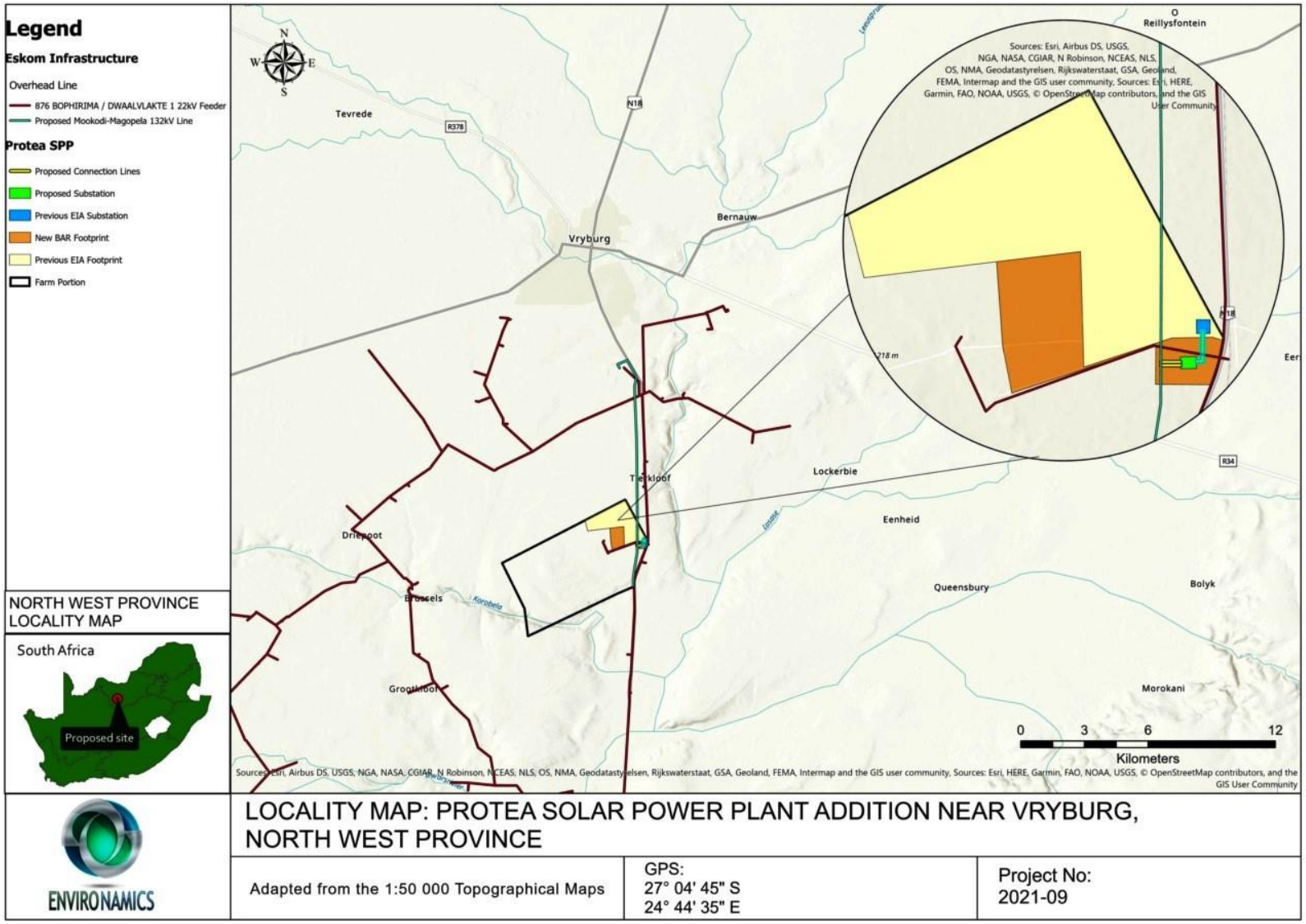

Figure 1: Locality map for the proposed Protea Solar Power Plant near Vryburg, North West Province (Image supplied by Environamics Environmental Consultants). The footprint of the proposed additional infrastructure is shown in orange.

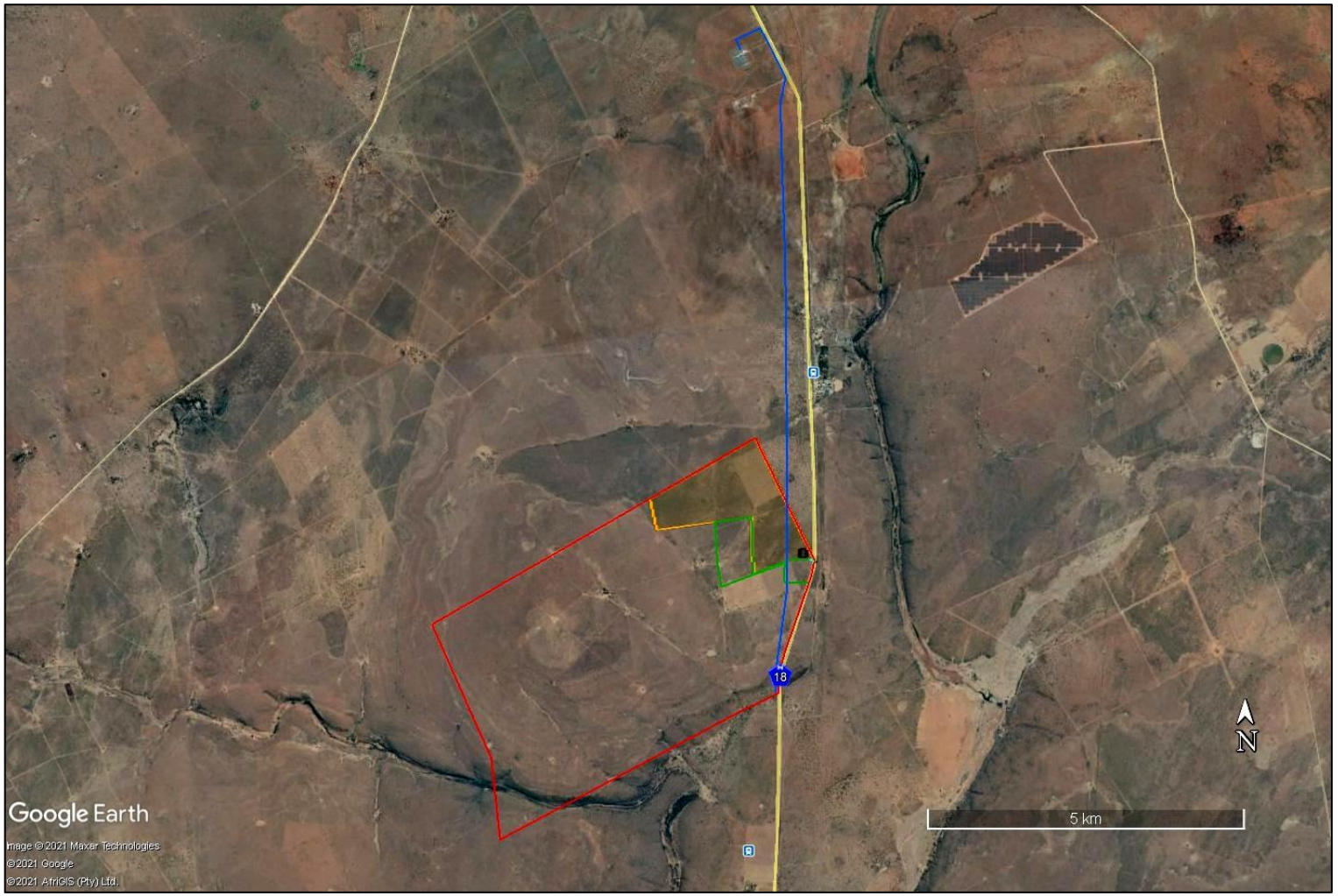

Figure 2: Google Earth© satellite image showing the Remaining Extent of the Farm Hartsboom No. 734, situated to the west of the N18 trunk road *c*. 13 km south of the town of Vryburg (red polygon), North West Province. The project area for the original (authorised) Protea Solar Power Plant is outlined in orange (tinted). The 70 hectare additional project areas assessed in this report are outlined in green and the authorized grid connection to the exiting Mookodi Substation is shown in dark blue.

2. APPROACH TO THE PALAEONTOLOGICAL HERITAGE STUDY

The approach to this 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 of the broader study region, and the author's field experience and palaeontological database. Based on this data, the impact significance of the proposed development is assessed with recommendations for any further studies or mitigation.

In preparing a palaeontological desktop study the potentially fossiliferous rock units (groups, formations *etc*) represented within the study area are determined from geological maps and satellite images. The known fossil heritage within each rock unit is inventoried from the published scientific literature, previous palaeontological impact studies in the same region, and the author's field experience. Consultation with professional colleagues as well as examination of institutional fossil collections may play a role here, or later following field assessment (if required) during the compilation of the final report. This data is then used to assess the palaeontological sensitivity of each rock unit to development. The likely impact of the proposed development on local fossil heritage is then determined on the basis of (1) the palaeontological sensitivity of the rock units concerned and (2) the nature and scale of the development itself, most significantly the extent of fresh bedrock excavation envisaged. When rock units of moderate to high palaeontological sensitivity are present within the development footprint, a Phase 1 field assessment study by a professional palaeontologist is usually warranted to identify any palaeontological hotspots and make specific recommendations for any monitoring or mitigation required before or during the construction phase of the development.

On the basis of the desktop and Phase 1 field assessment studies, the likely impact of the proposed development on local fossil heritage and any need for specialist mitigation are determined. Adverse palaeontological impacts normally occur during the construction rather than the operational or decommissioning phase. Phase 2 mitigation by a professional palaeontologist – normally involving the recording and sampling of fossil material and associated geological information (*e.g.* sedimentological data) may be required (a) in the pre-construction phase where important fossils are already exposed at or near the land surface and / or (b) during the construction phase when fresh fossiliferous bedrock has been exposed by excavations. To carry out mitigation, the palaeontologist involved will need to apply for palaeontological collection permits from the relevant heritage management authorities, *i.e.* SAHRA for the North West Province (Contact details: SAHRA, 111 Harrington Street, Cape Town. P.O. Box 4637, Cape Town 8000, South Africa. Phone: +27 (0)21 462 4502. Fax: +27 (0)21 462 4509. Web: www.sahra.org.za). It should be emphasized that, *providing appropriate mitigation is carried out*, the majority of developments involving bedrock excavation can make a *positive* contribution to our understanding of local palaeontological heritage.

2.1. Information sources

The information used in this palaeontological heritage study was based on the following:

1. A short project description, maps and kmz files provided by Environamics Environmental Consultants, Potchefstroom;

2. A review of the relevant satellite images, topographical maps and scientific literature, including published geological maps and accompanying sheet explanations, as well as several previous desktop and field-based palaeontological assessment studies in the broader study region (*e.g.* Almond 2013a-c, Almond 2016a-i, Butler 2016, 2018, Groenewald 2016, Rubidge 2012, Durand 2018). Several of these PIA reports include project areas adjoining the present one, notably that by Almond (2016g) that covers the original Protea Solar Power Plant project area.

3. The author's previous field experience with the formations concerned and their palaeontological heritage.

2.2. 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 ("mappable") bedrock units as well as major areas of superficial "drift" deposits (alluvium, colluvium) but for most regions give little or no idea of the level of bedrock outcrop, depth of superficial cover (soil *etc*), degree of bedrock weathering or levels of small-scale tectonic deformation, such as cleavage. All of these factors may have a major influence on the impact significance of a given development on fossil heritage and can only be reliably assessed in the field.

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

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

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

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

(a) *underestimation* of the palaeontological significance of a given study area due to ignorance of significant recorded or unrecorded fossils preserved there, or
(b) *overestimation* of the palaeontological sensitivity of a study area, for example when originally rich fossil assemblages inferred from geological maps have in fact been destroyed by tectonism or weathering, or are buried beneath a thick mantle of unfossiliferous “drift” (soil, alluvium *etc*).

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

In the case of the present study area near Vryburg in North West Province exposure of potentially fossiliferous bedrocks is very limited due to the largely flat terrain, extensive soil cover and dense grassy vegetation during summer. However, a number of relevant field-based palaeontological studies have been carried out in the broader region by the author and others so confidence levels for this desktop level assessment are rated as medium.

2.3. Legislative context for palaeontological assessment studies

The proposed alternative energy project is located in an area that is underlain by potentially fossiliferous sedimentary rocks of Precambrian and younger, Late Tertiary or Quaternary, age (Sections 3 and 4). The construction phase of the proposed development will entail substantial excavations into the superficial sediment cover and into the underlying bedrock as well. These may include, for example, surface clearance and excavations for the PV panel footings, internal and access roads, underground cables, , auxiliary buildings and construction site camp. All these developments may adversely affect potential, legally-protected fossil heritage within the study area by destroying, disturbing or permanently sealing-in fossils at or beneath the surface of the ground that are then no longer available for scientific research or other public good. The operational and decommissioning phases of the renewable energy facility are however unlikely to involve further adverse impacts on local palaeontological heritage.

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

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

According to Section 35 of the National Heritage Resources Act, dealing with archaeology, palaeontology and meteorites:
(1) The protection of archaeological and palaeontological sites and material and meteorites is the responsibility of a provincial heritage Resources authority.

(2) All archaeological objects, palaeontological material and meteorites are the property of the State.
(3) Any person who discovers archaeological or palaeontological objects or material or a meteorite in the course of development or agricultural activity must immediately report the find to the responsible heritage Resources authority, or to the nearest local authority offices or museum, which must immediately notify such heritage Resources authority.
(4) No person may, without a permit issued by the responsible heritage Resources authority—
(a) destroy, damage, excavate, alter, deface or otherwise disturb any archaeological or palaeontological site or any meteorite;
(b) destroy, damage, excavate, remove from its original position, collect or own any archaeological or palaeontological material or object or any meteorite;
(c) trade in, sell for private gain, export or attempt to export from the Republic any category of archaeological or palaeontological material or object, or any meteorite; or
(d) bring onto or use at an archaeological or palaeontological site any excavation equipment or any equipment which assist in the detection or recovery of metals or archaeological and palaeontological material or objects, or use such equipment for the recovery of meteorites.
(5) When the responsible heritage Resources authority has reasonable cause to believe that any activity or development which will destroy, damage or alter any archaeological or palaeontological site is under way, and where no application for a permit has been submitted and no heritage Resources management procedure in terms of section 38 has been followed, it may—
(a) serve on the owner or occupier of the site or on the person undertaking such development an order for the development to cease immediately for such period as is specified in the order;
(b) carry out an investigation for the purpose of obtaining information on whether or not an archaeological or palaeontological site exists and whether mitigation is necessary;
(c) if mitigation is deemed by the heritage Resources authority to be necessary, assist the person on whom the order has been served under paragraph *(a)* to apply for a permit as required in subsection (4); and
(d) recover the costs of such investigation from the owner or occupier of the land on which it is believed an archaeological or palaeontological site is located or from the person proposing to undertake the development if no application for a permit is received within two weeks of the order being served.

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

3. GEOLOGICAL CONTEXT

A short account of the topographical and geological context for the original, authorized Protea Solar Power Plant project area on the Remaining Extent of the Farm Hartsboom No. 734 near Vryburg has been provided by Almond (2016g) and will not be repeated in full here. The small additional project area being assessed as part of the expansion comprise flat-lying, featureless terrain between *c*. 1180 to 1210 m amsl. Based on satellite imagery, bedrock exposure here is probably extremely low to non-existent due to extensive cover by superficial deposits such as sandy soils and calcrete (Fig. 2).

The geology of the project area to the south of Vryburg is shown on the 1: 250 000 geology map 2724 Christiana (Council for Geoscience, Pretoria; Fig. 3 herein). An explanation for the Christiana geological map has been published by Schutte (1994). The additional project area for the expansion is underlain by Permo-Carboniferous glacially-related sediments of the **Dwyka Group** (Karoo Supergroup). (C-Pd, grey in Fig. 3). A short description of the Dwyka Group succession on the 1: 250 000 geological map sheet 2724 Christiana is given by Schutte (1994). The best exposures here occur in low-lying areas along the Droë Hartsrivier, especially to the north of Taung. The Dwyka sedimentary rocks consist of tillite, boulder mudstone rich in a wide range of erratics, sandstone lenses and shale, this last including seasonally varved mudrocks. The Dwyka outcrop area is characterised by the widespread occurrence of downwasted glacial erratics (Keyser & Du Plessis 1993).Glacial striations of Dwyka age that are incised into older resistant quartzitic rocks of the Vryburg Formation near Mookodi Substation on the farm Rosendal 673 indicate southerly ice transport directions (Schutte 1994).

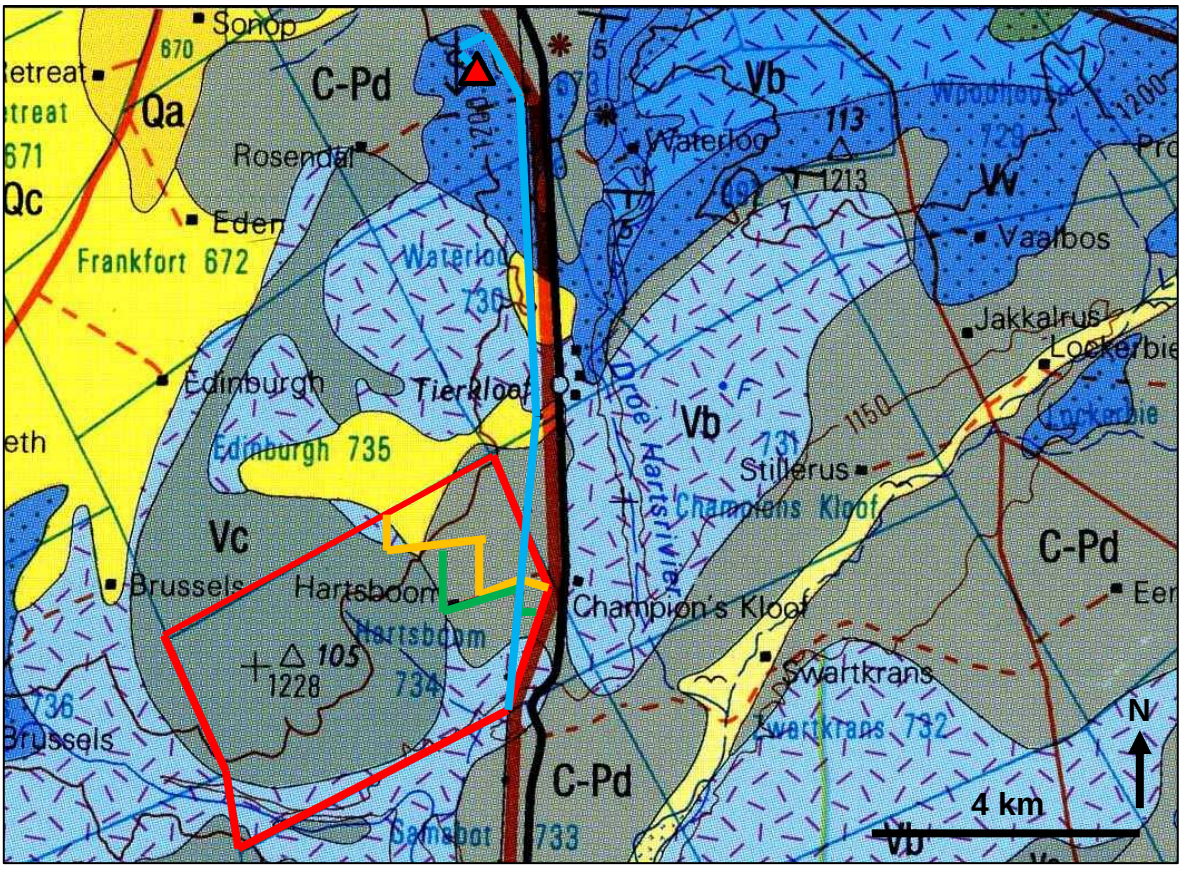

Figure 3: Extract from the 1: 250 000 geological map 2724 Christiana (Council for Geoscience, Pretoria) showing the original project area for the proposed Protea Solar Power Plant study area on the Remaining Extent of the Farm Hartsboom 734, some 12 km south of Vryburg (orange polygon), as well as the small additional project area (green polygons). The latter are underlain by Permo-Carboniferous glacial sediments of the Dwyka Group (C-Pd, grey) that are generally mantled at surface by Late Caenozoic superficial deposits such as downwasted gravels, calcrete and sandy soils.

Given their high susceptibility to weathering, the Dwyka glacial beds are unlikely to exposed at surface due to the pervasive cover by **Late Caenozoic superficial sediments**. These may include Tertiary (Neogene) to Quaternary calcrete hardpans and downwasted polymict

surface gravels. Alluvial gravels of Quaternary age related to the ancient Dröe Harts drainage system might be represented in the east, but are not mapped here. These older superficial deposits are, in turn, likely to be mantled by orange-brown sandy soils and pale grey-brown calcareous soils.

4. PALAEONTOLOGICAL HERITAGE

The fossil record of the **Dwyka Group** is generally poor, as expected for a glacial sedimentary succession (McLachlan & Anderson 1973, Anderson & McLachlan 1976, Visser 1989, Visser *et al*., 1990, MacRae 1999, Visser 2003, Almond 2008a, 2008b, Almond & Pether 2008a, 2008b). Sparse, low diversity trace fossil biotas from the Elandsvlei Formation mainly consist of delicate arthropod trackways (probably crustacean) and fish swimming trails associated with recessive-weathering dropstone laminites (Anderson 1974, 1975, 1976, 1981). Sporadic vascular plant remains (drifted wood and leaves of the *Glossopteris* Flora) are also recorded (Anderson & Anderson 1985, Bamford 2000, 2004), while palynomorphs (organic-walled microfossils) are likely to be present within finer-grained mudrock facies. Glacial diamictites (tillites or "boulder mudstones") are normally unfossiliferous but do occasionally contain fragmentary transported plant material as well as palynomorphs in the fine-grained matrix (Plumstead 1969). There are biogeographically interesting records of limestone glacial erratics from tillites along the southern margins of the Great Karoo that contain Cambrian eodiscid trilobites as well as archaeocyathid sponges. Such derived fossils provide important data for reconstructing the movement of Gondwana ice sheets (Cooper & Oosthuizen 1974).

The Dwyka Group bedrocks within the small additional project area for the Protea Solar Power Plant on the Remaining Extent of the Farm Hartsboom No. 734 is likely to be poorly exposed as well as dominated by unfossiliferous tillite facies. At most, erratic boulders within the Dwyka tillites might include occasional clasts of stromatolitic carbonate derived from Precambrian Transvaal Supergroup shelf sediments of the Ghaap Plateau. However, such occurrences are of low conservation significance.

The **Neogene to Recent superficial deposits** within the broader project area - viz. sandy soils, downwasted surface gravels, alluvial gravels, calcrete pedocretes (including older pan sediments) - are likely to be of Low to Very Low palaeosensitivity for the most part. However, these younger sediments might occasionally contain important fossil biotas, notably the bones, teeth and horn cores of mammals (*e.g.* Cooke 1974, Skead 1980, 2011, Klein 1984, MacRae 1999, Partridge & Scott 2000, Churchill et al. 2000, Boshoff & Kerley 2013). These may include ancient human remains of considerable palaeoanthropological significance (*e.g*. Grine *et al.,* 2007). Other potential late Caenozoic fossil biotas from these superficial deposits include non-marine molluscs (bivalves, gastropods), ostrich egg shells, trace fossils (*e.g.* calcretised termitaria and other insect burrows or nests, coprolites, rhizoliths), and plant remains such as peats or palynomorphs (pollens) in fine-grained, organic-rich alluvial horizons. Quaternary alluvial sediments may contain reworked Stone Age artifacts that are useful for constraining their maximum age.

It is concluded that the palaeosensitivity of the additional project area for the expansion of the Protea Solar Power Plant is Low to Very Low.

5. SITE SENSITIVITY VERIFICATION AND EVALUATION OF IMPACTS ON PALAEONTOLOGICAL HERITAGE

5.1. Site sensitivity verification

A MEDIUM palaeosensitivity has been provisionally assigned to the additional project area for the expansion of the Protea Solar Power Plant on the Remaining Extent of the Farm Hartsboom No. 734 near Vryburg by the DFFE screening tool (Fig. 4, abstracted from the Screening Report for Environmental Authorisation prepared by Environamics Environmental Consultants, February 2021).

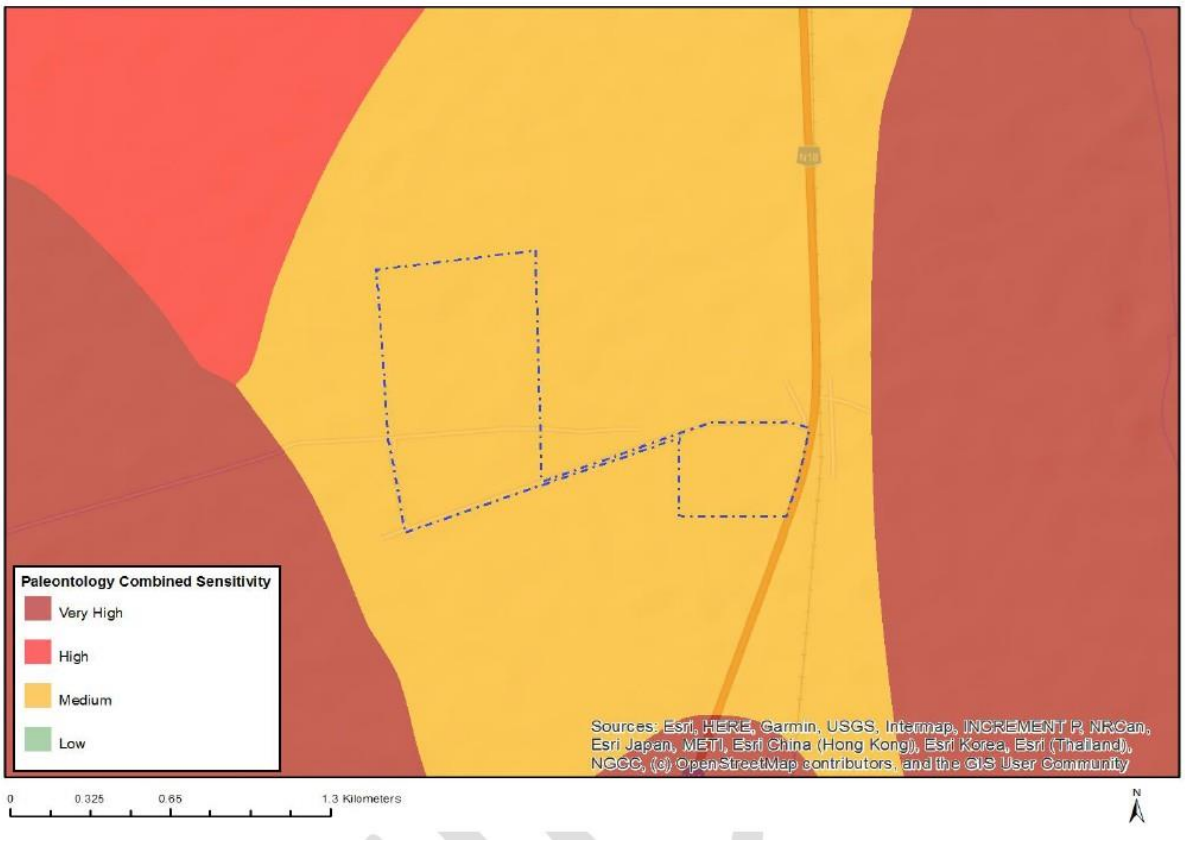

Figure 4: Palaeosensitivity map for the small additional project area for the expansion of the Protea Solar Power Plant (blue dotted polygons) (Figure abstracted from the Screening Report for Environmental Authorisation prepared by Environamics Environmental Consultants). The new areas are provisionally mapped here as of Medium Palaeosensitivity. However, a Low Palaeosensitivity is inferred based on desktop and local field data.

The originally proposed Medium palaeosensitivity of the additional Protea Solar Power Plant project area is *contested* here. Rather, a generally LOW palaeosensitivity is assigned to the project area in the present PIA report. This is largely based on the combined desktop and field-based palaeontological assessment for the original Protea Solar Power Plant by Almond (2016g) as well as satellite imagery and geological mapping.

5.2. Impact assessment

The Protea Solar Power Plant project area is located in a region that is underlain by potentially fossiliferous sedimentary rocks of Precambrian, Palaeozoic and younger, Neogene to Holocene age (Almond 2016g, Sections 3 & 4 herein). Existing impacts to palaeontological heritage within the project area are likely to be minimal, largely comprising occasional damage to fossils exposed at the ground surface through agricultural activities. These on-going impacts are offset by the slow exposure of fresh fossil material through bedrock weathering.

The construction phase of the proposed solar energy facility will entail substantial excavations into the superficial sediment cover and perhaps locally into the underlying bedrock as well. These include, for example, surface clearance and excavations for the PV panel footings, laydown areas, internal and access roads, underground cables, and other associated ancillary infrastructure. All these activities may adversely affect potential legally-protected fossil heritage within the project footprint as a result of excavations and surface disturbance (*e.g.* surface clearing and vehicle activity) during the construction phase by destroying, disturbing or permanently sealing-in fossils preserved at or beneath the surface of the ground that are then no longer available for scientific research or other public good.

The inferred impact of the proposed expansion of the Protea Solar Power Plant on legally-protected, local fossil heritage resources of scientific or broader conservation value is briefly evaluated here in Table 2A. This assessment applies only to the *construction phase* of the development since further significant impacts on fossil heritage during the planning, operational and decommissioning phases of the facility are not anticipated.. Confidence levels in this assessment are *medium*, given (1) very low levels of bedrock exposure within the solar power plant project area and (2) the unpredictable distribution of well-preserved fossils in the subsurface, factors which are partially offset by the number of field-based palaeontological studies carried out in the Vryburg region in recent years (*cf* Table 3 and References).

As motivated in Table 2A, the impact significance of the proposed development in terms of palaeontological heritage is assessed as *Negative Low* without mitigation. Should the recommended mitigation measures for the construction phase of the solar facility development, as outlined in Section 6 (incl. Table 4) and Appendix 2 of this report, be consistently followed-through, the impact significance would remain *Negative Low* but would entail both positive and negative impacts. Residual negative impacts from inevitable loss of *some* valuable fossil heritage would be partially offset by an improved palaeontological database for the study region as a direct result of appropriate mitigation. The latter is a *positive* outcome because any new, well-recorded and suitably-curated fossil material would constitute a useful addition to our scientific understanding of the fossil heritage of the Ghaap Plateau region of North West Province. The No-Go option would probably have a neutral impact significance; protection of local fossils from damage or destruction would be partially offset by natural surface weathering processes as well as lost opportunities to improve the palaeontological database through professional mitigation of chance fossil finds.

There are no fatal flaws associated with the proposed solar PV project from a palaeontological heritage viewpoint and no objections to authorisation of the development, provided that the recommended mitigation measures are fully implemented.

Table 2A: Evaluation of anticipated impacts on local palaeontological heritage resources due to the proposed expansion of the authorized Protea Solar Power Plant near Vryburg, North West Province (Construction Phase)

Palaeontological Heritage Impacts	Disturbance, damage or destruction of legally-protected fossil heritage* within the development footprint during the construction phase	
	Pre-mitigation impact rating	**Post mitigation impact rating**
Status (positive or negative)	Negative	Negative / positive
Extent	Site (1)	Site (1)
Probability	Unlikely (1)	Unlikely (1)
Duration	Permanent (4)	Permanent (4)
Magnitude	Low (1)	Low (1)
Reversibility	Irreversible (4)	Irreversible (4)
Irreplaceable loss of resources	Marginal (2)	Marginal (2)
Cumulative impact	Low (2).	
Significance	**Negative low (28)**	**Negative low (28)**
Can impacts be mitigated?	Yes. Through implementation of recommended Chance Fossil Finds Procedure.	

***** *N.B.* Refers essentially to impacts on well-preserved and / or rare fossils of scientific and conservation value.

5.2. Cumulative impact assessment

A tabulated summary of comparable renewable energy projects within a 30 km radius of the present project area near Vryburg is presented in Table 3 and Figure 5 below (Data provided by Environamics Environmental Consultants).

Based on the SAHRIS website, palaeontological heritage assessments (PIAs) are available for the majority, if not quite all, of the projects listed (Almond 2013a-c, Almond 2016a-i, Butler 2016, 2018, Groenewald 2016, Rubidge 2012, Durand 2018). It is noted that (1) of the available PIA reports several are only desktop studies with no field-based ground truthing and (2) a LOW palaeontological impact significance is inferred for most, but not all, of the projects concerned. This applies most notably to those projects featuring similar Dwyka Group and Late Caenozoic sedimentary rock units to those mapped in the present project area where surface exposure of stromatolitic bedrocks is low to non-existent. Higher palaeosensitivities and levels of impact significance are understandably inferred for projects that involve surface exposure of Precambrian stromatolites (fossil microbial mounds) which are almost certainly *not* represented at surface in the Protea Solar Power Plant additional project area (*cf* Almond 2013a, 2016e, Groenewald 2016). In the author's opinion:

- Palaeontological impact significances inferred for renewable energy projects, where these are assessed at all, may well to some extent reflect different assessment approaches rather than contrasting palaeontological sensitivities and impact levels;

- Meaningful cumulative impact assessments require comprehensive data on *all* major developments within a region, not just those involving renewable energy, as well as an understanding of the extent to which recommended mitigation measures are followed through;

- Trying to assess cumulative impacts on different fossil assemblages from different stratigraphic units (for example, Precambrian stromatolites from 2.6 billion years ago *versus* Late Caenozoic alluvial and calcrete sediments less than 2.5 million years old) has limited value.

Table 2B: Evaluation of anticipated cumulative impacts on local palaeontological heritage resources due to solar power developments in the Vryburg region, including the proposed expanded area for the Protea Solar Power Plant (Construction Phase)

Palaeontological Heritage Impacts*	Disturbance, damage or destruction of legally-protected fossil heritage within the development footprints during the construction phase	
	Pre-mitigation impact rating	**Post mitigation impact rating**
Status (positive or negative)	Negative	Negative / positive
Extent	Local (2)	Local (2)
Probability	Definite (4)	Probable (3)
Duration	Permanent (4)	Permanent (4)
Magnitude	Medium (2)	Low (1)
Reversibility	Irreversible (4)	Irreversible (4)
Irreplaceable loss of resources	Marginal (2)	Marginal (2)
Cumulative impact	Medium (3).	
Significance	**Negative medium (38)**	**Negative low (18)**
Can impacts be mitigated?	Yes. • Protection of recorded sensitive fossil sites through buffers and / or judicious professional collection: • ECO monitoring of surface clearance and excavations for fossil remains; • Implementation of recommended Chance Fossil Finds Procedure.	

***** *N.B.* Refers essentially to impacts on well-preserved and / or rare fossils of scientific and conservation value.

Given (1) the comparatively small combined footprint of the renewable energy projects under consideration compared with the very extensive outcrop areas of Late Caenozoic superficial deposits in the region as well as (2) the generally low palaeosensitivity of these younger deposits and (3) the probable (albeit *unconfirmed*) rarity of *scientifically valuable* occurrences of well-preserved stromatolites within flat-lying terrain preferred for solar energy projects, the anticipated cumulative impact of the proposed or authorized solar power plant developments in the Vryburg region - including the proposed expanded Protea Solar Power Plant - is assessed as *Negative Medium* (without mitigation), potentially falling to *Negative*

Low (with full mitigation) (Table 2B). There are therefore no objections on palaeontological grounds to authorization of this project.

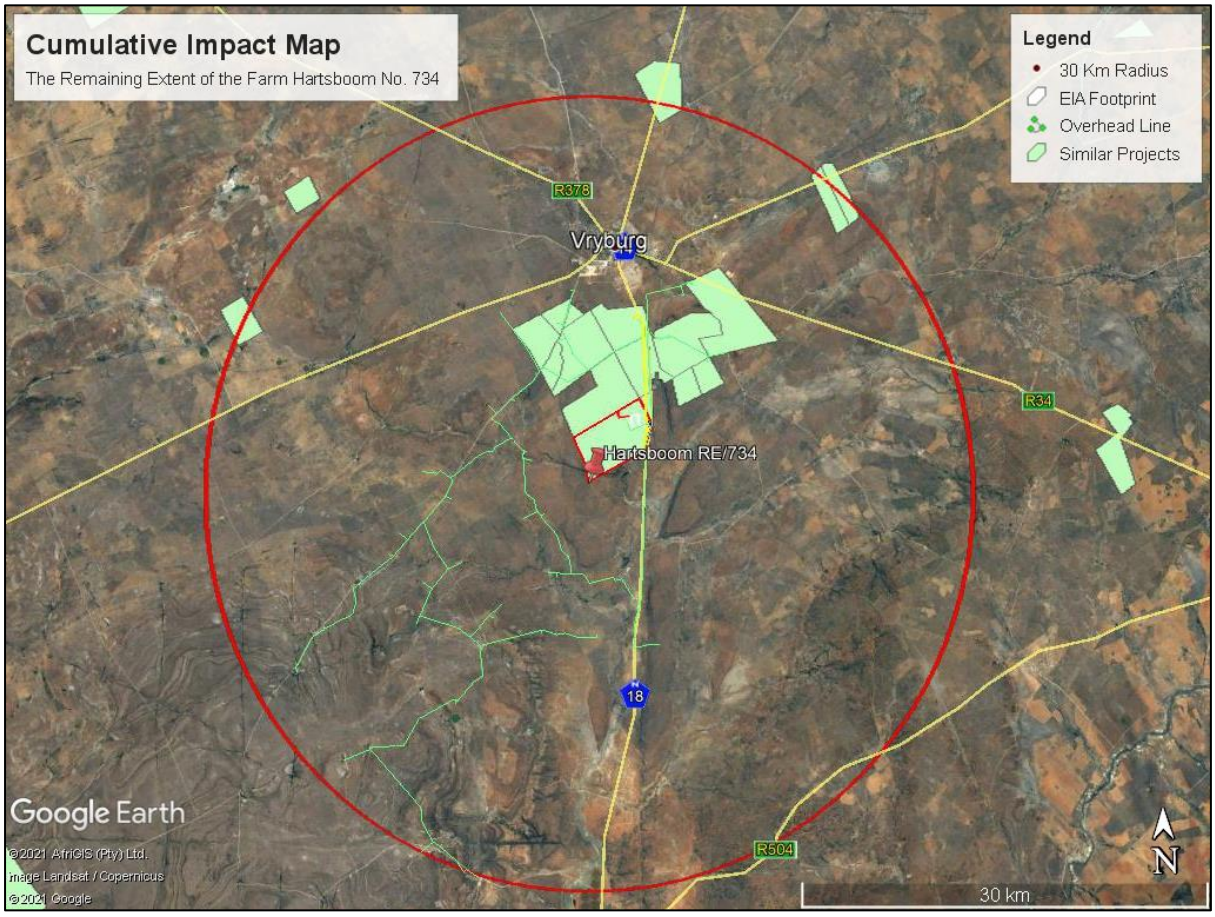

Figure 5: Map of renewable energy developments within a 30 km radius of the Protea Solar Power Plant (Image provided by Environamics Environmental Consultants). Not all of these developments share the same geological (and hence palaeontological) context.

Table 3: Summary of related renewable energy projects within a 30 km radius of the present project area that may contribute to cumulative impacts (Data collated by Environamics Environmental Consultants). Palaeontological impact assessments for these projects are listed in the References.

Site name	Distance from study area	Proposed generating capacity	DEFF reference	EIA process	Project status
Waterloo	4.4 km	75 MW	14/12/16/3/3/2/308	Scoping and EIA	Operational
Tiger Kloof	1.4 km	75 MW	14/12/16/3/3/2/535	Scoping and EIA	Approved
Naledi	5.7 km	75 MW	14/12/16/3/3/2/390	Scoping and EIA	Approved
Carocraft	23 km	75 MW	14/12/16/3/3/2/374	Scoping and EIA	Approved
Elda	25.6 km	75 MW	14/12/16/3/3/2/750	Scoping and EIA	Approved
Khubu SPP	9.2km	115MW	14/12/16/3/3/2/912	Scoping and EIA	Approved
Gamma SPP	10.3km	115MW	14/12/16/3/3/2/917	Scoping and EIA	Approved
Sonbesie SPP	200m	115MW	14/12/16/3/3/2/915	Scoping and EIA	Approved
Woodhouse PV 1	10.7km	100MW	14/12/16/3/3/2/863	Scoping and EIA	Approved
Woodhouse PV 2	10.7km	100MW	14/12/16/3/3/2/865	Scoping and EIA	Approved
Vryburg PV 1	500m	115MW	14/12/16/3/3/1/1939	Scoping and EIA	Approved
Vryburg PV 2	500m	115MW	14/12/16/3/3/1/1940	Scoping and EIA	Approved
Vryburg PV 3	500m	115MW	14/12/16/3/3/1/1941	Scoping and EIA	Approved
Protea SPP	8.4km	115MW	14/12/16/3/3/2/914	Scoping and EIA	Approved
Sendawo 1	4.2km	75MW	14/12/16/3/2/893	Scoping and EIA	Approved
Sendawo 2	4.2km	75MW	14/12/16/3/2/893	Scoping and EIA	Approved
Sendawo 3	4.2km	75MW	14/12/16/3/2/893	Scoping and EIA	Approved
Moeding Solar	6km	115MW	14/12/16/3/3/1/1987	Scoping and EIA	Approved
Alpha SPP	23km	115MW	14/12/16/3/3/2/916	Scoping and EIA	Approved
Meerkat SPP	21km	115MW	14/12/16/3/3/2/913	Scoping and EIA	Approved

6. RECOMMENDATIONS FOR MONITORING AND MITIGATION

No palaeontological High Sensitivity or No-Go areas or other fossil sites requiring specialist mitigation have been identified within the additional solar power plant development project area.

The ECO responsible for the construction phase of the solar plant development should be aware of the potential for important fossil finds – notably stromatolites (fossil microbial mounds) within Precambrian bedrocks and fossil mammalian remains, land snails and trace fossils (*e.g.* termite nests) within calcretes - and the necessity to conserve them for possible professional mitigation. The ECO should monitor all substantial surface clearance operations and excavations into sedimentary rocks for fossil remains on an on-going basis during the construction phase. A Chance Fossil Finds Procedure for this development is outlined in Appendix 1.

Recommended mitigation of chance fossil finds during the construction phase of the solar PV plant involves safeguarding of the fossils (preferably *in situ*) by the responsible ECO and reporting of finds to SAHRA (Contact details: 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). Where appropriate, judicious sampling and recording of fossil material and associated geological data by a qualified palaeontologist, appointed by the developer, may be required by the relevant heritage regulatory authorities. Any fossil material collected should be curated within an approved repository (museum / university fossil collection) by a qualified palaeontologist. These recommendations should be included within the Environmental Management Programme for the proposed renewable energy project.

7. ACKNOWLEDGEMENTS

Ms Christia Van Dijk and Ms Carli Steenkamp of Environamics Environmental Consultants, Potchefstroom are both thanked for commissioning this study and for providing the relevant background information. Additionally, I am grateful to Ms Lisa Opperman of Environamics for careful editorial work on the draft PIA reports.

Table 4: Proposed monitoring and mitigation measures for incorporation into the EMPr for the Protea Solar Plant project (Construction phase)

POTENTIAL ASPECTS RESULTING IN POTENTIAL ENVIRONMENTAL IMPACT DURING CONSTRUCTION	RECOMMENDED MITIGATION MEASURES					
	Desired Outcomes	**Targets & Indicators**	**Management and mitigation measures**	**Timeframe**	**Responsibility**	**Monitoring**
Fossil Heritage Resources						
Disturbance, destruction or damage to fossils preserved at or below surface through surface clearance and excavations during construction phase.	Reporting of chance fossil finds to SAHRA for professional recording and sampling.	Any areas of bedrock exposure displaying well-preserved stromatolites. Superficial deposits (alluvium, soils, gravels) with fossil remains (*e,g.* mammalian bones, teeth).	Monitoring of all major site clearance and excavation work for fossil remains. Substantial well-preserved fossils (stromatolites, vertebrate bones, teeth) to be safeguarded, preferably *in situ*, and reported to SAHRA. Fossil recording and sampling.	On-going during construction phase. Following report of chance fossil finds.	ECO Developer to appoint palaeontologist following significant new fossil finds. Professional palaeontologist.	Compliance to be verified by ECO.

Table 5: Summary of impacts and mitigation measures for the Protea Solar Plant project (Construction Phase)

SPECIALIST STUDY	IMPACT	PRE-MITIGATION RATING	POST MITIGATION RATING	SUMMARY OF MITIGATION MEASURES
Palaeontological heritage	Disturbance, destruction or damage to fossils preserved at or below surface through surface clearance and excavations during construction phase.	Negative low	Negative low	• Monitoring of all major site clearance and excavation work for fossil remains by ECO. • Substantial well-preserved fossils (stromatolites, vertebrate bones, teeth) to be safeguarded, preferably *in situ*, and reported by ECO to SAHRA. • Recording and sampling of significant new fossil finds by professional palaeontologist.

8. REFERENCES

ALMOND, J.E. 2008a. Fossil record of the Loeriesfontein sheet area (1: 250 000 geological sheet 3018). Unpublished report for the Council for Geoscience, Pretoria, 27 pp.

ALMOND, J.E. 2008b. Palaeozoic fossil record of the Clanwilliam sheet area (1: 250 000 geological sheet 3218). Unpublished report for the Council for Gesocience, Pretoria, 49 pp.

ALMOND, J.E. 2013a. Proposed PV Solar Facility on a portion of the farm Waterloo 992 near Vryburg, Naledi Local Municipality, North-West Province.Palaeontological heritage assessment: combined desktop & field-based study, 29 pp. Natura Viva cc, Cape Town.

ALMOND, J.E. 2013b. Proposed PV Solar Facility on a portion of the farm Rosendal 673 near Vryburg, Naledi Local Municipality, North-West Province. Palaeontological heritage assessment: desktop study, 15 pp. Natura Viva cc, Cape Town.

ALMOND, J.E. 2013c. Proposed Tiger Kloof Solar Photovoltaic Energy Facility near Vryburg, Naledi Local Municipality, North West Province. Palaeontological heritage assessment: desktop study, 16 pp. Natura Viva cc, Cape Town.

ALMOND, J.E. 2016a. Proposed Sonbesie PV Solar Power Plant on the Remaining Extent of Farm Retreat 671 near Vryburg, North-West Province. Palaeontological heritage assessment: combined desktop & field-based study, 19 pp. Natura Viva cc, Cape Town.

ALMOND, J.E. 2016b. Proposed AMDA Delta Solar PV development on the Remaining Extent of Klondike No. 670-IN, Naledi Local Municipality, Northwest Province. Recommended exemption from further palaeontological studies, 9 pp.

ALMOND, J.E. 2016c. Proposed AMDA Echo Solar PV development on the Remaining Extent of Klondike No. 670-IN, Naledi Local Municipality, Northwest Province. Recommended exemption from further palaeontological studies, 9 pp. Natura Viva cc, Cape Town.

ALMOND, J.E. 2016d. Proposed AMDA Foxtrot Solar PV development on the Remaining Extent of Klondike No. 670-IN, Naledi Local Municipality, Northwest Province. Recommended exemption from further palaeontological studies, 9 pp. Natura Viva cc, Cape Town.

ALMOND, J.E. 2016e. Proposed Gamma Solar Power Plant on the Remaining Extent of Portion 4 (Bos Kop), Farm Champions Kloof 731 near Vryburg, Naledi Local Municipality, North-West Province. Palaeontological heritage assessment: combined desktop & field-based study, 30 pp. Natura Viva cc, Cape Town.

ALMOND, J.E. 2016f. Proposed Khubu Solar Power Plant on Portion 5 (Shadow Eve) (Portion of Portion 4), Farm Champions Kloof 731 near Vryburg, Naledi Local Municipality, North-West Province. Palaeontological heritage assessment: combined desktop & field-based study, 32 pp. Natura Viva cc, Cape Town.

ALMOND, J.E. 2016g. Proposed Protea Solar Power Plant on the Remaining Extent of Farm Hartsboom 734 near Vryburg, North-West Province. Palaeontological heritage assessment: combined desktop & field-based study, 19 pp. Natura Viva cc, Cape Town.

ALMOND, J.E. 2016h. Proposed Meerkat Solar Power Plant on Portion 3 (Portion of Portion 2) of the Farm Vyflings Pan 598 near Vryburg, Naledi Local Municipality, North-West Province.Palaeontological heritage assessment: combined desktop & field-based study, 23 pp. Natura Viva cc, Cape Town.

ALMOND, J.E. 2016i. Proposed Alpha Solar Power Plant on Portion 3 of Farm Middel Pan 605 near Vryburg, Naledi Local Municipality, North-West Province Palaeontological heritage assessment: combined desktop & field-based study, 22 pp. Natura Viva cc, Cape Town.

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

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

ANDERSON, A.M. 1974. Arthropod trackways and other trace fossils from the Early Permian lower Karoo Beds of South Africa. Unpublished PhD thesis, University of Witwatersrand, Johannesburg, 172 pp.

ANDERSON, A.M. 1975. Turbidites and arthropod trackways in the Dwyka glacial deposits (Early Permian) of southern Africa. Transactions of the Geological Society of South Africa 78: 265-273.

ANDERSON, A.M. 1976. Fish trails from the Early Permian of South Africa. Palaeontology 19: 397-409, pl. 54.

ANDERSON, A.M. 1981. The Umfolozia arthropod trackways in the Permian Dwyka and Ecca Groups of South Africa. Journal of Paleontology 55: 84-108, pls. 1-4.

ANDERSON, A.M. & MCLACHLAN, I.R. 1976. The plant record in the Dwyka and Ecca Series (Permian) of the south-western half of the Great Karoo Basin, South Africa. Palaeontologia africana 19: 31-42.

ANDERSON, J.M. & ANDERSON, H.M. 1985. Palaeoflora of southern Africa. Prodromus of South African megafloras, Devonian to Lower Cretaceous, 423 pp, 226 pls. Botanical Research Institute, Pretoria & Balkema, Rotterdam.

BAMFORD, M.K. 2000. Fossil woods of Karoo age deposits in South Africa and Namibia as an aid to biostratigraphical correlation. Journal of African Earth Sciences 31, 119-132.

BAMFORD, M.K. 2004. Diversity of woody vegetation of Gondwanan South Africa. Gondwana Research 7, 153-164.

BUTLER, E. 2016. Palaeontological impact assessment of the proposed Woodhouse Solar 2 PV facility and associated infrastructure on the Remaining Extent of farm Woodhouse 729, near Vryburg, North West Province, 32 pp.

BUTLER, E. 2018. Palaeontological field assessment for the Moeding Siolar PV Facility and associated grid connection, North West Province, 61 pp. Banzai Environmental (Pty) Ltd.

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

COOKE, H.B.S. 1974. The fossil mammals of Cornelia, O.F.S., South Africa. In: Butzer, K.W., Clark, J.D. & Cooke, H.B.S. (Eds.) The geology, archaeology and fossil mammals of the Cornelia Beds, O.F.S. Memoirs of the National Museum, Bloemfontein 9: 63-84.

COOPER, M.R. & OOSTHUIZEN, R. 1974. Archaeocyathid-bearing erratics from Dwyka Subgroup (Permo-Carboniferous) of South Africa, and their importance to continental drift. Nature 247, 396-398.

DURAND, J.F. 2018. Palaeontological Impact Assessment for the proposed construction of three Solar Photovoltaic (PV) Facilities (*i.e.* Vryburg Solar 1, Vryburg Solar 2 and Vryburg Solar 3) and associated electrical infrastructure, near Vryburg, in the North-West Province, 45 pp.

GRINE, F.E. *et al.* 2007. Late Pleistocene human skull from Hofmeyr, South Africa, and modern human origins. Science 315, 226-229.

GROENEWALD, G. 2016. Proposed construction of the Sendawo Solar Photovoltaic (PV) Energy Facility near Vryburg, Northwest Province. Palaeontological Assessment Report, 77 pp.

GROENEWALD, G. & GROENEWALD D. 2014. Palaeontological heritage of North West. SAHRA palaeotechnical report, 22 pp.

KEYSER, N. & DU PLESSIS, C.P. 1993. The geology of the Vryburg area. Explanation to 1: 250 000 geology sheet 2624 Vryburg, 28 pp. Council for Geoscience, Pretoria.

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

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

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

MCLACHLAN, I.R. & ANDERSON, A. 1973. A review of the evidence for marine conditions in southern Africa during Dwyka times. Palaeontologia africana 15: 37-64.

PLUMSTEAD, E.P. 1969. Three thousand million years of plant life in Africa. Alex Du Toit Memorial Lectures No. 11. Transactions of the Geological Society of South Africa, Annexure to Volume 72, 72pp. 25 pls.

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

RUBIDGE, B. 2012. Palaeontological Assessment – Carocraft Solar Park, 3 pp. BPI, Wits University, Johannesburg.

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

SCHUTTE, I.C. 1994. Die geologie van die gebied Christiana. Explanation to 1: 250 000 geology sheet 2724 Christiana, 58 pp. Council for Geoscience, Pretoria.

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

SKEAD, C.J. 2011. Historical incidence of the larger land mammals in the broader Western and Northern Cape provinces. 2011 (Editors: A Boshoff, G Kerley and P Lloyd), 533 pages plus tables, maps and numerous illustrations. Centre for African Conservation Ecology, Nelson Mandela Metropolitan University, Port Elizabeth.

VISSER, J.N.J. 1992. Deposition of the Early to Late Permian Whitehill Formation during a sea-level highstand in a juvenile foreland basin. South African Journal of Geology 95: 181-193.

VISSER, J.N.J. 1994. A Permian argillaceous syn- to post-glacial foreland sequence in the Karoo Basin, South Africa. In Deynoux, M., Miller, J.M.G., Domack, E.W., Eyles, N. & Young, G.M. (Eds.) Earth's Glacial Record. International Geological Correlation Project Volume 260, pp. 193-203. Cambridge University Press, Cambridge.

VISSER, J.N.J. 1997. Deglaciation sequences in the Permo-Carboniferous Karoo and Kalahari Basins of southern Africa: a tool in the analysis of cyclic glaciomarine basin fills. Sedimentology 44: 507-521.

VISSER, J.N.J. 2003. Lithostratigraphy of the Elandsvlei Formation (Dwyka Group). South African Committee for Stratigraphy, Lithostratigraphic Series No. 39, 11 pp. Council for Geoscience, Pretoria.

VISSER, J.N.J., VON BRUNN, V. & JOHNSON, M.R. 1990. Dwyka Group. Catalogue of South African Lithostratigraphic Units 2, 15-17. Council for Geoscience, Pretoria.

9. 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, Mpumalanga, Free State, Limpopo, Northwest and Kwazulu-Natal under the aegis of his Cape Town-based company *Natura Viva* cc. He has been 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).

Declaration of Independence

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

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

<table>
<tr><td colspan="3">APPENDIX 1: CHANCE FOSSIL FINDS PROCEDURE: Protea Solar Power Plant on the Remaining Extent of the Farm Hartsboom No. 734 near Vryburg</td></tr>
<tr><td>Province & region:</td><td colspan="2">North West Province: Naledi Local Municipality</td></tr>
<tr><td>Responsible Heritage Resources Agency</td><td colspan="2">SAHRA, P.O. Box 4637, Cape Town 8000.
Contact: Dr Ragna Redelstorff. Tel: 021 202 8651. Email: rredelstorff@sahra.org.za
or Ms Natasha Higgitt. Tel: 021 462 4502. Email: nhiggitt@sahra.org.za</td></tr>
<tr><td>Rock unit(s)</td><td colspan="2">Dwyka Group (Karoo Supergroup).
Neogene to Holocene alluvium, aeolian sands, downwasted surface gravels, calcrete hardpans</td></tr>
<tr><td>Potential fossils</td><td colspan="2">Stromatolitic carbonate erratics within or eroding out of Dwyka tillites.
Vertebrate bones & teeth, vertebrate and other burrows (e.g. calcretised termitaria), land snails within superficial sediments.</td></tr>
<tr><td rowspan="5">ECO protocol</td><td colspan="2">1. Once alerted to fossil occurrence(s): alert site foreman, stop work in area immediately (N.B. safety first!), safeguard site with security tape / fence / sand bags if necessary.</td></tr>
<tr><td colspan="2">2. Record key data while fossil remains are still in situ:
Accurate geographic location – describe and mark on site map / 1: 50 000 map / satellite image / aerial photo
Context – describe position of fossils within stratigraphy (rock layering), depth below surface
Photograph fossil(s) in situ with scale, from different angles, including images showing context (e.g. rock layering)</td></tr>
<tr><td>3. If feasible to leave fossils in situ:
Alert Heritage Resources Agency and project palaeontologist (if any) who will advise on any necessary mitigation
Ensure fossil site remains safeguarded until clearance is given by the Heritage Resources Agency for work to resume</td><td>3. If not feasible to leave fossils in situ (emergency procedure only):
Carefully remove fossils, as far as possible still enclosed within the original sedimentary matrix (e.g. entire block of fossiliferous rock)
Photograph fossils against a plain, level background, with scale
Carefully wrap fossils in several layers of newspaper / tissue paper / plastic bags
Safeguard fossils together with locality and collection data (including collector and date) in a box in a safe place for examination by a palaeontologist
Alert Heritage Resources Agency and project palaeontologist (if any) who will advise on any necessary mitigation</td></tr>
<tr><td colspan="2">4. If required by Heritage Resources Agency, ensure that a suitably-qualified specialist palaeontologist is appointed as soon as possible by the developer.</td></tr>
<tr><td colspan="2">5. Implement any further mitigation measures proposed by the palaeontologist and Heritage Resources Agency</td></tr>
<tr><td>Specialist palaeontologist</td><td colspan="2">Record, describe and judiciously sample fossil remains together with relevant contextual data (stratigraphy / sedimentology / taphonomy). Ensure that fossils are curated in an approved repository (e.g. museum / university / Council for Geoscience collection) together with full collection data. Submit Palaeontological Mitigation report to Heritage Resources Agency. Adhere to best international practice for palaeontological fieldwork and Heritage Resources Agency minimum standards.</td></tr>
</table>