LETSOAI AND ENAMANDLA SOLAR ENERGY FACILITIES ON FARM HARTEBEESTVLEI NEAR AGGENYS, NORTHERN CAPE: PALAEONTOLOGICAL HERITAGE

Enamandla PV 3

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1. Geological Context

The proposed BioTherm Enamandla PV Site 3 (hereafter referred to "Enamandla PV 3") is to be constructed in a fairly flat-lying (*c*. 870 to 920 m amsl), arid area of Bushmanland approximately 20 km southeast of the small town of Aggeneys, Northern Cape (Figs. 1 to 3). The surface terrain in this region is predominantly sandy to gravelly with low hills and patchy outcrops of basement rocks as well as a number of shallow, ephemeral streams.

The geology of the Aggeneys region is shown on 1: 250 000 geological map 2918 Pofadder (Council for Geoscience, Pretoria) (Fig. 1) (Agenbacht 2007). The geology is essentially the same in the project area for the proposed Enamandla PV Project on the Farm Hartebeestvlei 86 (green polygon in Fig. 1) as well as in the area traversed by the alternative corridors for the associated powerlines running towards the north and northeast (blue polygon in Fig. 1) is essentially the same. The scattered basement inliers are composed of a variety of resistant-weathering igneous and high grade metamorphic rocks - mainly gneisses, schists, quartzites and amphibolites - of Late Precambrian (Mokolian / Mid-Proterozoic) age. These ancient basement rocks are assigned to the **Namaqua-Natal Province** and are approximately one to two billion years old (Cornell *et al.* 2006, Moen 2007, Agenbacht 2007). The flatter portions of the study area – including those that will be directly affected by the proposed solar facility development - are underlain by a spectrum of unconsolidated superficial sediments of Late Caenozoic age. These include **Quaternary to Recent sands and gravels** of probable braided fluvial or sheet wash origin (**Q-s_2** in Fig. 1), as well as a veneer of downwasted surface gravels and colluval (rocky scree) deposits that are not indicated separately on the geological map. The alluvial and colluvial sediments are locally overlain, and perhaps also underlain, by unconsolidated aeolian (*i.e.* wind-blown) sands of the **Gordonia Formation** (**Kalahari Group**) that are Pleistocene to Holocene in age (**Q-s_1** in Fig. 1; orange dunes on satellite images; Figs. 2 & 3). All these superficial sediments can be broadly subsumed into the Late Cretaceous to Recent **Kalahari Group**, the geology of which is reviewed by Partridge *et al.* (2006).

An important Caenozoic geological feature in the Aggeneys area is the **Koa River Palaeovalley** - a defunct south bank tributary of the River Orange of Late Tertiary (Miocene – Pliocene) age that fed into the palaeo-Orange River near Henkries (Malherbe *et al*. 1986, De Wit 1990, 1993, 1999, De Wit *et al*. 2000, Partridge *et al.* 2006). The palaeovalley runs along a SE-NE line just to the northeast of the Enamandla PV 3 site and then turns west across the transmission line area. It can be readily seen on satellite images where it is marked by intermittent pans and a veneer of orange-brown Kalahari wind-blown sands (Figs. 2 & 3. See also arcuate band of yellow Q-s_1 on the geological map Fig. 1).

2. Palaeontological heritage

Mid Proterozoic basement rocks of the **Namaqua-Natal Province** are entirely unfossiliferous (Almond & Pether 2008). Fossil biotas recorded from each of the main sedimentary rock units mapped in the Aggeneys region and along the Orange River to the north have been reviewed in several previous palaeontological heritage assessments by the author Almond (*e.g.* 2011, 2012, 2013a, 2013b, 2014; see also Almond & Pether 2008, Almond 2009, Almond *in* Macey *et al.* 2011 and extensive references therein).

An important Early to Middle Miocene vertebrate faunule has been recorded from alluvial deposits (gravels, grits and lenses of sand, clay) of the **Koa River Palaeo-valley** system at Bosluis Pan, some 50 km SSW of Aggeneys. The fossil fauna has been dated to 15-16 Ma and is reviewed by Senut *et al*. (1996; see also Malherbe *et al*. 1986, De Wit 1999, Partridge *et al*. 2006, Agenbacht 2007, Almond *in* Macey *et al.* 2011). It includes rare bones, tusks, molars and numerous tooth fragments of *Gomphotherium*, a four-tusked, browsing proboscidean with characteristic rounded (mastodont) tooth cusps. There are also crocodile teeth and tortoise shell fragments, as well as remains of grazing elephant shrews, giraffids, bovids, a rhinocerotid and air-breathing catfish. However, fossiliferous fluvial sediments have not yet been recorded from the northern sector of the Koa River Valley near Aggeneys; if present, they are likely to be deeply buried beneath superficial sediments (*e.g.* younger alluvium, aeolian sands). Significant impacts on subsurface fossils within the study areas for the solar energy facility and associated infrastructure (transmission lines, pipelines) - where deep excavations are not involved - are therefore not anticipated here.

The various younger superficial deposits of the **Kalahari Group** in Bushmanland, including aeolian sands, alluvium, calcretes and pan deposits, are poorly known in palaeontological terms. The fossil record of the Kalahari Group as a whole is generally sparse and low in diversity; no fossils are recorded here in the Pofadder and Onseepkans geology sheet explanations by Agenbacht (2007) and Moen and Toogood (2007) respectively. The Kalahari beds may very occasionally contain important Late Caenozoic fossil biotas, notably the bones, teeth and horn cores of mammals as well as remains of reptiles like tortoises, non-marine molluscs (bivalves, gastropods), ostrich egg shells, trace fossils (*e.g.* calcretised termitaria, coprolites), plant remains such as peats or palynomorphs (pollens, spores) in organic-rich alluvial horizons as well as siliceous diatoms in pan sediments. Calcrete hardpans might also contain trace fossils such as rhizoliths, termite nests and other insect burrows, or even mammalian trackways.

3. Palaeontological heritage assessment

All South African fossil heritage is protected by law (South African Heritage Resources Act, 1999) and fossils may not be collected, damaged or disturbed without a permit from the relevant Provincial Heritage Resources Agency (in this case SAHRA). The construction phase of the proposed solar energy facility will entail extensive surface clearance as well as shallow excavations into the superficial sediment cover and underlying bedrock. The development may adversely affect potential fossil heritage within the study area by destroying, damaging, disturbing or permanently sealing-in fossils preserved at or beneath the surface of the ground that are then no longer available for scientific research or other public good. Such impacts on fossil heritage are generally direct, negative and of permanent effect (non-reversible). The planning, operational and decommissioning phases of the solar energy facility are unlikely to involve further adverse impacts on local palaeontological heritage. A desktop palaeontological heritage assessment of the Enamandla PV project area has been commissioned by WSP | Parsons Brinckerhoff, Environment & Energy, Africa.

In terms of palaeontological sensitivity outcrop areas of basement rocks are very low while the overlying Late Caenozoic superficial deposits (alluvium, gravels, aeolian sands *etc*) are generally of low sensitivity. No highly-sensitive palaeontological sites or no-go areas have been identified within the Enamandla PV 3 site. Impacts on unique or irreplaceable fossil heritage resources are improbable and their severity is anticipated to be negligible since (1) highly significant fossil sites are

unlikely to be affected and (2) in many cases these impacts can be mitigated. The overall impact significance of the proposed Enamandla PV 3 facility is rated as VERY LOW in terms of palaeontological heritage resources. This assessment applies to the Enamandla PV 3 facility, including access roads and alternative transmission line connections to the Eskom grid. Cumulative impacts inferred for the various alternative energy developments in the Aggeneys region of the Northern Cape are likewise assessed as very low.

Pending the potential discovery of significant fossil remains (*e.g.* mammalian bones or teeth) during the construction phase, no further specialist palaeontological studies or mitigation are recommended for the Enamandla PV 3. Chance fossil finds should be safeguarded - preferably *in situ* - and reported by the ECO as soon as possible to SAHRA (Contact details: Mrs Colette Scheermeyer, P.O. Box 4637, Cape Town 8000. Tel: 021 462 4502. Email: cscheermeyer@sahra.org.za), so that appropriate mitigation (*i.e.* recording, sampling or collection) by a palaeontological specialist can be considered and implemented. The palaeontologist concerned with mitigation work would need a valid fossil collection permit from SAHRA and any material collected would have to be curated in an approved depository (*e.g.* museum or university collection) (SAHRA 2013). These recommendations should be incorporated into the Environmental Management Programme (EMPr) for the solar energy developments.

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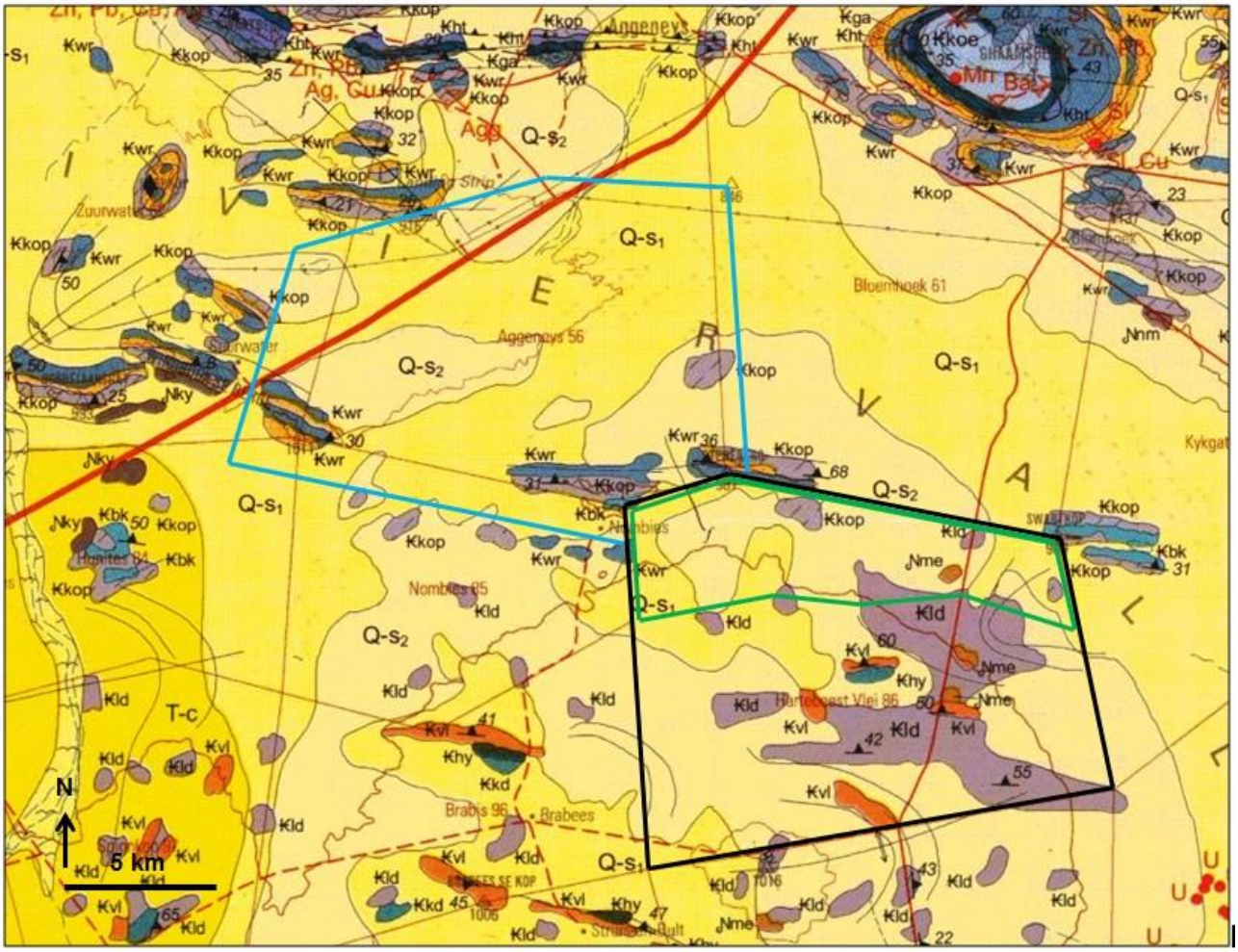

Figure 1. Extract from 1: 250 000 geological map 2918 Pofadder (Council for Geoscience, Pretoria) showing the location of the study area for the proposed Letsoai and Enamandla solar energy facilities near Aggeneys, Northern Cape (green polygon). Farm Hartebeestvlei 86 is outlined in black. The blue polygon approximately outlines the area traversed by the various transmission line corridor options under consideration. Geological units mapped here include:
(a) Several Precambrian (Mid Proterozoic) igneous and metamorphic basement rocks of the Namaqua-Natal Province: small purple, orange, blue-green, grey outcrop areas whose symbols start with K or N.
(b) Late Caenozoic superficial sediments: Q-s_1 (medium yellow) = red aeolian sands of the GORDONIA FORMATION (Kalahari Group); Q-s_2 (pale yellow) = sand, scree, rubble and sandy soil. Note the arcuate Koa River Valley (medium yellow) to the east and north of the solar facility study area.

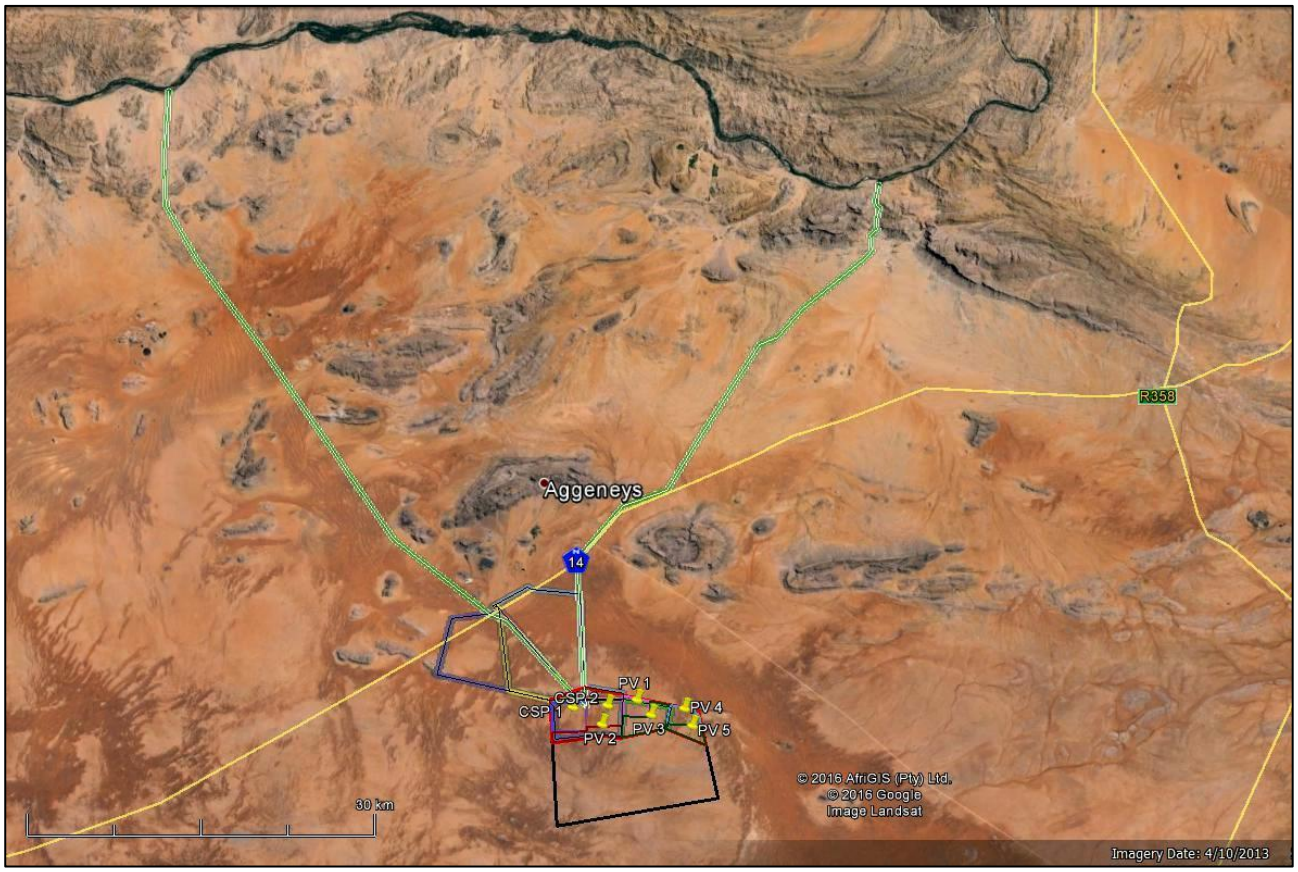

Figure 2. Google earth© satellite image of the arid Aggenys region in Bushmanland, Northern Cape. The Biotherm Letsoai and Enamandla solar energy facility project area to the southeast of Aggeneys is shown in more detail in Figure 3 below. Alternative pipeline connections to the Orange River are shown in green.

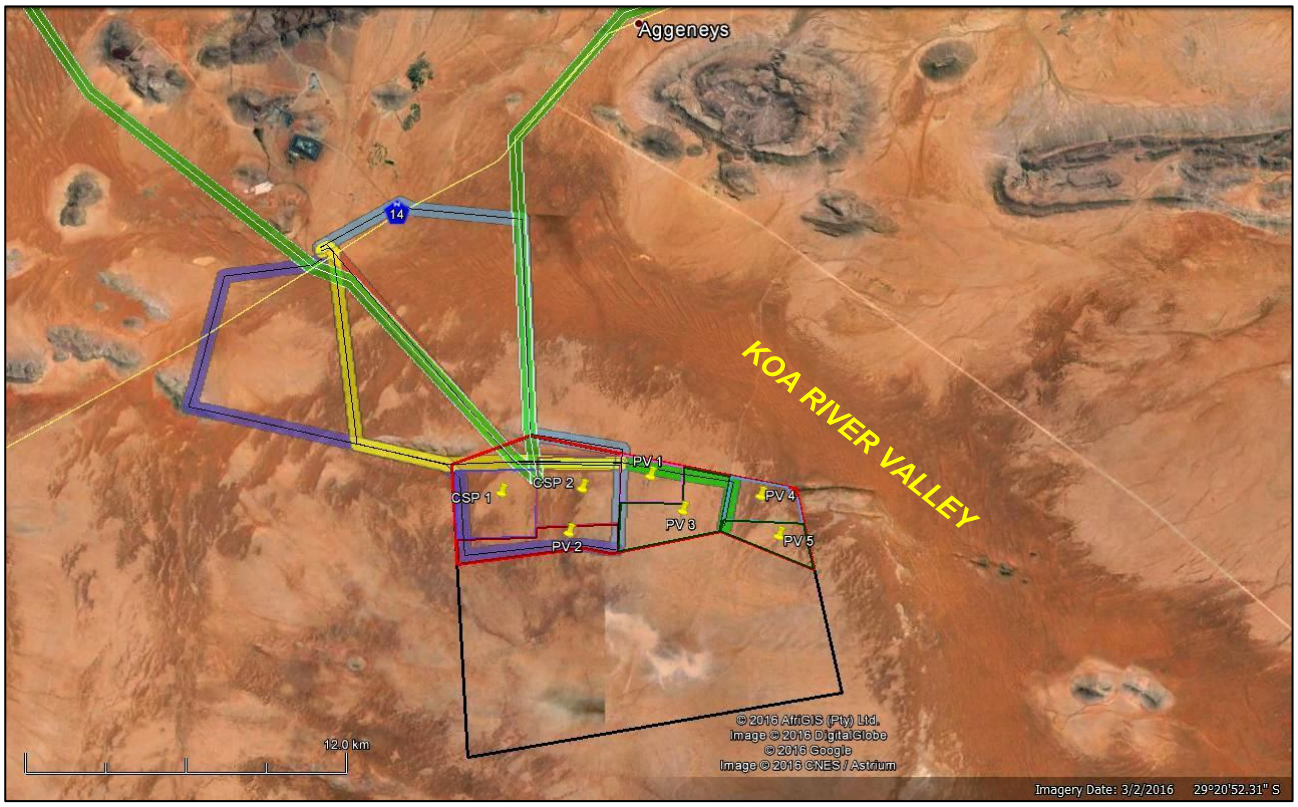

Figure 3. Google earth© satellite image of the Letsoai and Enamandla solar energy facility project area to the southeast of Aggeneys. Note the course of the defunct Koa River Valley marke by orange sand dunes running to the northeast and north of the solar facility project area. The farm Hartebeestvlei 86 is outlined in black while the red polygon shows the study area for the Letsoai and Enamandla solar PV and CSP facilities on the northern portion of the farm. Several optional transmission line corridors (purple, yellow, blue) extend towards and along the N14 tar road between Pofadder and Upington. The green lines indicate optional routes for the proposed pipeline connection to the Orange River.

5. Qualifications & experience of the author

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

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

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.

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