Palaeontological specialist assessment: desktop study

PROPOSED HENNENMAN 5 MW SOLAR ENERGY FACILITY NEAR VENTERSBURG, MATJHABENG LOCAL MUNICIPALITY, FREE STATE

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EXECUTIVE SUMMARY

Bluewave Capital SA (Pty) Ltd is proposing to develop a photovoltaic solar energy facility of approximately 5 MW generation capacities to be located *c.* 5 km from the town of Hennenman and 10 km northwest of Ventersburg, Free State.

The study area near Ventersburg is underlain at depth by Late Permian lacustrine to fluvial sediments of the Lower Beaufort Group / Adelaide Subgroup (Karoo Supergroup) that are extensively intruded by Early Jurassic dolerites of the Karoo Dolerite Suite. These bedrocks are for the most part mantled by Quaternary sands, soils and other superficial deposits of low palaeontological sensitivity. Exposure levels of potentially fossiliferous Karoo sediments are correspondingly very low.

No fossil remains have been recorded from the Lower Beaufort Group bedrocks in the region near Ventersburg and these are furthermore extensively baked by dolerite intrusions, compromising their fossil heritage. The overlying Pleistocene dune sands are of low palaeontological sensitivity. The overall impact significance of the proposed Hennenman Solar Energy Facility is consequently rated as LOW as far as palaeontological heritage is concerned. This applies equally to all three site alternatives under consideration.

Pending the discovery of significant new fossil remains (*e.g.* fossil vertebrates, petrified wood) during excavation, no further palaeontological studies or professional mitigation are therefore recommended for this alternative energy project. The Environmental Control Officer (ECO) for the project should be alerted to the potential for, and scientific significance of, new fossil finds during the construction phase of the development.

The following mitigation measures to safeguard any fossils exposed on site during the construction phase of the development are recommended:

- The ECO and / or the Site Engineer responsible for the development must remain aware that all sedimentary deposits have the potential to contain fossils and he / she should thus monitor all substantial excavations into sedimentary bedrock for fossil remains. If any substantial fossil remains (*e.g.* vertebrate bones, teeth, horn cores) are found during construction SAHRA should be notified immediately (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) so that appropriate mitigation (*i.e.* recording, sampling or collection) by a palaeontological specialist can be considered and implemented, at the developer's expense.

- A chance-find procedure should be implemented so that, in the event of fossils being uncovered, the ECO / Site Engineer will take the appropriate action, which includes:
    - Stopping work in the immediate vicinity and fencing off the area with tape to prevent further access;
    - Reporting the discovery to the provincial heritage agency and/or SAHRA;
    - Appointing a palaeontological specialist to inspect, record and (if warranted) sample or collect the fossil remains;
    - Implementing any further mitigation measures proposed by the palaeontologist; and
    - Allowing work to resume only once clearance is given in writing by the relevant authorities.

If the mitigation measures outlined above are adhered to, the residual impact significance of any construction phase impacts on local palaeontological resources is considered to be LOW.

The mitigation measures proposed here should be incorporated into the Environmental Management Programme (EMP) for the Hennenman Solar Energy Facility project. The palaeontologist concerned with mitigation work will need a valid collection permit from SAHRA. All work would have to conform to international best practice for palaeontological fieldwork and the study (*e.g.* data recording fossil collection and curation, final report) should adhere to the minimum standards for Phase 2 palaeontological studies recently published by SAHRA (2013).

1. INTRODUCTION

1.1. Project outline and brief

The company Bluewave Capital SA (Pty) Ltd (Bluewave Capital) is proposing to develop a photovoltaic solar energy facility of approximately 5 MW generation capacity to be located *c.* 5 km from the town of Hennenman and 10 km northwest of Ventersburg. The development site lies on the south-western outskirts of Phomolong and on the north-eastern side of the R70 tar road on the Farm Uitsig 723/1 and Uitsig 723/2, Matjhabeng Local Municipality, Free State (Fig. 1).

The solar facility development footprint will be less than 19.5 ha in extent. The main infrastructural components of the facility are as follows:

- Photovoltaic (PV) panels between 4 m – 6 m in height (fixed or single axis tracking technology) with a combined capacity of up to 5 MW;
- Mounting structures to be either rammed steel piles or piles with pre-manufactured concrete footing to support the PV panels;
- Cabling between the project components, to be laid in trenches *c.* 1-2 m deep;
- Power inverters between the PV arrays;
- An overhead power line to evacuate the power into the Eskom grid *via* the Hennenman Rural 132/22/11kV Substation, situated within a maximum distance of 600 m from the proposed PV site;
- Internal access roads (up to 7 m wide);
- Water storage facility/reservoir;
- Office, workshop area for maintenance and storage;
- A temporary laydown area during construction;
- Fencing.

Three site alternatives are under consideration (Fig. 1). Site Alternative 1 (preferred alternative) occupies an area immediately to the east of the Hennenman Rural Substation on Portion 1 and Portion 2 of the Farm Uitsig 723. Site Alternative 2 occupies an area approximately 700 m southeast of the Hennenman Rural Substation on Portion 1 of the Farm Uitsig 723. Site Alternative 3 occupies an area approximately 950 m south east of the Hennenman Rural Substation on Portion 1 of the Farm Uitsig 723.

The proposed development area is underlain by potentially fossiliferous sedimentary rocks of Palaeozoic to Late Caenozoic age (Sections 2 and 3). The construction phase of the development may entail substantial surface clearance as well as excavations into the superficial sediment cover (*e.g.* for PV solar panel footings, underground cables, building foundations, internal access roads). All these developments may adversely affect potential fossil heritage at or beneath the surface of the ground within the study area by destroying, disturbing or permanently sealing-in fossils that are then no longer available for scientific research or other public good.

All palaeontological heritage resources in the Republic of South Africa are protected by the National Heritage Resources Act (Act 25 of 1999) (See Section 1.2 below). Heritage resource management in the Free State is the responsibility of the South African Heritage Resources Agency or 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).

A desktop Palaeontological Impact Assessment for the study area has been requested by SAHRA (Interim Comment, 24 April 2015; SAHRA ref. 7566) since the area is indicated as being of moderate sensitivity on the PalaeoSensitivity map on SAHRIS (http://www.sahra.org.za/sahris/map/palaeo). The present report has accordingly been commissioned as part of a HIA for this development by Savannah Environmental (Pty) Ltd (Contact details: Ms Sheila Muniongo, Savannah Environmental (Pty) Ltd**.** 1st Floor, Block 2, 5 Woodlands Drive Office Park, Woodlands Drive, Woodmead, 2191. Tel: +27 11 656 3237. Fax: +27 86 684 0547. Cell: 073 517 6823. Email: sheila@savannahsa.com. Postal address: P.O. Box 148, Sunninghill, 2157).

1.2. Legislative context for palaeontological assessment studies

The various categories of heritage resources recognised as part of the National Estate in Section 3 of the National Heritage Resources Act (Act 25 of 1999) 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 recently been published by SAHRA (2013).

1.3. Approach to the desktop palaeontological heritage study

The approach to this desktop 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 as well as field examination of representative exposures of all major sedimentary rock units present, 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 during the compilation of the final report). This data is then used to assess the palaeontological sensitivity of each rock unit to a development (Provisional tabulations of palaeontological sensitivity of all formations in the Western, Eastern and Northern Cape as well as the Free State have already been compiled by J. Almond and colleagues; *e.g.* Almond & Pether 2008. See also palaeosensitivity maps published on the SAHRIS website: http://www.sahra.org.za/sahris/map/palaeo).

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 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 then 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 a palaeontological collection permit from the relevant heritage management authority (*e.g.* SAHRA for the Free State). It should be emphasized that, *provided that appropriate mitigation is carried out*, the majority of developments involving bedrock excavation can make a *positive* contribution to our understanding of local palaeontological heritage.

1.4. Assumptions & limitations

The accuracy and reliability of palaeontological specialist studies as components of heritage impact assessments are generally limited by the following constraints:

1. Inadequate database for fossil heritage for much of the RSA, given the large size of the country and the small number of professional palaeontologists carrying out fieldwork here. Most development study areas have never been surveyed by a palaeontologist.

2. Variable accuracy of geological maps which underpin these desktop studies. For large areas of terrain these maps are largely based on aerial photographs alone, without ground-truthing. The maps generally depict only significant ("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 study area near Ventersburg a major limitation for fossil heritage studies is the very low level of surface exposure of potentially fossiliferous bedrocks, as well as the paucity of previous specialist palaeontological studies in the region as a whole (*cf* Groenewald 2013, Millsteed 2013, Almond 2014).

1.5. Information sources

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

1. A short project outline in the Final Basic Assessment Report produced by Savannah Environmental (dated June 2015);

2. A review of the relevant scientific literature, including published geological maps and accompanying sheet explanations as well as previous palaeontological assessment studies in the broader Ventersburg region of the Free State by the author (*e.g.* Groenewald 2013, Millsteed 2013, Almond 2014);

3. Examination of relevant topographical maps and satellite images;

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

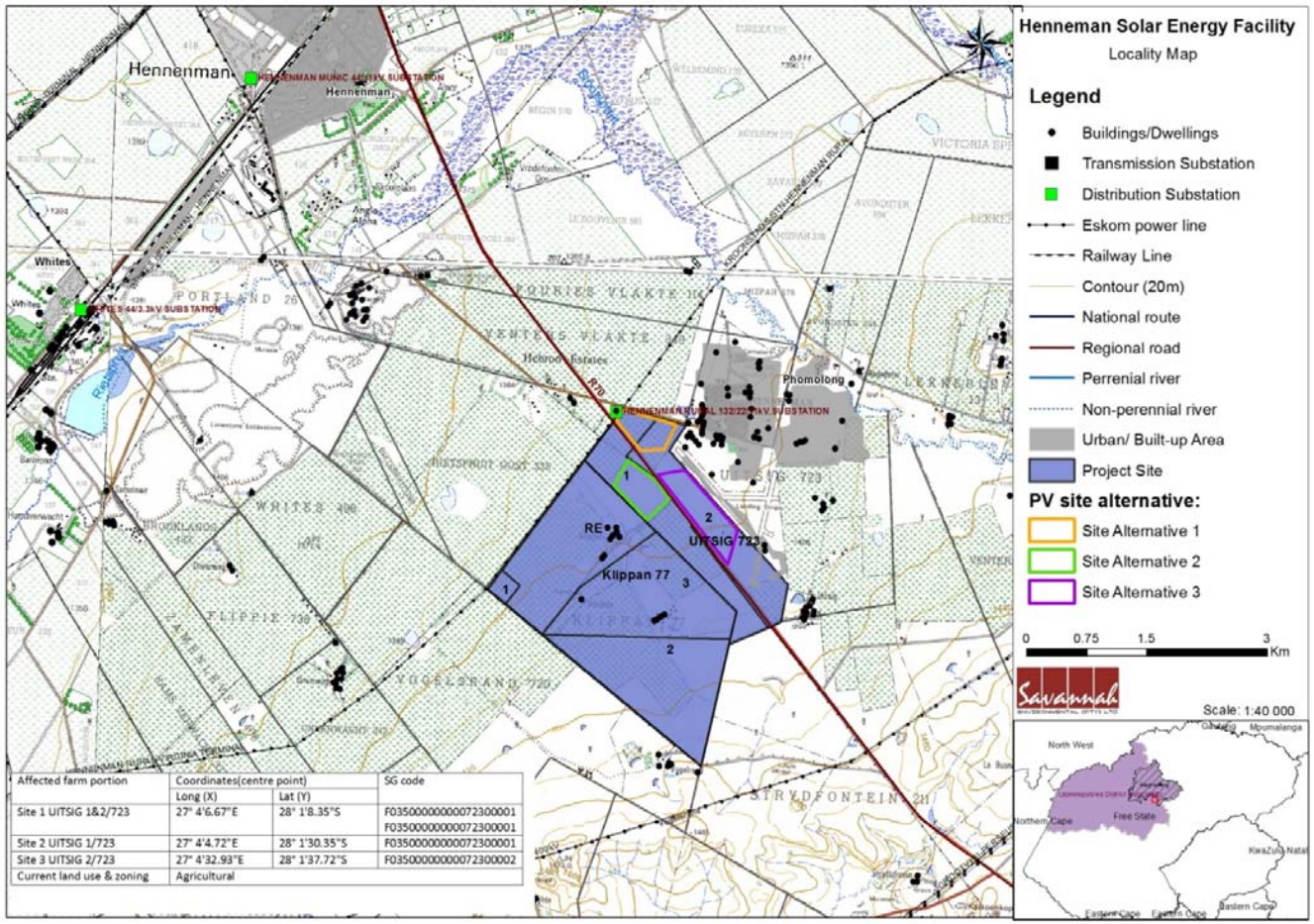

Figure 1: Locality map showing the location of the study area for the proposed Hennenman 5 MW Solar Energy Facility near Ventersburg, Free State. (Site Alternatives 1, 2 and 3 on Portions 1 and 2 of the Farm Uitsig 723 are indicated in relation to the communities of Phomolong and Hennenman (Image abstracted from the Final Basic Assessment Report by Savannah Environmental, June 2015).

Figure 2. Google earth© satellite image of the study area for the proposed Hennenman PV Solar Energy Facility adjacent to the R70 road near Ventersburg (red polygon). Note flat-lying terrain and lack of surface exposure of bedrocks here.

2. GEOLOGICAL OUTLINE OF THE STUDY AREA

Satellite images show that the Hennenman Solar Energy Facility study area situated along the R70 road *c*. 10 km to the northwest of Ventersburg, Free State comprises very flat-lying terrain at *c*. 1400 m amsl. That has been completely transformed for agriculture (ploughed fields) (Fig. 2). No bedrock exposure is visible within the study area on the satellite images. A small, meandering drainage line (Slootspruit) runs on the far (north-eastern) side of Phomolong and there are a few dams in the vicinity.

The geology of the study area near Ventersburg is outlined on the 1: 250 000 geology sheets 2826 Winburg (Nolte 1995) (Fig. 3). This region lies towards the northern edge of the Main Karoo Basin of South Africa and is underlain by fluvial / lacustrine continental sediments of the Karoo Supergroup of Late Permian age, with a broadly younging trend towards the south (Johnson *et al.* 2006). According to the 1: 250 000 geological map, these Karoo sediments belong to the predominantly fluvial **Lower Beaufort Group** (**Adelaide Subgroup, Pa**) that is of latest Permian age in this part of the basin, as determined from vertebrate fossil data (*i.e. Dicynodon* Assemblage Zone; Kitching 1995, Rubidge 2005, Van der Walt *et al.* 2010) (See Section 3). A brief account of the Lower Beaufort Group rocks in the Winburg sheet area is given by Nolte (1995) but good exposures here are comparatively rare and none were encountered during a recent field study along the N1 to the north of Ventersburg by Almond (2014). Adelaide Subgroup sediments are likely to underlie the present Hennenman solar study area at depth.

The Karoo Supergroup sediments in the northern portion of the Main Karoo Basin around Ventersburg are extensively intruded by sills and dykes referred to the **Karoo Dolerite Suite** (Jd) of Early Jurassic age (*c*. 182 Ma; Duncan & Marsh 2006). Dolerite intrusion has led to baking of sandstones and mudrocks in the country rock successions to quartzites and hornfels respectively. Dolerite bedrocks are mapped at surface to the east and southeast of Hennenman / Phomolong (Fig. 3, Jd) and are suggested by rusty-brown, often uncultivated areas on satellite images, including some of the area around Phomolong itself.

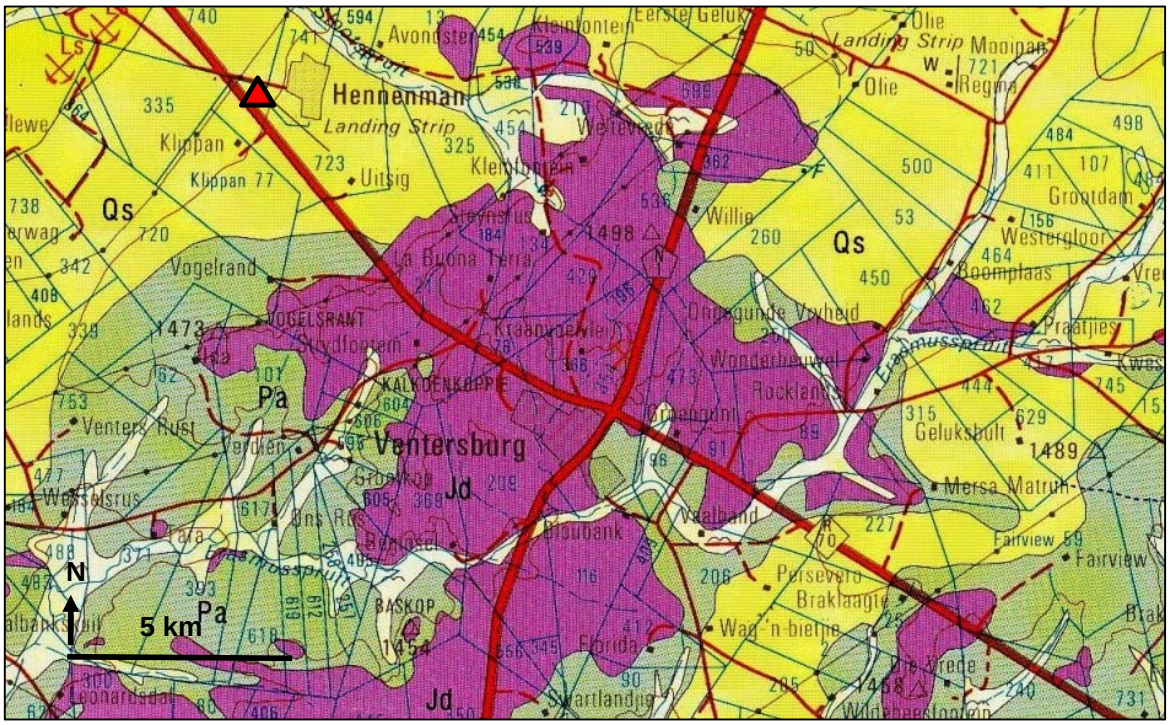

Figure 3. Extract from 1: 250 000 geological map 2826 Winburg (Council for Geoscience, Pretoria) showing the location (red triangle) of the proposed Hennenman Solar Energy Facility on the south-western outskirts of Phomolong (here labled Hennenman). The major rock units represented in the region to the northwest of Ventersburg include:

- **Qs (yellow) = aeolian and reworked sands, sandy soils (Quaternary)**
- **Jd (purple) = dolerite intrusions of the Karoo Dolerite Suite (Early Jurassic)**
- **Pa (grey-green) = continental sediments of the Lower Beaufort Group / Adelaide Subgroup (Late Permian)**

Other Late Caenozoic superficial sediments such as soils, gravels, alluvium, pan sediments and pedocretes are generally not mapped at this scale.

Various types of **superficial deposits** of Late Caenozoic (Miocene / Pliocene to Recent) age occur widely throughout the Great Karoo region. They include pedocretes (*e.g*. calcretes), slope deposits (scree *etc*), river alluvium, diverse soils and surface gravels as well as spring and pan sediments (*cf* Partridge *et al*. 2006). As a result, surface exposure of fresh Karoo Supergroup rocks within the region is generally very poor, apart from stream beds, dongas and steeper hill slopes as well as artificial exposures in road and railway cuttings, farm dams and borrow pits. The hill slopes are typically mantled with a thin layer of **colluvium** or slope deposits (*e.g.* sandstone and dolerite scree). Thicker accumulations of sandy, gravelly and bouldery **alluvium** of Late Caenozoic age (< 5 Ma), including pediment gravels, are found in streams and river valleys. These

colluvial and alluvial deposits may be extensively calcretised (*i.e.* cemented with soil limestone or calcrete), especially in the neighbourhood of dolerite intrusions. In the Hennenman / Phomolong area, including the Hennenman Solar Facility study site, the Karoo Supergroup and dolerite bedrocks are largely mantled by **aeolian sands** (Qs) that according to Schutte (1993) overlie an extensive Early Tertiary erosion surface. These Early to Late Pleistocene superficial deposits and the various soils in the region have been described in detail by Harmse (1963, 1967). In the Winburg sheet explanation by Nolte (1995) the aeolian sands and sandy soils are reported as varying from a few meters to 5 m in thickness.

3. POTENTIAL PALAEONTOLOGICAL HERITAGE WITHIN THE STUDY AREA

The predominantly fluvial Lower Beaufort Group (Adelaide Subgroup, Pa) sediments mapped in the Ventersburg area have been assigned to the latest Permian ***Dicynodon* Assemblage Zone** (Kitching 1995, Rubidge 2005, Van der Walt *et al.* 2010) (Fig. 4). This biozone has been assigned to the Changhsingian Stage (= Late Tartarian), right at the end of the Permian Period, with an approximate age range of 253.8-251.4 million years (Rubidge 1995, 2005).

Good accounts, with detailed faunal lists, of the rich Late Permian fossil biotas of the *Dicynodon* Assemblage Zone have been given by Kitching (*in* Rubidge 1995), Cole *et al*. (2004) and Smith *et al.* (2012). See also the reviews by Cluver (1978), MacRae (1999), McCarthy & Rubidge (2005) and Almond *et al*. (2008). In general, the following broad categories of fossils might be expected within the sediments of this biozone (Fig. 5):

- isolated petrified bones as well as articulated skeletons of terrestrial vertebrates such as true **reptiles** (notably large herbivorous pareiasaurs, small lizard-like millerettids and younginids) and **therapsids** (diverse dicynodonts such as *Dicynodon* and the much smaller *Diictodon*, carnivorous gorgonopsians, therocephalians such as *Theriognathus* (= *Whaitsia*), primitive cynodonts like *Procynosuchus*, and biarmosuchians).
- aquatic vertebrates such as large, crocodile-like temnospondyl **amphibians** like *Rhinesuchus* (usually disarticulated), and palaeoniscoid **bony fish** (*Atherstonia*, *Namaichthys*).
- freshwater **bivalves** (*Palaeomutela*).
- **trace fossils** such as worm, arthropod and tetrapod burrows and trackways, coprolites (fossil droppings).

- **vascular plant remains** including leaves, twigs, roots and petrified woods ("*Dadoxylon*") of the *Glossopteris* Flora (usually sparse, fragmentary), especially glossopterids and arthrophytes (horsetails).

The abundance and variety of fossils within the *Dicynodon* Assemblage Zone decreases towards the top of the succession (Cole *et al*., 2004). From a palaeontological viewpoint, these diverse *Dicynodon* AZ biotas are of extraordinary interest in that they provide some of the best available evidence for the last flowering of ecologically-complex terrestrial ecosystems immediately preceding the catastrophic end-Permian mass extinction (*e.g.* Smith & Ward, 2001, Rubidge 2005, Retallack *et al*., 2006).

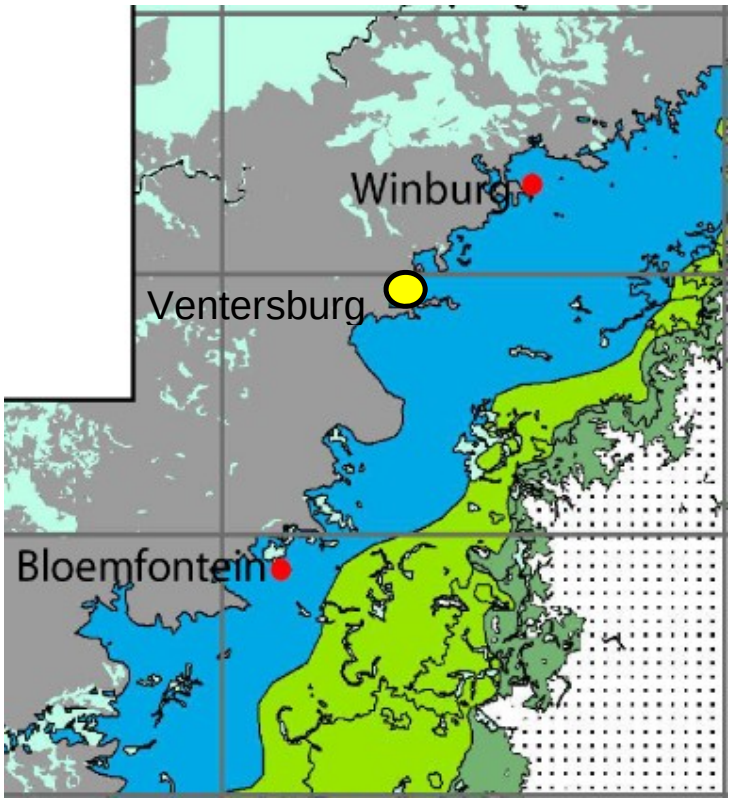

Figure 4. Extract from the latest Karoo vertebrate fossil biozonation map produced by Van der Walt *et al.* (2010) showing that Lower Beaufort Group sediments in the Ventersburg region (yellow spot) lie within the latest Permian *Dicynodon* Assemblage Zone (*N.B.* Kroonstad is mistakenly labelled as Winburg on this map).

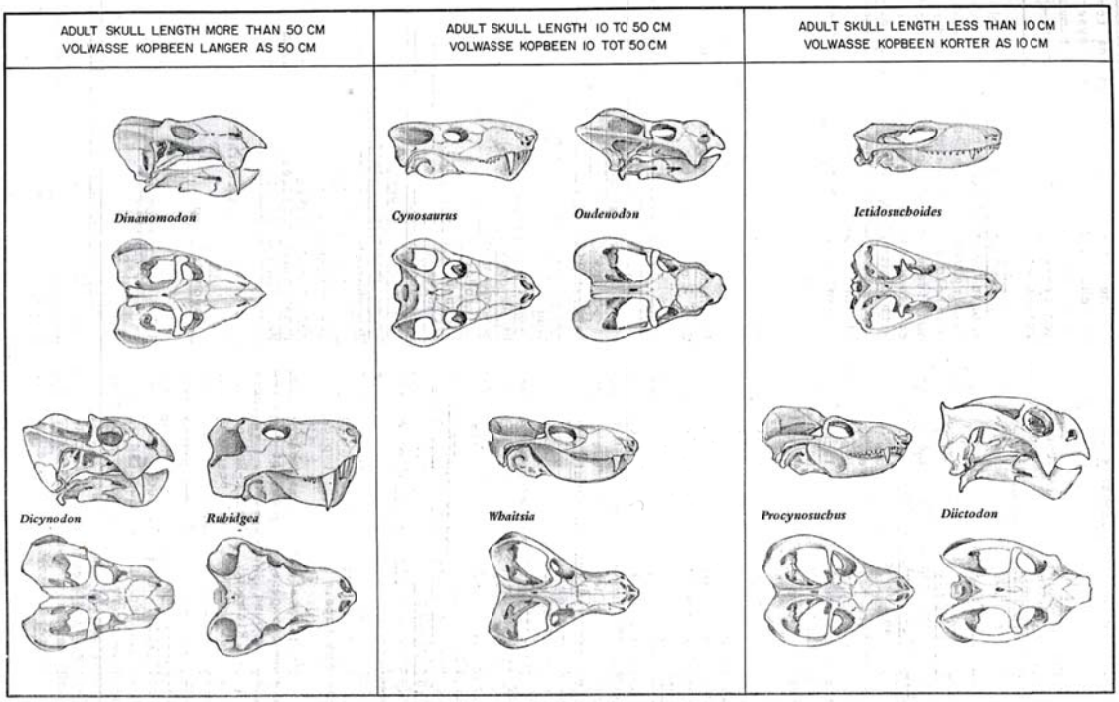

Figure 5. Skulls of characteristic fossil vertebrates – all therapsids - from the *Dicynodon* Assemblage Zone (From Keyser & Smith 1977-1978). Among the dominant therapsids ("mammal-like reptiles"), *Rubidgea* and *Cynosaurus* are carnivorous gorgonopsians, *Whaitsia* (now *Theriognathus*) is a predatory therocephalian while *Ictidosuchoides* is a small insectivorous member of the same group, *Procynosuchus* is a primitive cynodont, and the remainder are large- to small-bodied dicynodont herbivores.

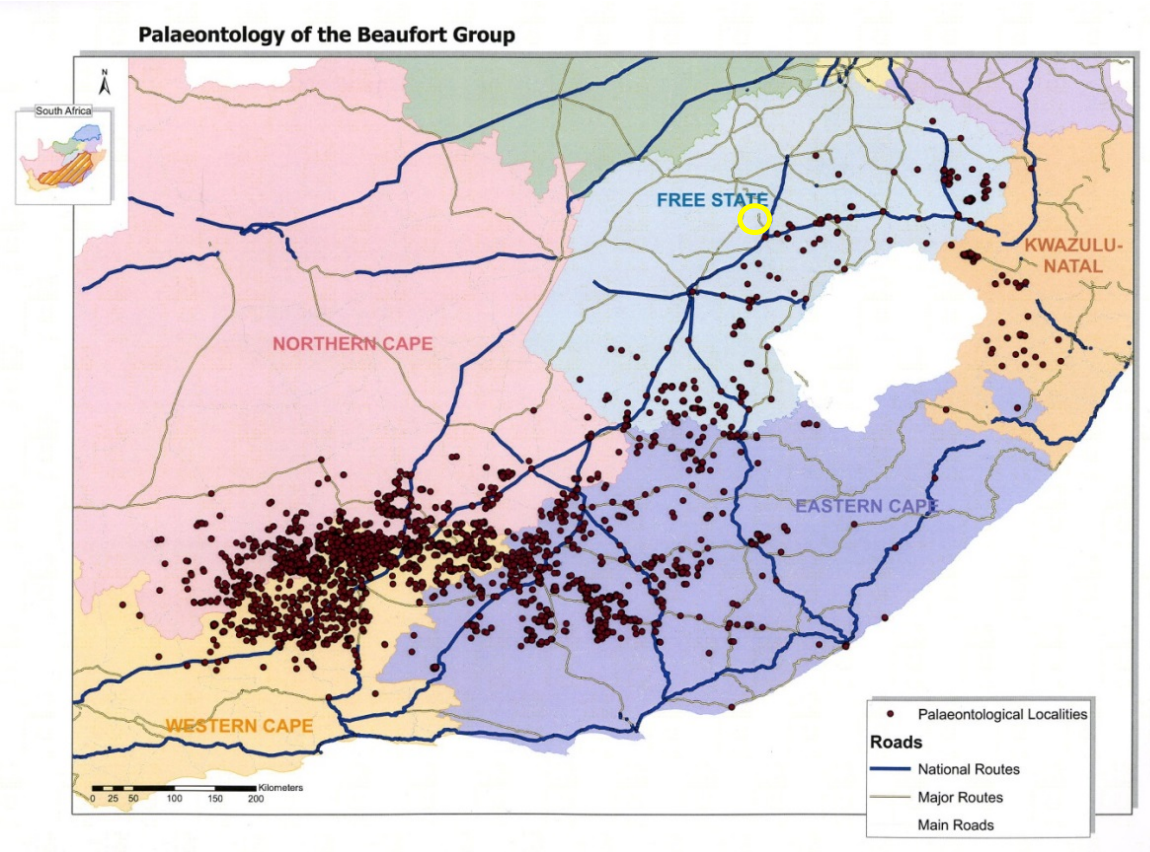

Figure 6. Distribution of recorded fossil vertebrate localities within the Beaufort Group (Main Karoo Basin) showing the lack of fossil records from the Hennenman – Ventersburg region of the Free State (yellow circle) (Map abstracted from Nicolas 2007).

According to the map of Karoo vertebrate fossil sites compiled by Nicolas (2007) there are no well-documented vertebrate fossil sites reported from the Ventersburg area (Fig. 6); however, this may change as a consequence of ongoing fieldwork by palaeontologists at the Bernard Price Institute (Wits. University). The field-based palaeontological heritage study by Almond (2014) reported very little Beaufort Group exposure in the Ventersburg area (mainly channel sandstones) and no fossil remains. Only unidentified trace fossil assemblages (bioturbation) were recorded from this succession in the relevant sheet explanation by Nolte (1995). No fossil remains were reported from the Pleistocene aeolian sands in this area by the same author. A desktop palaeontological assessment for a solar project located *c*. 20 southwest of Hennenman, near Welkom, does not report any known fossil sites within the Adelaide Subgroup nor from the aeolian sands (Groenewald 2013). A second palaeontological desktop study for a large solar project proposal just west of Hennenman (Millsteed 2013) is not yet available on the SAHRIS database.

4. CONCLUSIONS AND RECOMMENDATIONS

The study area near Ventersburg is underlain at depth by Late Permian lacustrine to fluvial sediments of the Lower Beaufort Group / Adelaide Subgroup (Karoo Supergroup) that are extensively intruded by Early Jurassic dolerites of the Karoo Dolerite Suite. These bedrocks are for the most part mantled by Quaternary sands, soils and other superficial deposits of low palaeontological sensitivity. Exposure levels of potentially fossiliferous Karoo sediments are correspondingly very low.

No fossil remains have been recorded from the Lower Beaufort Group bedrocks in the region near Ventersburg and these are furthermore extensively baked by dolerite intrusions, compromising their fossil heritage. The overlying Pleistocene dune sands are of low palaeontological sensitivity. The overall impact significance of the proposed Hennenman Solar Energy Facility is consequently rated as LOW as far as palaeontological heritage is concerned. This applies equally to all three site alternatives under consideration.

Pending the discovery of significant new fossil remains (*e.g.* fossil vertebrates, petrified wood) during excavation, no further palaeontological studies or professional mitigation are therefore recommended for this alternative energy project. The Environmental Control Officer (ECO) for the project should be alerted to the potential for, and scientific significance of, new fossil finds during the construction phase of the development.

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The mitigation measures proposed here should be incorporated into the Environmental Management Programme (EMP) for the Hennenman Solar Energy Facility project. The palaeontologist concerned with mitigation work will need a valid collection permit from SAHRA. All work would have to conform to international best practice for palaeontological fieldwork and the study (*e.g.* data recording fossil collection and curation, final report) should adhere to the minimum standards for Phase 2 palaeontological studies recently published by SAHRA (2013).

5. ACKNOWLEDGEMENTS

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7. 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 under the aegis of his Cape Town-based company *Natura Viva* cc. He is 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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