CHAPTER 12:
Palaeontology

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SITE SENSITIVITY VERIFICATION REPORT (IN TERMS OF PART A OF THE ASSESSMENT PROTOCOLS PUBLISHED IN GN 320 ON 20 MARCH 2020)

PROPOSED DEVELOPMENT OF THE KUDU SOLAR PHOTOVOLTAIC FACILITIES AND ASSOCIATED INFRASTRUCTURE NEAR PHILIPSTOWN AND DE AAR, PIXLEY KA SEME DISTRICT, NORTHERN CAPE PROVINCE

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EXECUTIVE SUMMARY

ABO Wind renewable energies (PTY) Ltd is proposing to develop the Kudu Solar Photovoltaic (PV) cluster[1] and associated Electricity Grid Infrastructure (EGI) near De Aar in the Pixley Ka Seme District, Northern Cape Province. The Kudu solar facility and grid connection project area largely comprises low-relief terrain mantled with thick Late Caenozioic calcrete hardpans, alluvial deposits, surface gravels and soils that are generally of low palaeosensitivity. Natural bedrock exposure here is very limited and mainly involves unfossiliferous dolerite as well as baked Ecca Group metasediments (probable Waterford Formation) building *kranzes* on upper hillslopes that will not be directly impacted by the proposed development. Early to Middle Permian basinal mudrocks of the Tierberg Formation (Ecca Group, Karoo Supergroup) underlie the majority of the project area but are rarely exposed and, where seen, are generally weathered, friable and extensively disrupted by near-surface calcrete veins. The offshore mudrocks of the Tierberg Formation are not known elsewhere to have a rich fossil record. In the present project area the potential for well-preserved fossils is further reduced by near-surface weathering, calcrete veining as well as baking of sedimentary bedrocks by intensive regional dolerite intrusion in Early Jurassic times. The only fossils recorded from the Ecca Group sediments during the 2-day palaeontological site visit comprise sparse, low diversity trace fossil assemblages of low scientific or conservation interest. Thick sandy to gravelly alluvial deposits associated with long-established drainage lines are extensively calcretised. No fossil remains were recorded within them.

According to the Department of Forestry, Fisheries and the Environment (DFFE) screening tool mapping, the majority of the Kudu solar PV facilities and associated grid connection corridor is of Medium to High palaeosensitivity. **This provisional assessment is *contested* in the present Site Sensitivity Verification Report**, based on a 2-day palaeontological site visit and several previous field-based and desktop Palaeontology Impact Assessment (PIA) studies in the broader De Aar – Kimberley region. **It is concluded that the Kudu solar PV and grid connection project areas are in fact of LOW to VERY LOW palaeosensitivity in general.** The only two fossil sites recorded in the region fall *outside* the PV project areas (Appendix 3) and are of low scientific / conservation interest so no mitigation is recommended with regard to them. The potential for rare, largely unpredictable fossil sites of High palaeosensitivity associated with older alluvial and pan deposits hidden in the subsurface cannot be discounted. Most such fossil sites would probably be protected during construction by environmental buffer zones along drainage lines. If any fossiliferous deposits are exposed by surface clearance or excavations during the construction phase of the development, the Chance Fossils Finds Protocol outlined in Appendix 2 to this report should be fully implemented. These recommendations should be included within the Environmental Management Programmes (EMPrs) for the Kudu Solar PV Facilities and associated infrastructure developments.

The project area for all the solar PV facilities, on-site substations, grid connection corridors and associated infrastructure currently under consideration are of LOW to VERY LOW palaeosensitivity. Provided that the Chance Fossil Finds Protocol tabulated in Appendix 2 is incorporated into the EMPrs and fully implemented during the construction phase of the solar PV facility and grid connection developments, there are no objections on palaeontological heritage grounds to authorisation of the proposed renewable energy developments. Pending the discovery of significant new fossil finds before or during construction, no further specialist palaeontological studies, reporting, monitoring or mitigation are recommended for these renewable energy projects.

[1] Each PV Facility will have a separate Project Applicant i.e. Kudu Solar Facility 1 (PTY) Ltd to Kudu Solar Facility 12.

These conclusions and recommendations apply equally to all solar PV Facility developments within the Kudu Solar PV cluster as well as to the development of associated Electricity Grid Infrastructure (See summary table below).

Tabulated summary of conclusions regarding palaeontological heritage for each of the Kudu Solar PV Facilities

Kudu PV Facility	Rock units present near surface	Desktop & field-based Palaeosensitivity	Recorded fossils	Recommended mitigation
PV1	Tierberg Formation (Ecca Group) Late Caenozoic superficial sediments (alluvium, calcrete hardpans, soils, eluvial surface gravels)	**LOW** **LOW**	**NONE**	**Application of Chance Fossil Finds Protocol during Construction Phase**
PV2	Tierberg Formation (Ecca Group) Late Caenozoic superficial sediments (alluvium, calcrete hardpans, soils, eluvial surface gravels)	**LOW** **LOW**	**NONE**	**Application of Chance Fossil Finds Protocol during Construction Phase**
PV3	Tierberg Formation (Ecca Group) Late Caenozoic superficial sediments (alluvium, calcrete hardpans, soils, eluvial surface gravels)	**LOW** **LOW**	**NONE**	**Application of Chance Fossil Finds Protocol during Construction Phase**
PV4	Tierberg Formation (Ecca Group) Late Caenozoic superficial sediments (alluvium, calcrete hardpans, soils, eluvial surface gravels)	**LOW** **LOW**	**NONE**	**Application of Chance Fossil Finds Protocol during Construction Phase**
PV5	Tierberg Formation (Ecca Group) Late Caenozoic superficial sediments (alluvium, calcrete hardpans, soils, eluvial surface gravels)	**LOW** **LOW**	**NONE**	**Application of Chance Fossil Finds Protocol during Construction Phase**
PV6	Tierberg Formation (Ecca Group) Late Caenozoic superficial sediments (alluvium, calcrete hardpans, soils, eluvial surface gravels)	**LOW** **LOW**	**NONE**	**Application of Chance Fossil Finds Protocol during Construction Phase**
PV7	Tierberg Formation (Ecca Group) Late Caenozoic superficial sediments (alluvium, calcrete hardpans, soils, eluvial surface gravels)	**LOW** **LOW**	**NONE**	**Application of Chance Fossil Finds Protocol during Construction Phase**
PV8	Tierberg Formation (Ecca Group) Late Caenozoic superficial sediments (alluvium, calcrete hardpans, soils, eluvial surface gravels)	**LOW** **LOW**	**NONE**	**Application of Chance Fossil Finds Protocol during Construction Phase**
PV9	Tierberg Formation (Ecca Group)	**LOW**	**NONE**	**Application of Chance Fossil Finds Protocol during Construction Phase**

Kudu PV Facility	Rock units present near surface	Desktop & field-based Palaeosensitivity	Recorded fossils	Recommended mitigation
	Late Caenozoic superficial sediments (alluvium, calcrete hardpans, soils, eluvial surface gravels)	**LOW**		
PV10	Tierberg Formation (Ecca Group) Late Caenozoic superficial sediments (alluvium, calcrete hardpans, soils, eluvial surface gravels)	**LOW** **LOW**	**NONE**	**Application of Chance Fossil Finds Protocol during Construction Phase**
PV11	Tierberg Formation (Ecca Group) Late Caenozoic superficial sediments (alluvium, calcrete hardpans, soils, eluvial surface gravels)	**LOW** **LOW**	**NONE**	**Application of Chance Fossil Finds Protocol during Construction Phase**
PV12	Tierberg Formation (Ecca Group) Late Caenozoic superficial sediments (alluvium, calcrete hardpans, soils, eluvial surface gravels)	**LOW** **LOW**	**NONE**	**Application of Chance Fossil Finds Protocol during Construction Phase**

CONTENTS

1. INTRODUCTION

The Project Applicant, ABO Wind renewable energies (PTY) Ltd and Kudu Solar Facility 1 (Pty) Ltd to Kudu Solar Facility 12 (Pty) Ltd, is proposing to develop the Kudu Solar Photovoltaic (PV) cluster and associated Electricity Grid Infrastructure (EGI) near the towns of De Aar and Philipstown in the Pixley Ka Seme District, Northern Cape Province (Figs. 1 & 2). Land parcels concerned with the development are shown in the satellite map in Figure 3; this is the study area covered by the present Site Sensitivity Verification report. The Kudu renewable energy project will entail the proposed development of up to several Solar PV Facilities as well as associated infrastructure and EGI[2]. Each solar PV facility will have a range of associated infrastructure including, but not limited to, an on-site substation complex and battery energy storage systems (BESS) and is proposed to connect to an existing 400 kV power line *via* dedicated 132 kV power lines. Each of the PV facilities would be its own project and would require its own, separate Environmental Authorisation (EA).

The proposed PV projects are not located within any of the Renewable Energy Development Zones (REDZs) that were gazetted in Government Notice (GN) 114 in February 2018 and GN 144 in February 2021. Therefore, full Scoping and Environmental Impact Assessment (EIA) Processes are needed for the PV projects. The proposed EGI projects are located within the Central Strategic Transmission Corridor that was gazetted in GN 113 in February 2018. Therefore, Basic Assessment (BA) and/or EGI Standard Registration Processes are needed for the EGI projects.

According to the Department of Forestry, Fisheries and the Environment (DFFE) National Web-Based Environmental Screening Tool (hereafter referred to as the "screening tool"), the majority of the Kudu Solar PV Facility and associated grid connection corridor study area is of Medium to High palaeosensitivity (Fig. 32). In accordance with Appendix 6 of the National Environmental Management Act (Act 107 of 1998, as amended) (NEMA) EIA Regulations of 2014, a combined field-based and desktop site sensitivity verification has therefore been undertaken in order to confirm or contest the environmental sensitivity of the proposed project area as identified by the Screening Tool.

The independent Environmental Practitioner co-ordinating the various Environmental Assessment processes for the proposed Kudu PV solar and associated infrastructure projects is the CSIR, Environmental Management Services (Contact details: Ms Rohaida Abed. CSIR - Environmental Management Services. P.O. Box 59081, Umbilo, Durban, 4075. Tel: 031 242 2318. E-mail: ems@csir.co.za).

This Palaeontology Site Verification Report has been compiled by Dr. John Almond of Natura Viva cc (CV included in Appendix 1, as well as a declaration of interest).

[2] The Scoping and EIA Process for the Solar PV Projects for Kudu Solar Facility 1 to 12 have commenced (Department of Forestry, Fisheries and the Environment (DFFE) Reference Numbers: 14/12/16/3/3/2/2244 to 14/12/16/3/3/2/2255). The Environmental Assessment Processes for the EGI Projects will be undertaken at a later stage. This Site Sensitivity Verification Report covers both the Solar PV Projects and EGI.

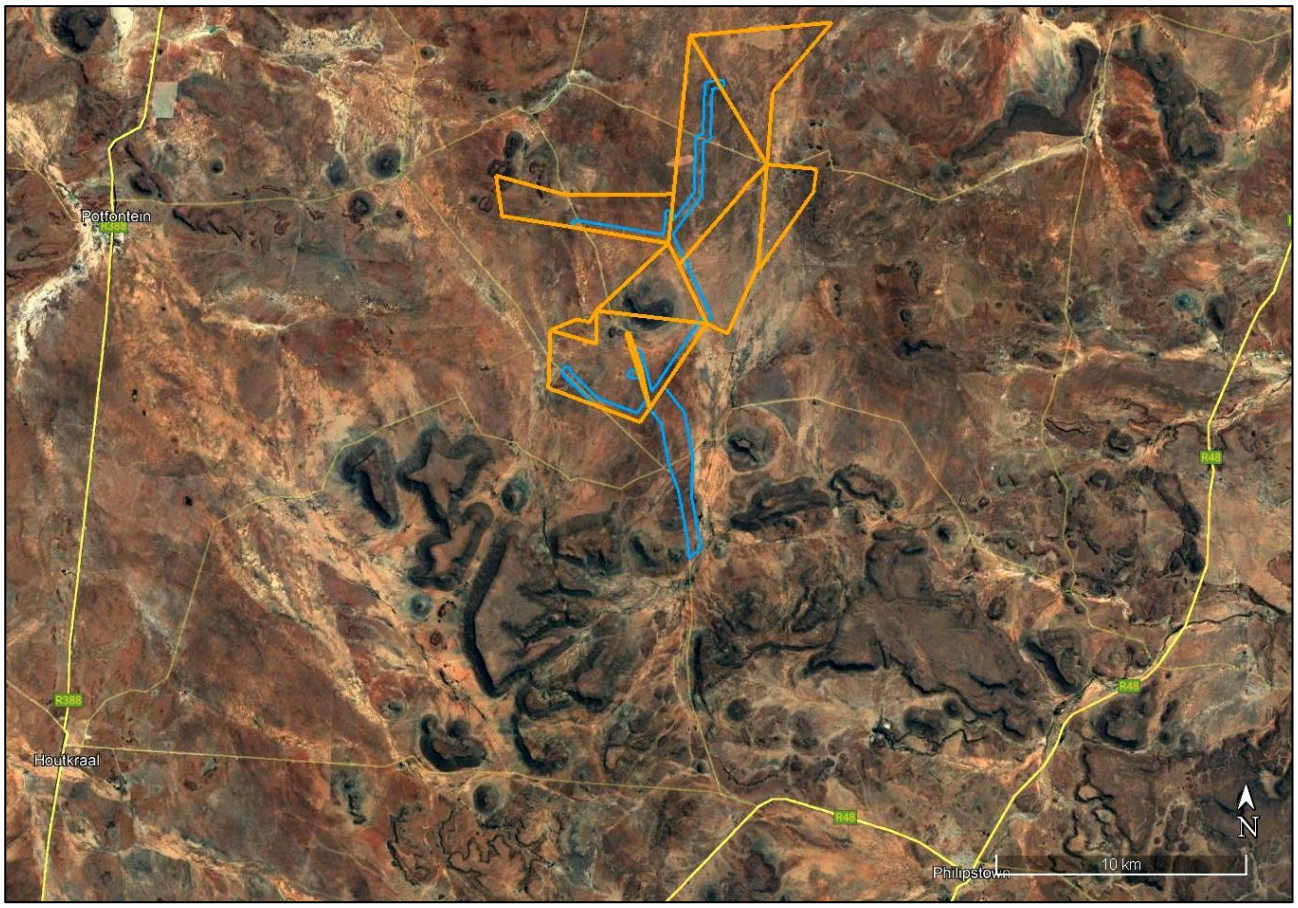

Figure 1: Google Earth© satellite image showing the project study area (orange polygon) for the proposed Kudu Solar PV Facilities near Philipstown, Pixley Ka Seme District, Northern Cape Province. Corridors for the various grid connection route options are shown in blue, including a 400 kV Loop-In-Loop-Out (LILO) from the existing Hydra-Perseus 400 kV Overhead Power Line to the proposed MTS. Site Sensitivity Verification for the solar PV facility and EGI project area is based on a recent 2-day palaeontological heritage site visit. Land parcels concerned within the project area are identified in Figure 3 below.

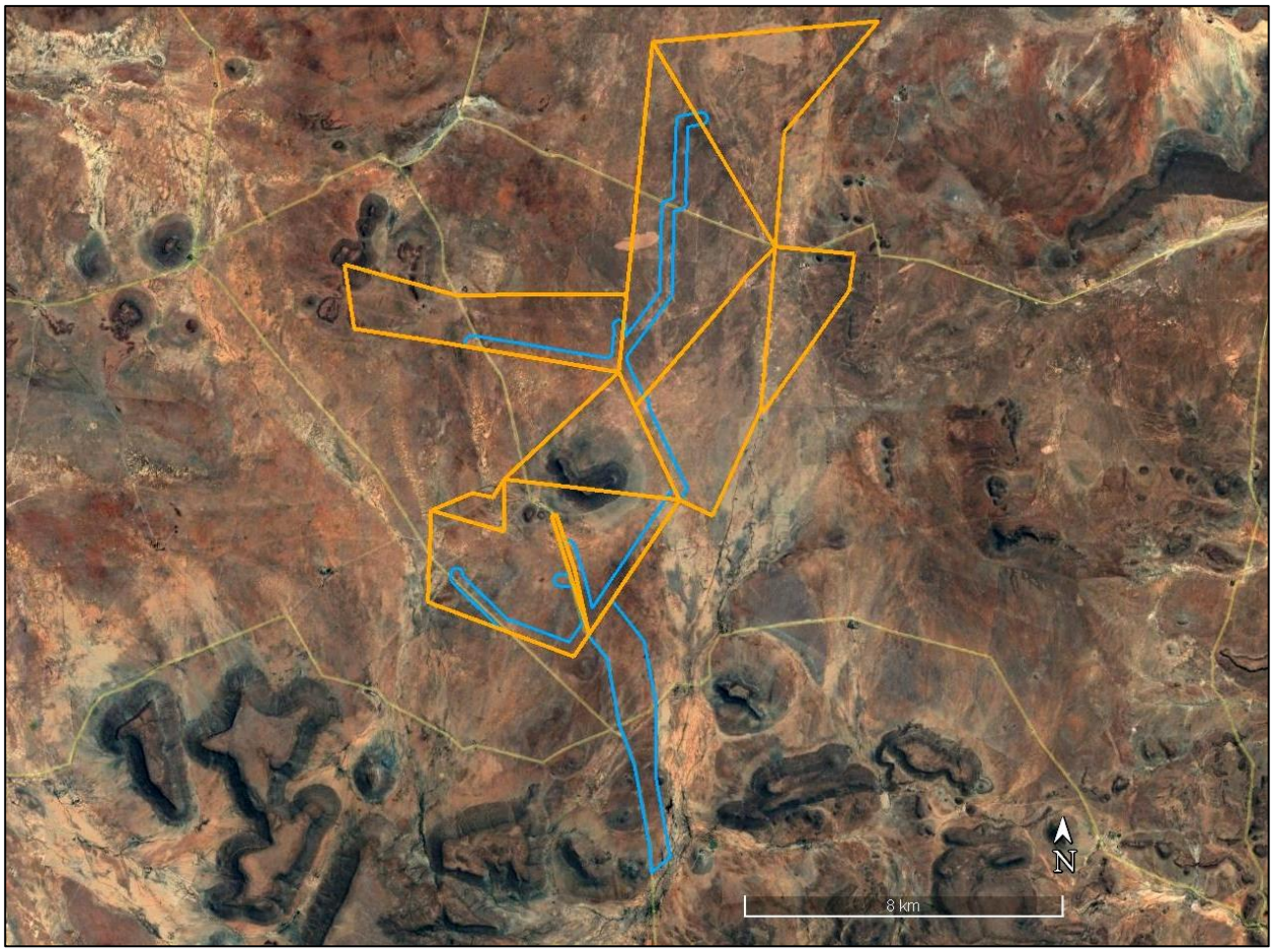

Figure 2: More detailed Google Earth© satellite image of the Kudu Solar PV cluster project area and associated EGI project area (blue polygon). Most of the project area features low relief, grassy terrain with very little or no bedrock exposure.

2. DATA SOURCES

The palaeontological heritage site sensitivity verification report for the Kudu solar facility and associated infrastructure project area is based on:

- Detailed project descriptions, maps, kmz files, DFFE screening reports and other relevant background documentation provided by the CSIR.

- A desktop review of (a) 1:50 000 scale topographic maps (3024AB Jakkalskuil, 3024AD Philipstown) and the 1:250 000 scale topographic map (sheet 3024 Colesberg), (b) Google Earth© satellite imagery, (c) published geological and palaeontological literature, including 1:250 000 geological maps (sheet 3024 Colesberg) and relevant sheet explanation (Le Roux 1993), as well as (d) several previous desktop and field-based fossil heritage (PIA) assessments in the De Aar – Kimberley region by the author (See References under Almond).

- A two day field survey of representative rock exposures within the broader PV and associated infrastructure project study area by the author on 22 and 23 April 2022.

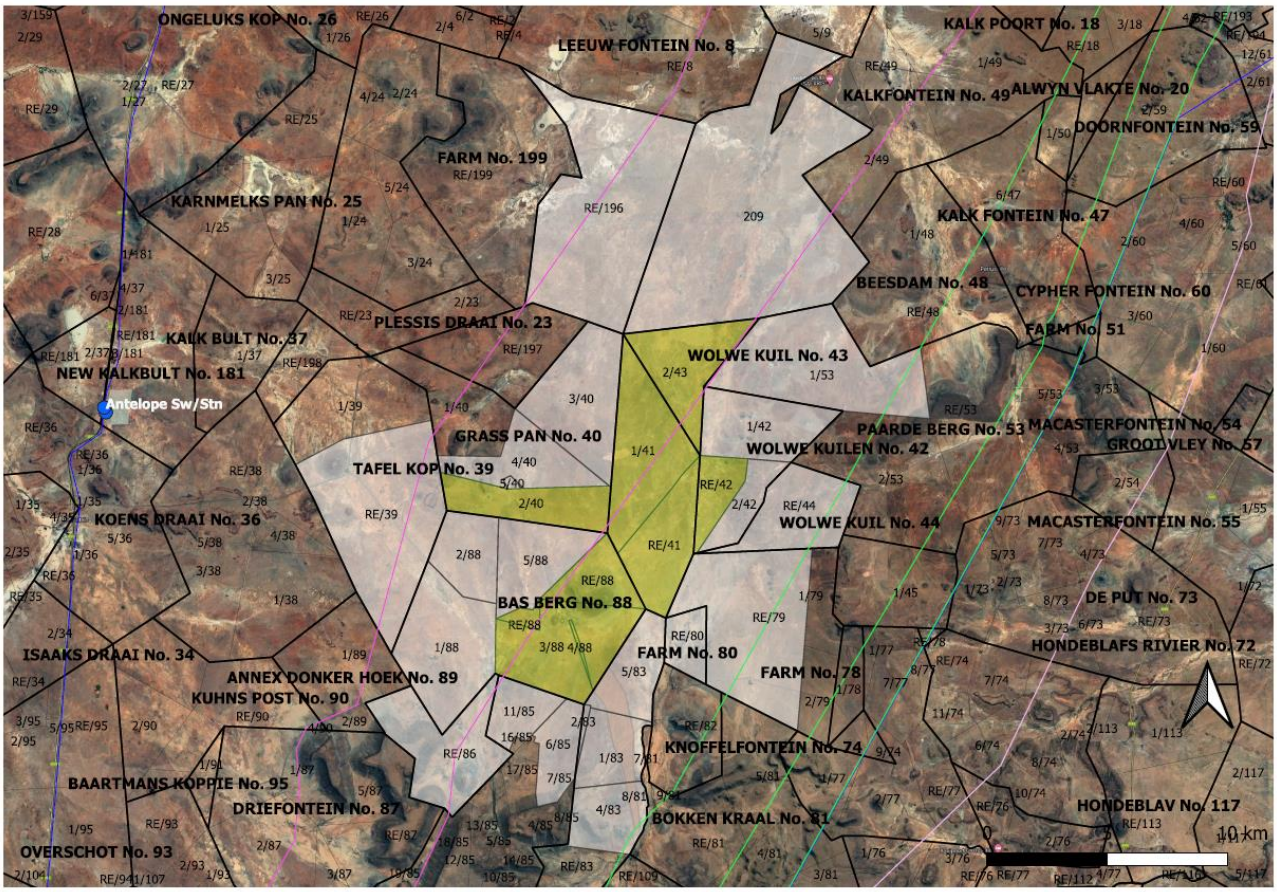

Figure 3: Overlay on satellite image showing the component land parcels concerned with the Kudu solar renewable energy project near De Aar (Image provided by the CSIR).

3. STATEMENT ON THE STUDY AREA

The study area for all the proposed Kudu Solar Facilities is the full extent of the eight affected farm properties[3] on which the proposed PV Facilities will be constructed (Figure 3), and the EGI Corridor. The full extent of these properties and the EGI Corridor has been assessed in this study in order to identify environmental sensitivities and no-go areas. The total **study area** for all the Kudu Solar Facilities is approximately 8 150 hectares (ha), as well as the EGI corridor.

At the commencement of this Scoping and EIA Process, Original Scoping Buildable Areas were identified by the Project Developer following the completion of high-level environmental screening based on the Screening Tool.

Following the identification of sensitivities during the Scoping Phase, the Project Developer considered such sensitivities and formulated the Revised Scoping Buildable Areas. The Revised Scoping Buildable Areas were used to inform the design of the layout and were further assessed during this EIA Phase in order to identify the preferred development footprint of the proposed project on the approved site as contemplated in the

[3] These farm properties are Remaining Extent of the Farm Bas Berg No. 88 (C05700000000008800000); Remaining Extent of Portion 3 of the Farm Bas Berg No. 88 (C05700000000008800003); Portion 4 (Portion of Portion 3) of the Farm Bas Berg No. 88 (C05700000000008800004); Remaining Extent of Portion 2 (Middel Plaats) (a Portion of Portion 1) of the Farm Grasspan No. 40 (C05700000000004000002); Remaining Extent of the Farm Annex Wolve Kuil No. 41 (C05700000000004100000); Portion 1 (Wolve Kuil West) of the Farm Annex Wolve Kuil No. 41 (C05700000000004100001); Portion 2 of the Farm Wolve Kuil No. 43 (C05700000000004300002); and Remaining Extent of the Farm Wolve Kuilen No. 42 (C05700000000004200000). Note that the farm names are extracted from the title deeds, and that all reference to these farm portions throughout this report refer to it as such.

accepted Scoping Report. The development footprint is where the actual development will be located, e.g. the footprint containing the PV solar arrays and associated infrastructure.

The development footprints or detailed layouts are considered suitable from a palaeontological perspective. Changes to the detailed layouts are deemed acceptable if the changes remain within the approved development footprint and area assessed in the EIA (with avoidance of no-go areas identified by relevant specialists).

4. GEOLOGICAL CONTEXT

The project study area for the proposed Kudu Solar Facilities and associated infrastructure (including EGI) is situated in low-relief, semi-arid, karroid to grassy terrain some 40 km SW of the Gariep River in the Northern Cape Province (Figs. 1, 2, 4 to 6). The towns of Philipstown and De Aar lie some 30 km to the SE and 60 km to the SSW respectively. The project study area lies just to the north of a range of low, dolerite-capped hills (*e.g.* Swartkoppies / Tierberg / Perdekop) and includes the small isolated *koppie* Basberg (1466 m amsl). The landscape slopes very broadly towards the north, from around 1370 down to 1250 m amsl. Drainage in this largely flat-lying region is ill-defined, comprising several N-flowing, shallow, intermittently-flowing water courses (unnamed), such as that running through Wolwekuil towards Jakkalskuil, and small pans (larger named pans such as Grasspan and Karringmelkpan lie shortly outside the project study area). Apart from dolerite-capped *koppies* and ridges as well as occasional borrow pits, bedrock exposure within the project area is very limited indeed due to pervasive cover by calcrete, alluvium and soils as well as dense grassy vegetation and *bossieveld*.

Figure 4: View from a dolerite-capped *koppie* just east of Wolwekuil farmstead (seen in middle ground on Wolwe Kuilen RE/42), looking south-westwards across the Kudu solar project area with the isolated *koppie* Basberg in the distance. The project area consists largely of low-relief, grassy terrain with almost no bedrock exposure.

Figure 5: Flat terrain with dense grassy vegetation and no bedrock exposure, typical of large portions of the Kudu solar project area, seen here on Annex Wolwe Kuil RE/41 with Basberg in the background.

Figure 6: Open patch within grassy vegetation exposing orange-brown sandy soils and sparse scatter of fine surface gravels (mainly calcrete, hornfels and dolerite clasts), looking due south towards Basberg, on Farm Grass Pan 2/40. These open areas were searched for reworked blocks of petrified wood.

The geology of the Kudu solar and EGI project area is outlined on 1: 250 000 geology sheet 3024 Colesberg (Council for Geoscience, Pretoria) with a short accompanying sheet explanation by Le Roux (1993) (Fig. 7). The majority of the area is underlain at depth by non-marine basinal mudrocks of the **Tierberg Formation** (**Ecca Group**, **Karoo Supergroup**) of Early to Middle Permian age whose type section has been designated on hillslopes on the farm Swart Koppies 86, just south of the present study area (Viljoen 2005).

The Tierberg Formation *sensu stricto* is a recessive-weathering, mudrock-dominated succession consisting predominantly of dark, well-laminated, carbonaceous shales with subordinate thin, fine-grained sandstones (Visser *et al.* 1977, Prinsloo 1989, Zawada 1992, Bosch 1993, Le Roux 1993, Viljoen 2005, Johnson *et al*., 2006). The Tierberg shales are Early to Middle Permian in age and were deposited in a range of offshore, quiet water environments below wave base. These include basin plain, distal turbidite fan and distal prodelta settings in ascending order (Viljoen 2005, Almond 2008a). Thin, coarsening-upwards cycles occur towards the top of the formation with local evidence of soft-sediment deformation, ripples and common calcareous concretions (often rusty-brown with well-developed cone-in-cone structures). A restricted, brackish water environment is reconstructed for the Ecca Basin at this time. Close to the contact with Karoo dolerite intrusions the Tierberg mudrocks are baked to a dark grey hornfels which typically develops an orange to reddish-brown surface weathering crust or patina (Prinsloo 1989).

These Ecca sedimentary bedrocks are currently only mapped at surface on the slopes of Basberg (Pt, pale brown in Fig. 7) as well as the *koppies* just east of Wolwekuil farmstead on Farm 42/RE where they crop out intermittently as low cliffs of metasediments which have been thermally metamorphosed by dolerite intrusion Figs. 8 to 10). More recent mapping along the Ecca – Beaufort Group contact in the northern sector of the Main Karoo Basin suggests that the prominent-weathering packages of wackes seen at higher elevations on hillslopes here, and which were originally included within the upper Tierberg Formation (*e.g.* Viljoen 2005), should be referred rather to the deltaic **Waterford Formation** (*cf* Groenewald *et al.* 2022). These delta front and platform sediments build the uppermost part of the Ecca Group succession and are conformably overlain by continental sediments of the **Adelaide Subgroup** (undifferentiated) in the De Aar region (cf Almond 2012a). Since neither the Waterford Formation nor Adelaide Subgroup bedrocks will be directly or indirectly impacted by the proposed Kudu renewable energy developments, they will not be discussed further here.

Well-developed sills and dykes of the Early Jurassic **Karoo Dolerite Suite** build and / or cap all the *koppies* within and on the margins of the Kudu project area (including Basberg) and also underlie some lower-lying areas (Figs. 15 to 18). Rubbly **colluvial deposits** of dolerite blocks and corestones mantle steeper hillslopes and obscure most underlying sedimentary bedrocks. Weathering of calcium-rich dolerite under semi-arid climates – probably in Pleistocene times for the most part - has contributed to the development of a pervasive, thick (up to 1 to 2 m or more) hardpan of cream-coloured **pedogenic calcrete** across most of the project area (Qc, yellow in Fig. 7). This hardpan is usually obscured by soil, alluvium and vegetation but is well exposed in occasional borrow pits inside and just outside the project area where extensive veining and disruption of weathered Ecca bedrocks by calcrete veins can also be seen (Figs. 12, 23 to 25). These pedogenic limestone deposits reflect seasonally arid climates in the region over the last five or so million years and are briefly described for the Britstown sheet area by Le Roux (1993). Although calcrete is still forming in the study area today, it forms subsurface and when exposed at the surface is “almost definitely fossil” (Botha 1988). The older, Pliocene - Pleistocene calcretes in the broader Kalahari region, including sandy limestones and calcretised conglomerates, have been assigned to the **Mokalanen Formation** of the **Kalahari Group** and are possibly related to a globally arid time period between 2.8 and 2.6 million years ago, *i.e.* late Pliocene (Partridge *et al.* 2006). Key review papers on South African calcretes are those by Netterberg (1969a-b, 1978, 1980, 1985, among other works). Calcrete types commonly encountered in the Northern Cape study area include glaebular calcrete (with discrete nodules), honeycomb calcrete (with coalescent glaebules) and hardpan calcrete (solid limestone within at most minor voids). The surface limestones may reach thicknesses of over 10m, but are often much thinner, and are locally conglomeratic with clasts of reworked calcrete as well as exotic pebbles.

Thick deposits of orange-brown, **sandy to sparsely gravelly older alluvium** of probable late Caenozoic age (perhaps Pleistocene or older) are associated with major drainage lines, such as that running just east of the EGI corridor (Figs. 19 to 22). Roadside borrow pit exposures of these sandy to gritty sediments on farm Koppy Alleen 83 show that they are semi- to well-consolidated and extensively calcretised (3D polygonal networks of calcrete veins, intermittent thin hardpans). The upper part of the succession includes calcretised gravel lenses incorporating flaked hornfels artefacts showing that at least these upper layers are of Pleistocene age or younger. Other Late Caenozoic superficial deposits encountered within the Kudu project area include eluvial (downwasted / sheetwashed) surface gravels – mainly composed of hornfels, dolerite, siltstone flakes and calcrete rubble with some grey-green wacke – as well as thick silty to sandy soils (Figs. 6, 26 to 29). Middle Stone Age (MSA) artefacts of patinated hornfels are common within the unconsolidated younger soils and are often concentrated along the interface with the underlying calcrete hardpan. Some of the orange-hued unconsolidated or partially calcretised surface sands within the project area might be relict patches of aeolian sands of the **Gordonia Formation** (**Kalahari Group**) of Pleistocene or younger age (*cf* Almond 2013b). Pale rounded features up to several decameters in diameter seen in flat-lying areas on satellite images are characterised by thick sandy soils with calcrete glaebules which are often extensively burrowed by modern mammals.

Representative exposures of the various rock units seen within or on the margins of the project area are illustrated below in Figures 8 to 29 with explanatory figure legends.

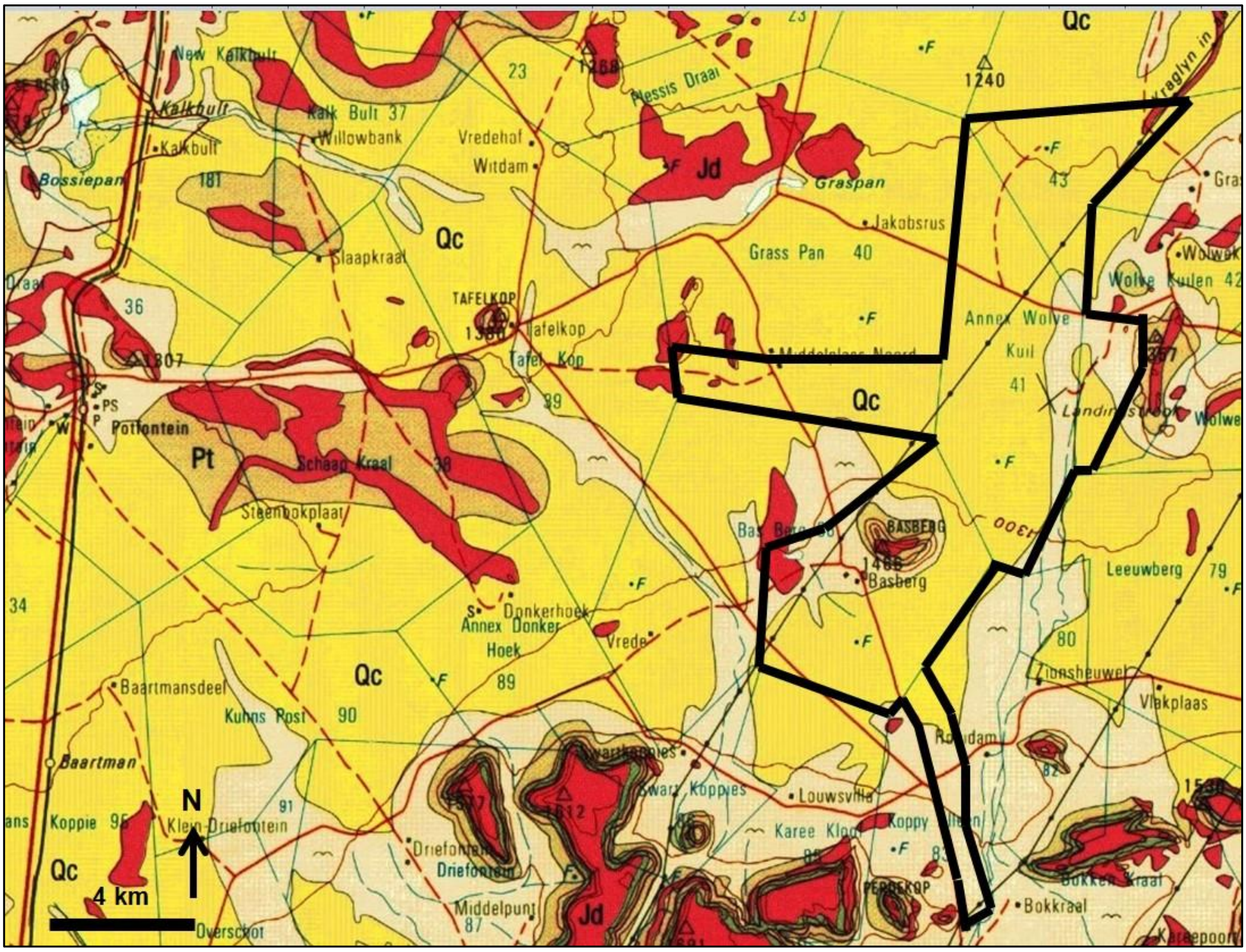

Figure 7: Extract from 1: 250 000 geology map 3024 Colesberg (Council for Geoscience, Pretoria) showing the project study area for the proposed Kudu solar facilities and associated infrastructure (including EGI corridor) near Philipstown and De Aar, Pixley Ka Seme District, Northern Cape (black polygon). The main geological units mapped within the wider study region include:
Tierberg Formation (Ecca Group, Karoo Supergroup) – Pt (pale brown) (*N.B.* the upper part of this succession is now referred to the Waterford Formation)
Adelaide Subgroup – Pa (pale green) (*outside* Kudu project area)
Karoo Dolerite Suite – Jd (red)
Quaternary calcrete hardpans – Qc (yellow)
Late Caenozoic alluvium – off white (flying –bird symbol)
Unmapped Late Caenozoic superficial sediments include colluvium, eluvial surface gravels and soils (including possible relict aeolian sands of the Gordonia Formation, Kalahari Group).

Figure 8: Upper north-eastern slopes of the isolated *koppie* Basberg on Farm Bas Berg RE/88 showing baked Ecca metasediments (EC, probably Waterford Formation) sandwiched between sills of dolerite (Jd). See following figure for more detail.

Figure 9: Close-up of brownish-weathering, bedded wackes of the Ecca Group on Basberg seen in the previous illustration. These beds are mapped as basinal Tierberg Formation but probably belong to the overlying deltaic Waterford Formation (uppermost Ecca Group). They will not be directly impacted by the proposed Kudu renewable energy projects.

Figure 10: Thin bedded, baked shales and / or wackes of the Tierberg Formation exposed among doleritic colluvium on the higher southern slopes of the *koppie* just east of Wolwekuil homestead on Farm Wolwe Kuilen RE/42 (Image kindly provided by Dr Jayson Orton, ASHA Consulting).

Figure 11: View westwards towards *koppie* on Zionsheuwel 82 (just east of and outside EGI corridor) showing laterally-persistent *kranz* of prominent-weathering Waterford Formation wackes on middle slopes as well as dolerite sill capping. The low-lying EGI corridor project area in the foreground is underlain by the Tierberg Formation but the recessive-weathering bedrocks are not exposed here.

Figure 12: Dark grey, weathered, crumbly Tierberg Formation mudrocks with extensive secondary calcrete veination (probably Quaternary age) exposed in roadside borrow pit excavation on Farm Wolwe Kuilen 1/42, just north of Wolwekuil farmstead on Farm Wolwe Kuilen RE/42.

Figure 13: Rusty-brown weathering large carbonate concretion weathered out at surface from the Tierberg Formation on Bas Berg 3/88 (scale in cm and mm). Such diagenetic concretions might contain fossil palynomorphs (spores *etc*) or microvertebrate remains.

Figure 14: Isolated downwasted block of greyish, baked wacke of the Tierberg Formation among doleritic rubble, Wolwe Kuilen RE/42 (hammer = 30 cm).

Figure 15: Apron of orange-patinated hornfels gravels on the margins of the dolerite-capped *koppie* on Wolwe Kuilen RE/42. The hornfels forms an important raw material for Stone Age artefacts in the region.

Figure 16: Dolerite sill showing well-developed columnar jointing capping Tafelkop, *c*. 4.5 km west of and outside the Kudu solar project area (Tafel Kop 39).

Figure 17: Ecca Group bedrocks on hillslopes below dolerite sills are typically very poorly exposed due to cover by rubbly doleritic colluvium, soils and vegetation, as seen here on Wolwe Kuilen RE/42.

Figure 18: Shallow stream exposure of a pervasive subsurface calcrete hardpan covered by orange-brown sandy soils of alluvial and / or aeolian provenance, EGI corridor on Koppy Alleen 83.

Figure 19: Large roadside borrow pit on Koppy Alleen 1/83 excavated into calcretised sandy alluvial deposits such as those represented beneath large portions of the EGI corridor and related to the long-established drainage line just to the east of the corridor.

Figure 20: 3D polygonal network of calcrete veins and calcrete hardpans within orange-brown, gritty to sandy alluvium exposed in the borrow pit shown in the previous illustration (hammer = 30 cm).

Figure 21: Lens of calcretised fine gravels within the consolidated alluvium shown in the previous two figures (scale in cm). The incorporated gravel clasts include several flaked hornfels artefacts showing that the deposits are Pleistocene or younger in age.

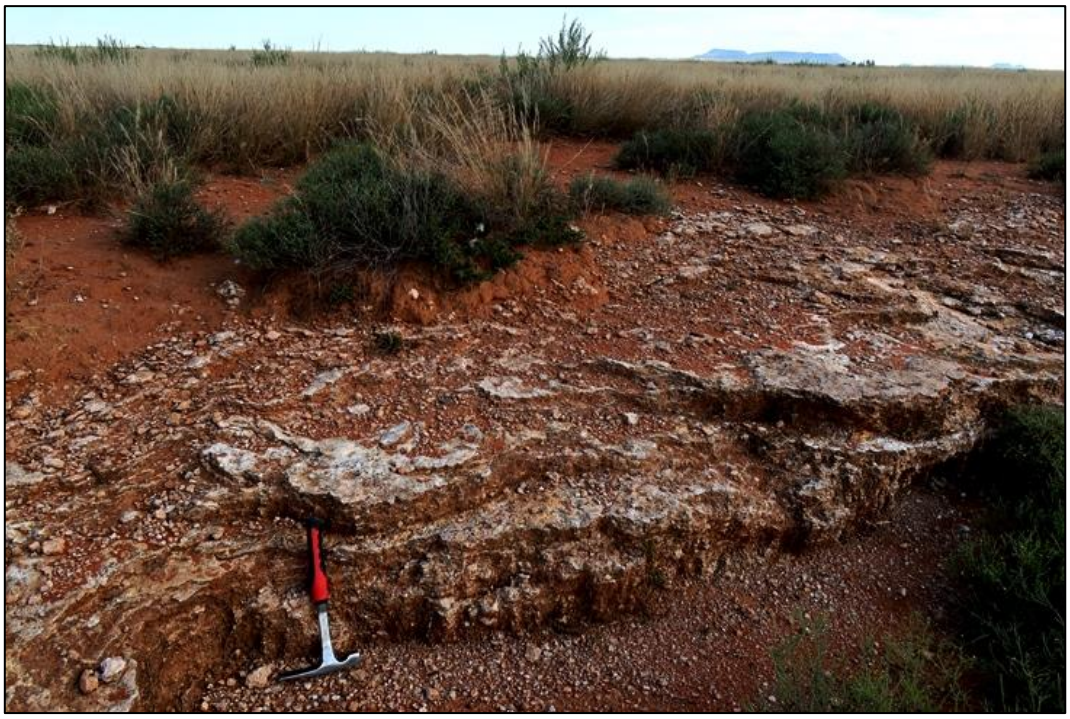

Figure 22: Heavily calcretised, orange-brown cover sands overlying weathered Tierberg Formation bedrocks on the margins of a borrow pit on Farm Wolwe Kuilen 1/42, just north of Wolwekuil farmstead on Farm Wolwe Kuilen RE/42 (See Figure 12) (hammer = 30 cm).

Figure 23: Good borrow pit exposure of the pervasive, thick calcrete hardpan overlying most of the low-lying terrain within the Kudu renewable energy project area, seen here on farm RE/197, outside and *c*. 4.7 km west of the project area itself.

Figure 24: Sporadic exposure of a near-surface calcrete hardpan and overlying rubbly calcrete gravels as well as hornfels clasts on Annex Wolwe Kuil 1/41.

Figure 25: Good exposure of dark-grey, weathered, friable Tierberg Formation mudrocks showing extensive near-surface disruption and veining by Quaternary calcrete veins, seen here in an elongate roadside borrow pit on farm Grass Pan 1/40, *c*. 6.5 km west of and outside the Kudu renewable energy project area.

Figure 26: Occasional greyish areas on satellite images of the project area prove, on the ground, to represent weathered siltstone bedrocks of the Tierberg Formation with downwasted surface gravels of flaky mudrock, hornfels and dolerite (seen here on Portion 0 (RE) of Farm Wolve Kuilen 42). Well-preserved fossils are unlikely in this context.

Figure 27: Close-up of weathered, fissile, greyish Tierberg Formation siltstones and surface gravels shown in the previous image (hammer = 30 cm).

Figure 28: Eluvial, sheetwashed surface gravels of dolerite, hornfels and wacke overlying sandy soils on the southern side of Basberg (Bas Berg 3/88). Reworked blocks of silicified wood from the Waterford Formation *might* occur in such contexts but none were recorded here.

Figure 29: Patches of thick, orange-brown sands with dispersed calcrete rubble are often intensely burrowed by modern mammals, as seen here on Annex Wolwe Kuil 1/41. They appear as pale rounded features on satellite images and probably have a biological basis (*cf heuweltjies*). The sands themselves might originally have had an aeolian provenance.

5. PALAEONTOLOGICAL HERITAGE

Potential and recorded fossils within the various rock units mapped within the Kudu solar PV project and grid connection project areas have already been reviewed in some detail in several previous PIA reports for the De Aar – Kimberley region by the author (See References). Since the Waterford Formation (Ecca Group) and Adelaide Subgroup beds in the region will not be impacted by the proposed developments, they are not treated further here.

The fossil record of the **Tierberg Formation** has been reviewed in detail by Almond (2008a). Rare body fossil records include disarticulated microvertebrates (*e.g.* fish teeth and scales) from calcareous concretions in the Koffiefontein sheet area (Zawada 1992) and allochthonous plant remains (drifted leaves, petrified wood). The latter become more abundant in the upper, more proximal (prodeltaic) facies of the Tierberg (*e.g.* Wickens 1984). Prinsloo (1989) records numerous plant impressions and unspecified "fragmentary vertebrate fossils" (possibly temnospondyl amphibians) within fine-grained sandstones in the Britstown sheet area. Dark carbonaceous Ecca mudrocks are likely to contain palynomorphs (*e.g.* pollens, spores, acritarchs). Bosch (1993) and Visser *et al.* (1977) briefly mention body fossils within the Tierberg mudrocks in the broader Kimberley region. Concretions within the lower part of the formation may contain fish scales, coprolites and sponge spicules. Records of abundant silicified wood within the upper Tierberg succession are now referred to the Waterford Formation (see below).

The commonest fossils by far in the Tierberg Formation are sparse to locally concentrated assemblages of trace fossils that are often found in association with thin event beds (*e.g.* distal turbidites, prodeltaic sandstones) within more heterolithic successions. A modest range of ten or so different ichnogenera have been recorded from the Tierberg Formation (*e.g.* Abel 1935, Anderson 1974, 1976, Wickens 1980, 1984, 1994, 1996, Prinsloo 1989, De Beer *et al.*, 2002, Viljoen 2005, Almond 2008a). These are mainly bedding parallel, epichnial and hypichnial traces, some preserved as undertracks. Penetrative, steep to subvertical burrows are rare, perhaps because the bottom sediments immediately beneath the sediment / water interface were anoxic. Most Tierberg ichnoassemblages display a low diversity and low to moderate density of traces. Apart from simple back-filled and / or lined horizontal burrows (*Planolites, Palaeophycus*) they include arthropod trackways (*Umfolozia*) and associated resting impressions (*Gluckstadtella*), undulose fish swimming trails (*Undichna*) that may have been generated by bottom-feeding palaeoniscoids, horizontal epichnial furrows (so-called *Scolicia*) often attributed to gastropods (these are also common in the co-eval Collingham Formation; Viljoen 1992, 1994), arcuate, finely-striated feeding excavations of an unknown arthropod (*Vadoscavichnia*), beaded traces ("*Hormosiroidea*" or "*Neonereites*"), small sinusoidal surface traces (*Cochlichnus*), small star-shaped feeding burrows (*Stelloglyphus*) and zigzag horizontal burrows (*Beloraphe*), as well as possible narrow (<1cm) *Cruziana* scratch burrows. The symmetrical, four-pronged trace *Broomichnium* (= *Quadrispinichna* of Anderson, 1974 and later authors) often occurs in groups of identical size (*c*. 3.5cm wide) and similar orientation on the bedding plane. This trace has frequently been misinterpreted as a web-footed tetrapod or arthropod trackway (*e.g.* Van Dijk *et al*. 2002 and references therein). However, Braddy and Briggs (2002) present a convincing case that this is actually a current-orientated arthropod resting trace (cubichnion), probably made by small crustaceans that lived in schools of similar-sized individuals and orientated themselves on the seabed with respect to prevailing bottom currents. Distinctive broad (3-4cm), strap-shaped, horizontal burrows with blunt ends and a more-or-less pronounced transverse ribbing occur widely within the Tierberg mudrocks. They have been described as "fucoid structures" by earlier workers (*e.g.* Ryan 1967) by analogy with seaweeds, and erroneously assigned to the ichnogenera *Plagiogmus* by Anderson (1974) and *Lophoctenium* by Wickens (1980, 1984). Examples up to one metre long were found in Tierberg mudrocks near Calvinia in 1803 by H. Lichtenstein, who described them as "eel fish". These are among the first historical records of fossils in South Africa (MacRae 1999). These as yet unnamed burrows are infilled with organized arrays of faecal pellets (Werner 2006). Sandstone sole surfaces with casts of complex networks of anastomosing (branching and fusing) tubular burrows have been attributed to the ichnogenus *Palaeodictyon* (Prinsloo 1989) but may more appropriately assigned to *Megagrapton* (Almond 1998). These so-called graphoglyptid burrows are associated with turbidite facies from the Ordovician to Recent times and have been interpreted as gardening burrows or *agrichnia* (Seilacher, 2007). Microbial mat textures, such as *Kinneyia*, also

occur in these offshore mudrocks but, like the delicate grazing traces with which they are often associated, are generally under-recorded.

The fossil record of the **Kalahari Group** is generally sparse and low in diversity. The **Gordonia Formation** dune sands were mainly active during cold, drier intervals of the Pleistocene Epoch that were inimical to most forms of life, apart from hardy, desert-adapted species. Porous dune sands are not generally conducive to fossil preservation. However, mummification of soft tissues may play a role here and migrating lime-rich groundwaters derived from the underlying bedrocks (including, for example, dolerite) may lead to the rapid calcretisation of organic structures such as burrows and root casts. Occasional terrestrial fossil remains that might be expected within this unit include calcretized rhizoliths (root casts) and termitaria (*e.g. Hodotermes*, the harvester termite), ostrich egg shells (*Struthio*) and shells of land snails (*e.g. Trigonephrus*) (Almond 2008a, Almond & Pether 2008). Other fossil groups such as freshwater bivalves and gastropods (*e.g. Corbula, Unio*) and snails, ostracods (seed shrimps), charophytes (stonewort algae), diatoms (microscopic algae within siliceous shells) and stromatolites (laminated microbial limestones) are associated with local watercourses and pans. Microfossils such as diatoms may be blown by wind into nearby dune sands (Du Toit 1954, Dingle *et al*., 1983). These Kalahari fossils (or subfossils) can be expected to occur sporadically but widely, and the overall palaeontological sensitivity of the Gordonia Formation is therefore considered to be low. Underlying calcretes of the **Mokolanen Formation** might also contain trace fossils such as rhizoliths, termite and other insect burrows, or even mammalian trackways. Mammalian bones, teeth and horn cores (also tortoise remains, and fish, amphibian or even crocodiles in wetter depositional settings such as pans; Partridge & Scott 2000) may be expected occasionally expected within Kalahari Group sediments and calcretes, notably those associated with ancient, Plio-Pleistocene alluvial gravels.

No High Palaeosensitivity fossil sites of scientific or conservation value were identified within the Kudu renewable energy project area during the palaeontological two-day site visit.

The only fossil material recorded from bedrock exposures here comprises low diversity trace fossil assemblages within fossil mudrocks of the Tierberg Formation excavated from a deep, steep-sided trench on farm Bas Berg RE 88 (30.245804° S, 24.315688° E) (Fig. 30 and Appendix 3, Fig. A3.1). The traces comprise poorly-preserved, simple to possibly branching horizontal burrows of *c*. 5 to 10 mm diameter which appear variously darker or paler than the surrounding speckled, grey-green siltstone matrix. Siltstone float blocks encountered among surface gravels sometimes contain broadly comparable simple horizontal burrows (*e.g.* south of Basberg on Bas Berg 3/88; 30.241383° S, 24.327129° E) (Fig. 31 and Appendix 3 Figure A3.1). These ichnoassemblages are of very widespread occurrence within the Tierberg Formation outcrop area and are not of significant scientific or conservation interest.

No fossils at all were recorded from the various Late Caenozoic superficial deposits within the Kudu renewable energy project area during the site visit. The potential for rare, largely unpredictable fossil sites of High palaeosensitivity associated with older alluvial and pan deposits in the subsurface cannot be entirely discounted (*e.g.* local concentrations of mammalian teeth, horncores and bones, non-marine molluscs, calcretised termitaria). Reworked blocks of silicified wood are likely to occur within surface gravels in the region but none were identified during the recent site visit.

Figure 30: Excavated block of speckled, grey-green Tierberg Formation siltstone containing vague, pale horizontal burrows (scale in cm and half-cm), farm Bas Berg RE 88 (30.245804° S, 24.315688° E). See Loc. 583 on satellite maps in Appendix 3.

Figure 31: Simple horizontal burrows preserved in dark material contrasting with the pale yellowish-grey matrix which is probably of baked Tierberg Formation mudrock, float block on farm Bas Berg 3/88 (30.241383° S, 24.327129° E) (scale in cm and mm). See Loc. 586 on satellite maps in Appendix 3.

6. SITE SENSITIVITY VERIFICATION

Provisional site sensitivity mapping for palaeontological heritage prepared by the CSIR using the DFFE National Web-Based Environmental Screening Tool suggests that the Kudu solar facility project area as well as the associated grid connection corridors are largely of Medium to High palaeosensitivity, with scattered small areas of zero or negligible sensitivity reflecting intrusions of Karoo dolerite (Fig. 32).

Based on several previous desktop and field-based PIA studies by the author in the broader De Aar region (listed in References) as well as the recent 2-day palaeontological site, it is concluded that the Kudu solar facility and grid connection project areas are in fact of **Low to Very Low palaeosensitivity overall**, although the potential for rare, largely unpredictable fossil sites of High palaeosensitivity associated with older alluvial and pan deposits in the subsurface cannot be entirely discounted. The DFFE-based palaeosensitivity mapping is accordingly *contested* here.

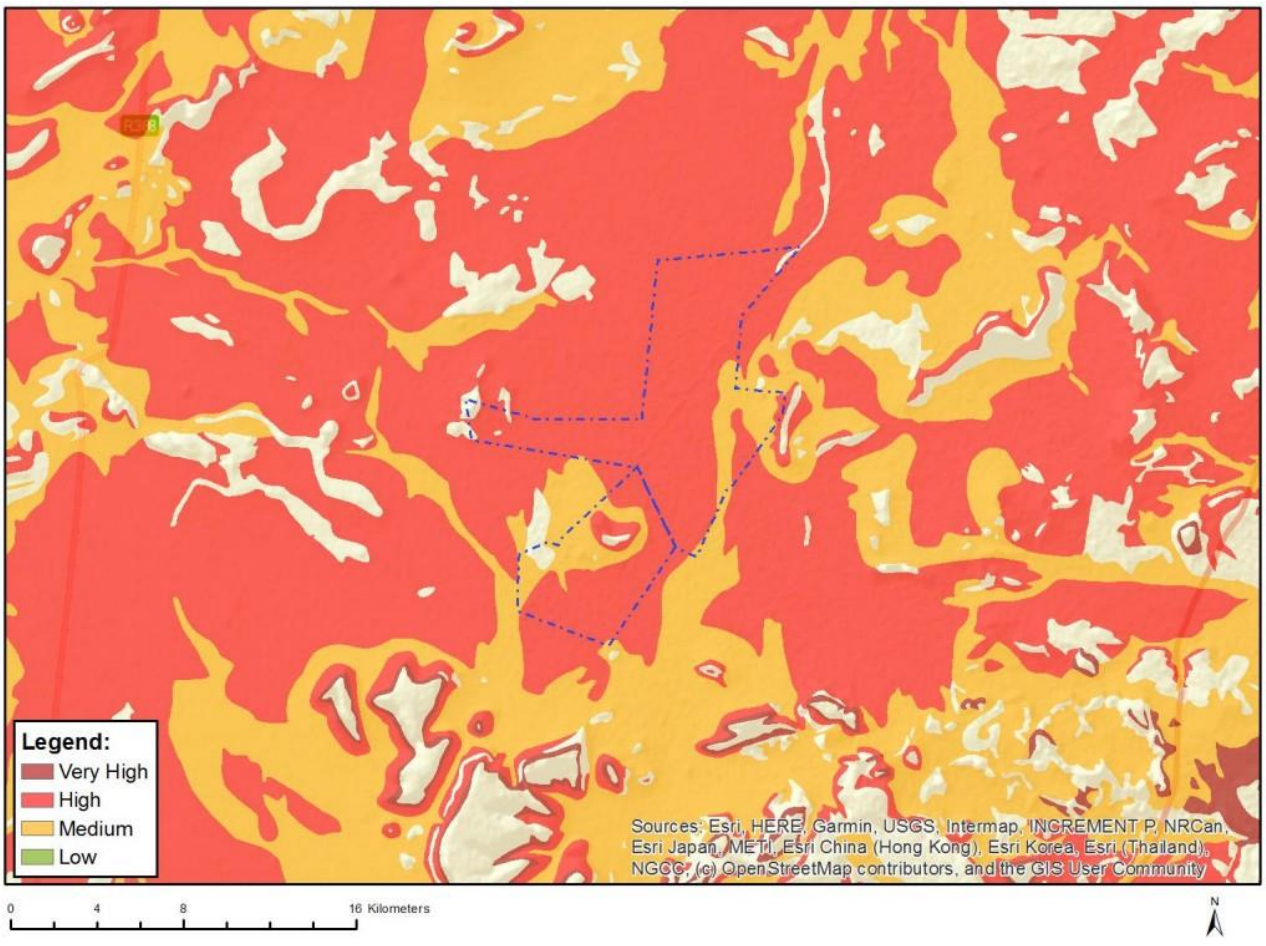

Figure 32: Palaeontological sensitivity map for the Kudu solar facility project area near De Aar, Northern Cape (blue dotted polygon), abstracted from the DFFE Screening Report prepared by the CSIR (February 2022[4]). The outcrop area of the Tierberg Formation is assigned a High palaeosensitivity, Late Caenozoic alluvium a Medium sensitivity while Karoo dolerite intrusions are designated as insensitive, according to the Screening Tool. This sensitivity mapping is *contested* in this report which concludes the entire Kudu project study area (including EGI corridor in the southeast) is of Low to Very Low palaeosensitivity overall.

[4] Screening Tool Reports generated in December 2022 and May 2023 do not result in any changes to the sensitivities depicted in this report.

7. CONCLUSIONS

The Kudu solar facility and grid connection project area near De Aar, Northern Cape, largely comprises low-relief terrain mantled with thick Late Caenozioic calcrete hardpans, alluvial deposits, surface gravels and soils that are generally of low palaeosensitivity. Natural bedrock exposure here is very limited and mainly involves unfossiliferous dolerite as well as baked Ecca Group metasediments (probable Waterford Formation) building *kranzes* on upper hillslopes (*e.g.* Basberg) that will not be directly impacted by the proposed development. Early to Middle Permian basinal mudrocks of the Tierberg Formation (Ecca Group, Karoo Supergroup) which are mapped as underlying the majority of the project area are hardly ever exposed and, where seen (*e.g.* in borrow pits), they are generally weathered, friable and extensively disrupted by near-surface calcrete veins. The offshore mudrocks of the Tierberg Formation are not known elsewhere to have a rich fossil record (mainly low-diversity trace fossil assemblages, petrified wood, palynomorphs and rare microvertebrate remains such as fish scales and teeth). In the present project area the potential for well-preserved fossils is further reduced by near-surface weathering, calcrete veining as well as baking of sedimentary bedrocks by intensive regional dolerite intrusion in Early Jurassic times. The only fossils recorded from the Ecca Group sediments during the 2-day palaeontological site visit comprise sparse, low diversity trace fossil assemblages of low scientific or conservation interest. Thick sandy to gravelly alluvial deposits associated with long-established drainage lines are extensively calcretised. No fossil remains were recorded within them.

According to the DFFE screening tool mapping, the majority of the Kudu solar PV facility and associated grid connection corridor is of Medium to High palaeosensitivity. This provisional assessment is *contested* in the present Site Sensitivity Verification Report, based on a 2-day palaeontological site visit and several previous field-based and desktop PIA studies in the broader De Aar - Kimberley region. It is concluded that the Kudu solar PV and grid connection project areas are in fact of LOW to VERY LOW palaeosensitivity in general. However, the potential for rare, largely unpredictable fossil sites (*e.g.* mammalian bones, teeth, horncores, non-marine molluscs, calcretised termitaria) of High palaeosensitivity associated with older alluvial and pan deposits hidden in the subsurface cannot be discounted. Most such fossil sites would probably be protected during construction by environmental buffer zones along drainage lines.

If any fossiliferous deposits are exposed by surface clearance or excavations during the construction phase of the development, the Chance Fossils Finds Protocol outlined in Appendix 2 to this report should be fully implemented. These recommendations should be included within the Environmental Management Programmes (EMPrs) for the Kudu Solar PV Facilities and associated infrastructure developments.

All of the various sites for solar PV facilities, on-site substations, grid connection corridors and associated infrastructure currently under consideration are of LOW to VERY LOW palaeosensitivity. The only two fossil sites recorded in the region fall *outside* the PV project areas (Appendix 3) and are of low scientific / conservation interest so no mitigation is recommended with regard to them. Provided that the Chance Fossil Finds Protocol tabulated in Appendix 2 is incorporated into the EMPrs and fully implemented during the construction phase of the solar PV facility and grid connection developments, there are no objections on palaeontological heritage grounds to authorisation of the proposed renewable energy developments. Pending the discovery of significant new fossil finds before or during construction, no further specialist palaeontological studies, reporting, monitoring or mitigation are recommended for these renewable energy projects.

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APPENDIX 1: John Almond Short CV

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

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

Declaration of Independence (See overleaf)

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**

environmental affairs
Department:
Environmental Affairs
REPUBLIC OF SOUTH AFRICA

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

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

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

PROJECT TITLE

Scoping and Environmental Impact Assessment Processes for the Proposed Development of 12 Solar Photovoltaic (PV) Facilities and associated infrastructure (i.e. Kudu Solar Facility 1 - 12), near De Aar, Northern Cape

Kindly note the following:

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

Departmental Details

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

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

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

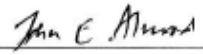
1. SPECIALIST INFORMATION

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

2. DECLARATION BY THE SPECIALIST

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

- I act as the independent specialist in this application;
- I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant;
- I declare that there are no circumstances that may compromise my objectivity in performing such work;
- I have expertise in conducting the specialist report relevant to this application, including knowledge of the Act, Regulations and any guidelines that have relevance to the proposed activity;
- I will comply with the Act, Regulations and all other applicable legislation;
- I have no, and will not engage in, conflicting interests in the undertaking of the activity;
- I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing - any decision to be taken with respect to the application by the competent authority; and - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
- all the particulars furnished by me in this form are true and correct; and
- I realise that a false declaration is an offence in terms of regulation 48 and is punishable in terms of section 24F of the Act.



Signature of the Specialist

NATURA VIVA CC

Name of Company

19th November 2022

Date

Details of Specialist, Declaration and Undertaking Under Oath

3. **UNDERTAKING UNDER OATH/ AFFIRMATION**

I, **Dr John Edward Almond,** swear under oath / affirm that all the information submitted or to be submitted for the purposes of this application is true and correct.

John E Almond

Signature of the Specialist

NATURA VIVA CC

Name of Company

19th November 2022

Date

Signature of the Commissioner of Oaths

2022-11-19

Date

SOUTH AFRICAN POLICE SERVICE
SHIFT COMMANDER
CAPE TOWN SAPS
2022 -11- 19
CAPE TOWN SAPS
SHIFT COMMANDER
SOUTH AFRICAN POLICE SERVICE

APPENDIX 2: Kudu Solar PV Facilities and Associated Infrastructure near De Aar

<table>
<tr><td>Province & region:</td><td colspan="2">Northern Cape: Pixley Ka Seme District</td></tr>
<tr><td>Responsible Heritage Resources Agency</td><td colspan="2">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).</td></tr>
<tr><td>Rock unit(s)</td><td colspan="2">Early to Middle Permian Tierberg and Waterford Formation (Ecca Group), Late Caenozoic calcrete hardpans, alluvium, aeolian sands, pan sediments, surface gravels (Kalahari Group)</td></tr>
<tr><td>Potential fossils</td><td colspan="2">Trace fossil assemblages, petrified wood, microvertebrate remains within Ecca Group sediments.
Potential for concentrations of mammalian fossil remains (bones, teeth, horncores), trace fossils, non-marine molluscs in association with calcrete hardpans.
Fossil mammal bones, teeth, horn cores, freshwater molluscs, plant material in Late Caenozoic alluvium and pan deposits.</td></tr>
<tr><td rowspan="5">Environmental Control Officer (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>

APPENDIX 3: FOSSIL LOCALITY DATA FOR KUDU SOLAR PHOTOVOLTAIC FACILITIES

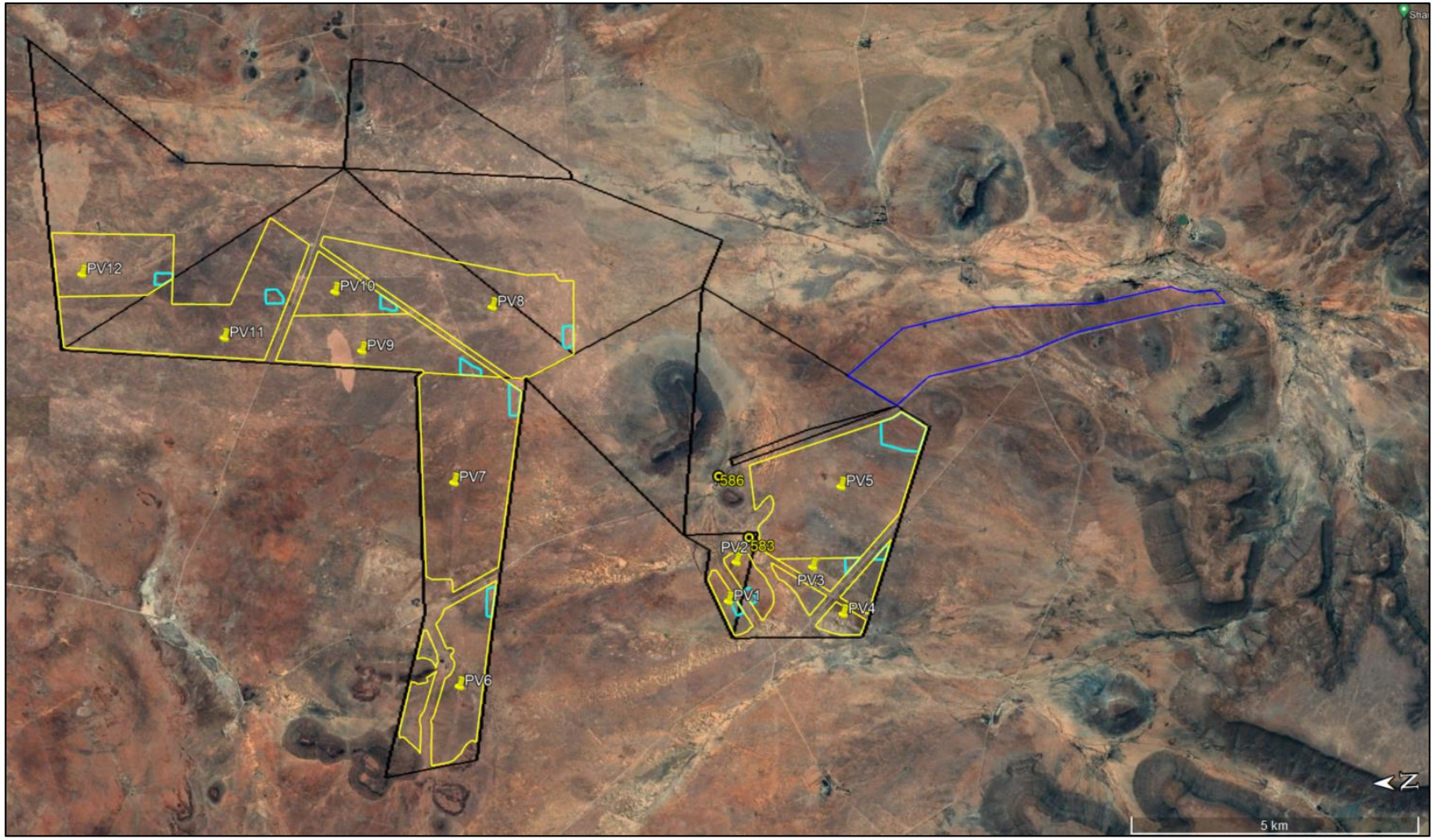


Figure A3.1: Google Earth© satellite image showing the project area for the Kudu Solar Photovoltaic Facilities and associated infrastructure near Philipstown and De Aar, Northern Cape (black and blue polygons) as well as the buildable area/development footprint for each PV project (yellow polygon) and proposed on-site substation complex sites (small, pale blue polygons). The two recorded fossil sites are indicated by the numbered yellow circles (Please see following figure for more detail). *N.B.* North is towards the LHS.

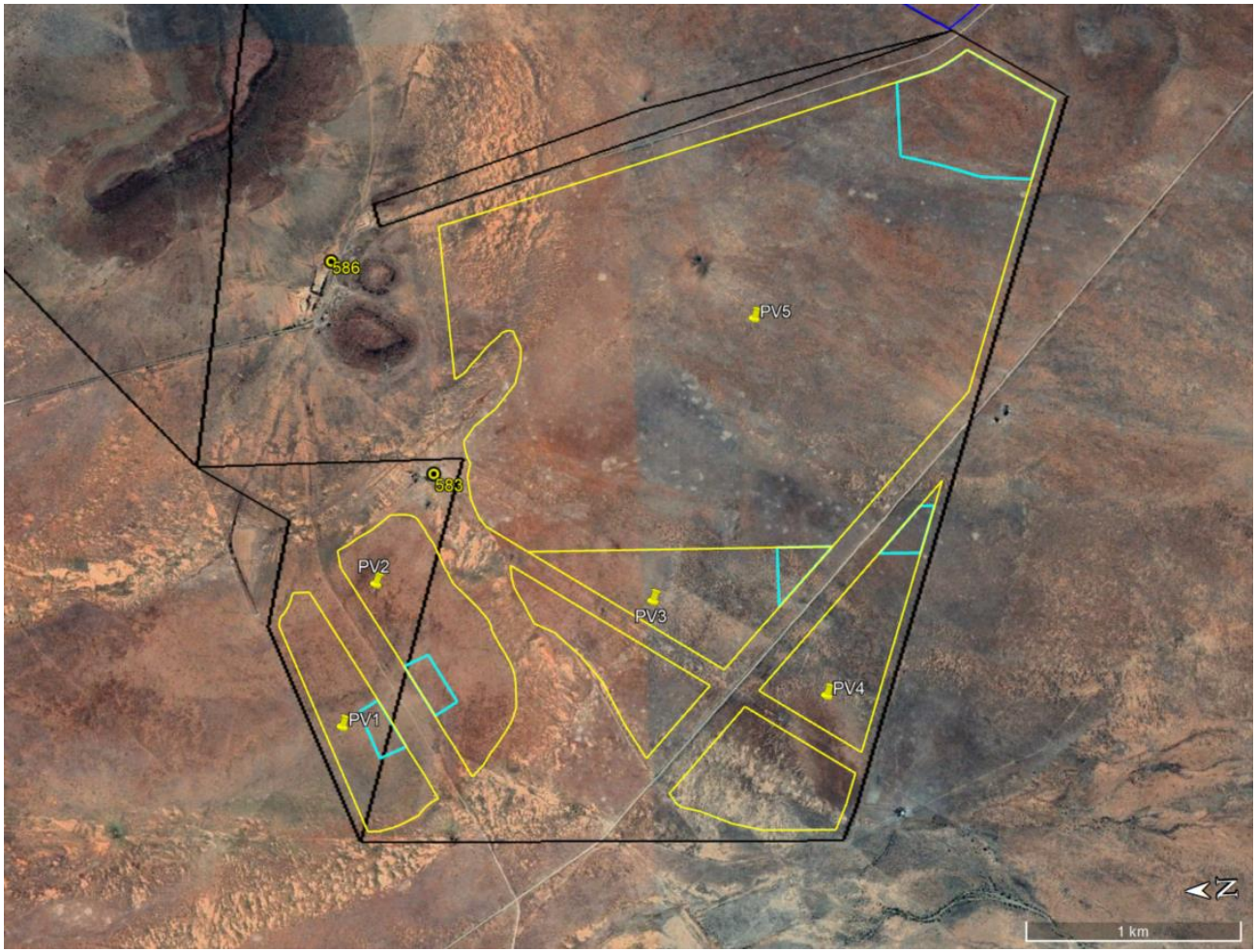


Figure A3.1: Google Earth© satellite image showing the project area for the southern cluster of Kudu Solar Photovoltaic Facilities and associated infrastructure near Philipstown and De Aar, Northern Cape. The two recorded fossil sites indicated by the numbered yellow circles (583, 586) both fall *outside* the PV buildable areas/development footprints and are of low scientific / conservation value so no mitigation is proposed with regard to them. *N.B.* North is towards the LHS.

Table A3.1: Palaeontological heritage data for Kudu Solar Photovoltaic Facilities

Kudu Solar PV Facility project	Recorded fossil heritage	Recommended mitigation
PV1	None	Application of Chance Fossil Finds Protocol during Construction Phase
PV2	None	Application of Chance Fossil Finds Protocol during Construction Phase
PV3	None	Application of Chance Fossil Finds Protocol during Construction Phase
PV4	None	Application of Chance Fossil Finds Protocol during Construction Phase
PV5	None	Application of Chance Fossil Finds Protocol during Construction Phase
PV6	None	Application of Chance Fossil Finds Protocol during Construction Phase
PV7	None	Application of Chance Fossil Finds Protocol during Construction Phase
PV8	None	Application of Chance Fossil Finds Protocol during Construction Phase
PV9	None	Application of Chance Fossil Finds Protocol during Construction Phase
PV10	None	Application of Chance Fossil Finds Protocol during Construction Phase
PV11	None	Application of Chance Fossil Finds Protocol during Construction Phase
PV12	None	Application of Chance Fossil Finds Protocol during Construction Phase

PALAEONTOLOGICAL SSV SITE VISIT APRIL 2022		
LOC	**GPS data**	**Comments**
583	**30.245804° S, 24.315688° E**	**Excavated block of speckled, grey-green Tierberg Formation siltstone containing vague, pale horizontal burrows (scale in cm and half-cm), farm Bas Berg RE 88. Provisional Field Rating IIIC Local Resource. Located *outside* PV project development area. No mitigation recommended.**
586	**30.241383° S, 24.327129° E**	**Simple horizontal burrows preserved in dark material contrasting with the pale yellowish-grey matrix which is probably of baked Tierberg Formation mudrock, float block on farm Bas Berg 3/88. Provisional Field Rating IIIC Local Resource. Located *outside* PV project development area. No mitigation recommended.**