FULL PALAEONTOLOGICAL HERITAGE IMPACT ASSESSEMENT REPORT ON THE SITE OF PROPOSED SOLAR ENERGY GENERATION FACILITIES (KHEIS SOLAR PROJECTS 1-3) TO BE LOCATED ON THE FARM NAMAKWARI 656 NEAR GROOTDRINK, NORTHERN CAPE PROVINCE

12 February 2014

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On Behalf of:

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Prepared By:

Dr B.D. Millsteed

EXECUTIVE SUMMARY

Gestamp Asetym Solar South Africa (Pty) Ltd is proposing to establish a commercial photovoltaic Solar Energy Park with a total generating capacity of 225 MW to be developed in 3 separate phases of 75 MW each, as well as associated infrastructure. The following project names apply:

- Kheis Solar Park 1
- Kheis Solar Park 2
- Kheis Solar Park 3

The project areas, which will contain the power generation infrastructure, are proposed to be located within Portion 7 and Portion 9 of the Farm Namakwari 656. The aerial extent of the three project areas varies; Keis Solar Park 1 will occupy and area of approximately 359 ha, Solar Park 2 will be approximately 232 ha and Solar Park 3 will occupy approximately 106 ha. The three project sites are collectively located approximately 5 km east of Grootdrink, !Kheis Local Municipality, Northern Cape Province (Figure 1).

Gestamp Asetym Solar South Africa (Pty) Ltd has appointed Savannah Environmental (Pty) Ltd, as the independent environmental consultant, to undertake the required Scoping Phase and Environmental Impact Assessment to identify and assess all the potential environmental impacts associated with the proposed project and to propose appropriate mitigation and management measures in an Environmental Management Programme (EMPr). Savannah Environmental (Pty) Ltd has appointed BM Geological Services to provide a Full Palaeontological Heritage Impact Assessment Report in respect of the proposed project that will form part of the final Heritage Impact assessment Report. The final location and extent of the project infrastructural elements is unknown at the time of compilation of this report and will only be finalised after the completion of the Scoping Study Phase of the Environmental Impact Assessment Program.

The three projects (Kheis Solar Parks 1-3) are variously underlain by metamorphic rocks of the Zonderhuis and Groblershoop Formations (Kaaien Terrane of the Namaqua-Natal Province). The metamorphic bed rocks are capped by unfossiliferous calcrete, which is itself overlain by potentially fossiliferous aeolian sands of the Gordonia Formation.

The potential for a negative impact on the fossil heritage of the area can be quantified in the following manner. It is improbable that there will be any negative impact on the palaeontological heritage of the Gordonia Formation as **no fossil materials were identified during the site visit**. However, should any undiscovered fossil materials be present they would potentially provide significant palaeoclimatic and palaeoecological information for the region. Thus, the magnitude of any negative impact upon the fossil assemblages contained within these geological units is characterised as potentially high. However, the probability of any negative impact being caused upon the fossil assemblages occurring within the project area is assessed as improbable. The area of

any potential negative impact caused by the project is characterised as local in extent. Similarly, the zone of permanent disruption is vertically restricted to the maximum depth of any excavations associated with the proposed constructions. The calcrete as well as the Zonderhuis and Groblershoop Formations are considered to be unfossiliferous. Thus, the proposed project poses nil probability of any negative impact upon the palaeontological heritage of these units.

The project has been assessed as being socially beneficial, herein, as it would provide renewable energy to a stressed South African power grid. The possibility of any negative impact on the palaeontological heritage of the project area could be minimised by a thorough examination of all excavations within the Gordonia Formation as they are being performed. Should any fossil materials be identified during the construction phase, the excavations should be halted and SAHRA informed of the discovery. Should scientifically or culturally significant fossil materials exist within the project area any negative impact upon it could be mitigated by their excavation (under permit from SAHRA) by a palaeontologist and the resultant material being lodged with an appropriately permitted institution. In the event that an excavation is impossible or inappropriate the fossil or fossil locality could be protected and the site of any planned construction moved.

A potential positive outcome of these mitigation protocols could be that fossil materials become available for scientific study that would otherwise have been hidden within or beneath the regolith. Should such new palaeontological material be located as a result of this site investigation this could prove to have a positive effect on the understanding of the fossil record of South Africa and positively affect the palaeontological heritage of the country.

In summary, this study has not identified any palaeontological reason to prejudice the progression of either Kheis Solar Parks 1, 2 or 3, subject to adequate mitigation programs being put in place.

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1 INTRODUCTION

Gestamp Asetym Solar South Africa (Pty) Ltd is proposing to establish a commercial photovoltaic solar energy park with a total generating capacity of 225 MW to be developed in 3 separate phases of 75 MW each, as well as associated infrastructure. The following project names apply to the three phases:

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2 TERMS OF REFERENCE AND SCOPE OF THE STUDY

The terms of reference for this study were as follows:-

- Identify all palaeontological materials located in the area of the project area.
- Quantify the palaeontological heritage significance of any fossil materials identified.
- Describe the possible impact of the proposed development on the palaeontological heritage of the site, according to a standard set of conventions (Appendix A).
- Propose suitable mitigation measures to minimise possible negative impacts, if any are identified, on the palaeontological heritage of the site.
- Provide an overview of the applicable legislative framework.

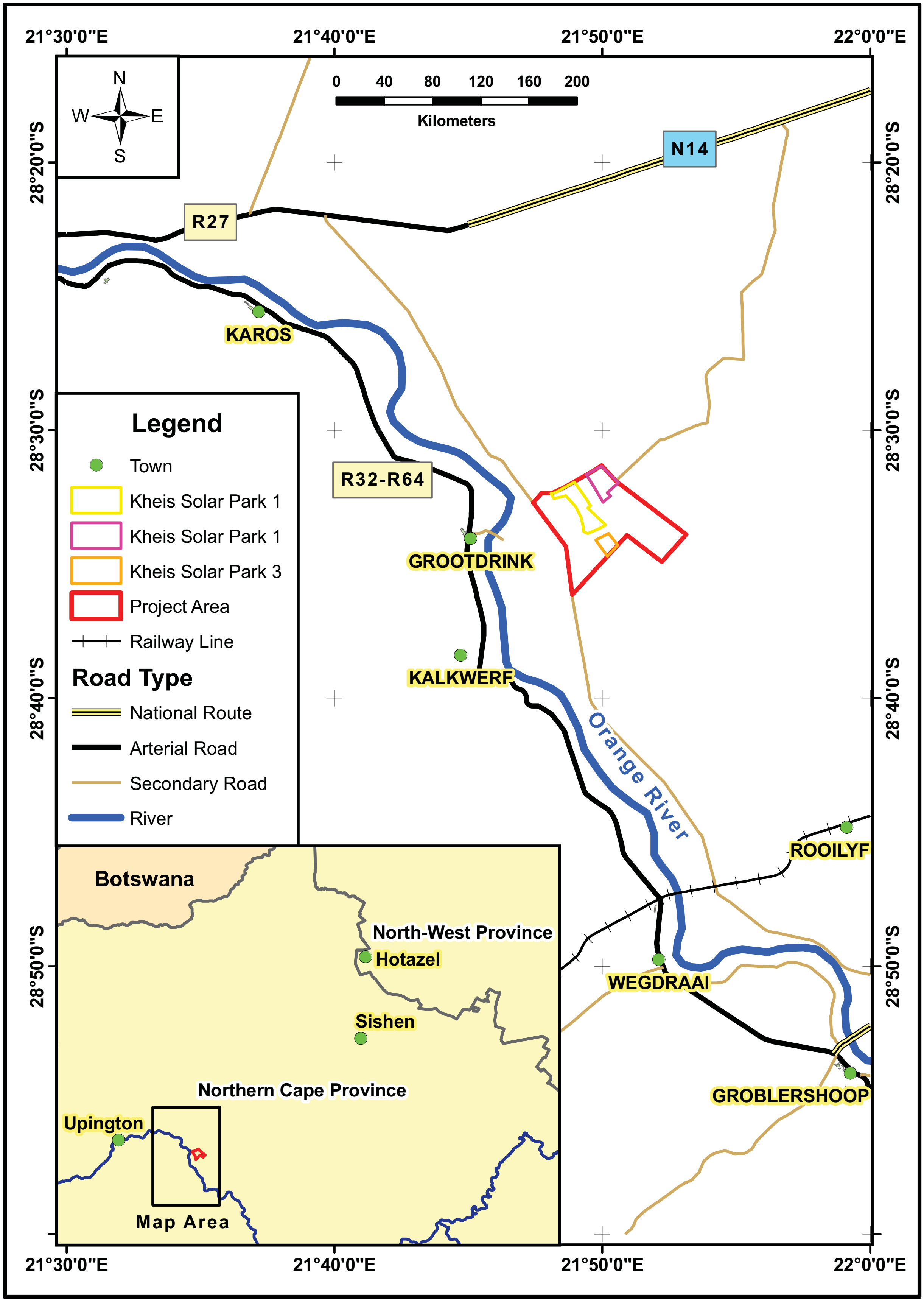

Figure 1: Location map showing the position of the proposed Kheis Solar Parks 1-3.

3 LEGISLATIVE REQUIREMENTS

South Africa's cultural resources are primarily dealt with in two Acts. These are the National Heritage Resources Act (Act 25 of 1999) and the National Environmental Management Act (Act 107 of 1998).

3.1 The National Heritage Resources Act

The following are protected as cultural heritage resources by the National Heritage Resources Act:

- Archaeological artefacts, structures and sites older than 100 years,
- Ethnographic art objects (e.g. prehistoric rock art) and ethnography,
- Objects of decorative and visual arts,
- Military objects, structures and sites older than 75 years,
- Historical objects, structures and sites older than 60 years,
- Proclaimed heritage sites,
- Grave yards and graves older than 60 years,
- Meteorites and fossils,
- Objects, structures and sites or scientific or technological value.

The Act also states that those heritage resources of South Africa which are of cultural significance or other special value for the present community and for future generations must be considered part of the national estate and fall within the sphere of operations of heritage resources authorities. The national estate includes the following:

- Places, buildings, structures and equipment of cultural significance,
- Places to which oral traditions are attached or which are associated with living heritage,
- Historical settlements and townscapes,
- Landscapes and features of cultural significance,
- Geological sites of scientific or cultural importance,
- Sites of Archaeological and palaeontological importance,
- Graves and burial grounds,
- Sites of significance relating to the history of slavery,
- Movable objects (e.g. archaeological, palaeontological, meteorites, geological specimens, military, ethnographic, books etc.).

Section 38 of the Act stipulates that any person who intends to undertake an activity that falls within the following:

3.2 Need for Impact Assessment Reports

Section 38 of the Act stipulates that any person who intends to undertake an activity that falls within the following:

- The construction of a linear development (road, wall, power line, canal etc.) exceeding 300m in length,
- The construction of a bridge or similar structure exceeding 50 m in length,
- Any development or other activity that will change the character of a site and exceed 5 000 m^2 or involve three or more existing erven or subdivisions thereof,
- Re-zoning of a site exceeding 10 000 m^2,
- Any other category provided for in the regulations of SAHRA or a provincial heritage authority.

must at the very earliest stages of initiating such a development, notify the responsible heritage resources authority and furnish it with details regarding the location, nature and extent of the proposed development. If there is reason to believe that heritage resources will be affected by such development, the developer may be notified to submit an impact assessment report. A Palaeontological Impact Assessment (PIA) only looks at the potential impact of the development palaeontological resources of the proposed area to be affected.

3.3 Legislation Specifically Pertinent to Palaeontology*

*****Note: Section 2 of the Act defines "palaeontological" material as "any fossilised remains or fossil trace of animals or plants which lived in the geological past, other than fossil fuels or fossiliferous rock intended for industrial use, and any site which contains such fossilised remains".

Section 35(4) of this Act specifically deals with archaeology, palaeontology and meteorites. The Act states that no person may, without a permit issued by the responsible heritage resources authority (national or provincial):

- Destroy, damage, excavate, alter, deface or otherwise disturb any archaeological or palaeontological site or any meteorite,
- Destroy, damage, excavate, remove from its original position, collect or own any archaeological or palaeontological material or object or any meteorite,
- 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

- Bring onto or use at an archaeological or palaeontological site any excavation equipment or any equipment that assists in the detection or recovery of metals or archaeological and palaeontological material or objects, or use such equipment for the recovery of meteorites,
- Alter or demolish any structure or part of a structure which is older than 60 years as protected.

The above mentioned palaeontological objects may only be disturbed or moved by a palaeontologist, after receiving a permit from the South African Heritage Resources Agency (SAHRA). In order to demolish such a site or structure, a destruction permit from SAHRA will also be needed.

Further to the above point, Section 35(3) of this Act indicates that "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.". Thus, regardless of the granting of any official clearance to proceed with any development based on an earlier assessment of its impact on the Palaeontological Heritage of an area, the development should be halted and the relevant authorities informed should fossil objects be uncovered during the progress of the development.

3.4 The National Environmental Management Act [As amended]

This Act does not provide the detailed protections and administrative procedures for the protection and management of the nation's Palaeontological Heritage as are detailed in the National Heritage Resources Act, but is more general in is application. In particular Section 2(2) of the Act states that environmental management must place people and their needs at the forefront of its concerns and, amongst other issues, serve their cultural interests equitably. Further to this point section 2(4)(a)(iii) states that disturbances of sites that constitute the nation's cultural heritage should be avoided, and where it cannot be avoided should be minimised and remedied.

Section 23(1) indicates that a general objective of integrated environmental management is to identify, predict and evaluate the actual and potential impact of activities upon the cultural heritage. This section also highlights the need to identify options for mitigating of negative effects of activities with a view to minimising negative impacts.

In order to give effect to the general objectives of integrated environmental management outlined in the Act the potential impact on cultural heritage of activities that require authorisation or permission by law must be investigated and assessed prior to their implementation and reported to the relevant organ of state. Thus, a survey and evaluation of cultural resources must be done in areas where development projects that will potentially negatively affect the cultural heritage will be performed. During this process the impact on the cultural heritage will be determined and proposals for the mitigation of the negative effects made.

4 METHODOLOGY

It was considered that the most effective methodology for determining the fossiliferous potential of the project area was to traverse the area by foot. Given the extensive aerial extent of the proposed development it was impossible to extensively visit the entire site within an acceptable timeframe. However, the bedrock underlying the study area appears to consist of unfossiliferous strata of either the Groblershoop or Zonderhuis Formations (Figure 3). It became apparent early in the site investigation that the bedrock tends to be capped by unfossiliferous calcrete. The only potentially fossiliferous unit present within the study area is the unconsolidated sands of the Gordonia Formation which lay upon the bedrock and calcrete. It was decided that the most appropriate methodology was to traverse the area by foot, and ensuring that there was a representative coverage of each of the three project areas was obtained. In addition to this general coverage of the area thick exposures of the Gordonia Formation sands were preferentially targeted for more intensive investigation where ever they were encountered.

The study area was visited on two separate occasions (being the 8th of November 2013 and the 8th of February, 2014) by Dr B.D. Millsteed (Figure 2). The traverse of the 8th of November 2013 included the area of Solar Park 2 and an extensive area to its southeast. While the areas to the southeast of Solar Park 2 are not included in any of the 3 Solar Park project areas they do contain extensive areas of Gordonia Formation sands (including well developed sand dunes). The traverse of this region of the Gordonia Formation provides invaluable additional insight into the fossiliferous potential of the formation in this local region. The traverse of the 8th of February, 2014 targeted Solar Parks 1 and 3 as well as the intervening land surface.

The paths of both foot traverses were recorded as trackways on a hand-held GPS and are indicated in Figure 2. Photographs were taken and observations made were taken at a number of locations (see data waypoint locations in Figure 2). The location of the photographs and observation points was recorded using a hand-held GPS.

5 RELEVENT EXPERIENCE

Dr Millsteed holds a PhD in palaeontology and has previously been employed as a professional palaeontologist with the Council for Geoscience in South Africa. He is currently the principle of BM Geological Services and has sufficient knowledge of palaeontology and the relevant legislation required to produce this Palaeontological

Impact Assessment Report. Dr Millsteed is registered with the South African Council for Natural Scientific Professions (SACNASP), and is a member of the Palaeontological Society of South African and the Geological Society of South Africa.

6 ACCESS AND INDEPENDENCE

The area to be impacted by the proposed electrical substation was supplied to BM Geological Services as a .kml files. The research was conducted completely free of any hindrance. Access was freely available to all portions of the study area and the field visit was able to be conducted wherever it was deemed necessary for the satisfactory completion of the study.

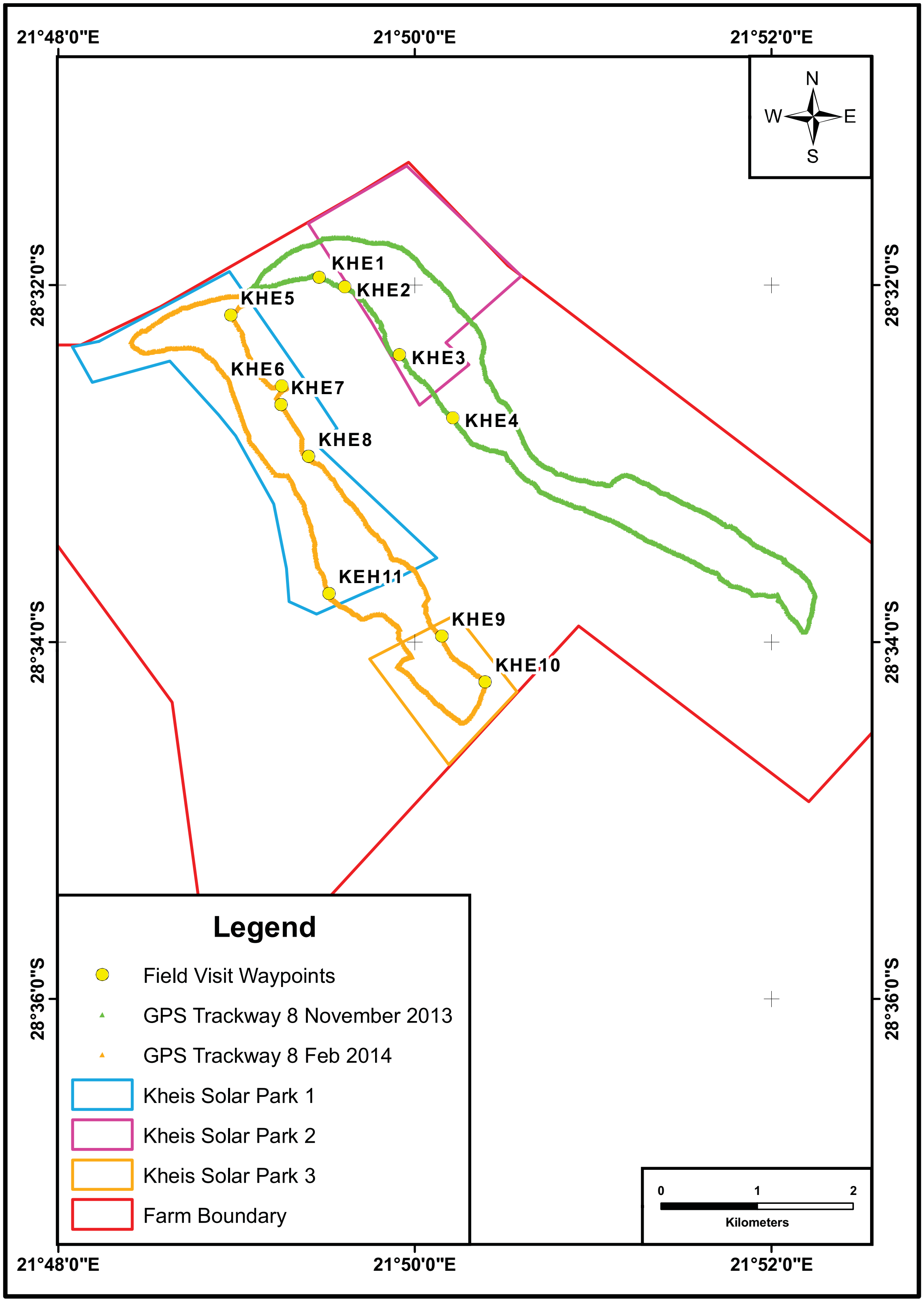

Figure 2: Map showing the location of the proposed Kheis Solar Parks 1-3, the GPs trackway representing the location of the two foot traverses conducted of the area and the location of waypoints at which data was collected.

The land surface is relatively flat to gently undulating and featureless, except for longitudinal northwest southeast oriented sand dunes located along the south eastern and western margins of the Solar Park 2 and low, poorly developed dunes present along the south eastern margins of Solar Park 1. The area is vegetated with either a sparse to dense cover of low acacia bushes and trees generally less than 4m high or wide expanses of grass and sparse, low (<50cm high) Karoo bushes. Accordingly, as the observations were conducted on foot there were no areas that could not be easily visited and studied.

Dr Millsteed was contracted as an independent consultant to conduct this Palaeontological Heritage Impact assessment study and shall receive fair remuneration for these professional services. Neither Dr Millsteed nor BM Geological Services has any financial interest in either Gestamp Asetym Solar South Africa (Pty) Ltd or the proposed power generation facilities.

7 GEOLOGY AND FOSSIL POTENTIAL

Figure 3 shows that the region underlying the three project areas is underlain by metamorphic bedrocks of either the Mesoproterozoic aged Zonderhuis or Groblershoop Formations (all components of the Kaaien Terrane of the Namaqua-Natal Province). The majority of the project area bears a superficial cover of Cenozoic regolith of the Gordonia Formation, Kalahari Group (Figure 3). The geology underlying each of Solar Parks 1-3 in particular is as follow:

- Solar Par 1: the majority of the project area is underlain by unconsolidated sands of the Gordonia Formation. The south western quadrant of the site contains extensive exposures of the Zonderhuis Formation. This formation appears to underlie the Gordonia Formation throughout the extent of the Solar Park area.
- Solar Park 2: The land surface of Solar Park 2 is composed completely of unconsolidated sands of the Gordonia Formation. It is probable that the Zonderhuis Formation forms the bedrock for the Kalahari sands throughout Solar Park 2.
- Solar Park 3: The land surface of the majority of this Solar Park is formed by bedrocks of the Groblershoop Formation. The Gordonia Formation sands form the land surface in the south western corner and along the southern margin of the Solar Park site. It is probable that the Groblershoop Formation underlies the Gordonia Formation throughout the Solar park site.

The site visit revealed that there is an aerially extensive horizon of grey calcrete that caps the Mesoproterozoic bedrocks and immediately underlies the sands of the Gordonia Formation. A summary of the characteristics of the geological units and their fossiliferous potentials follows.

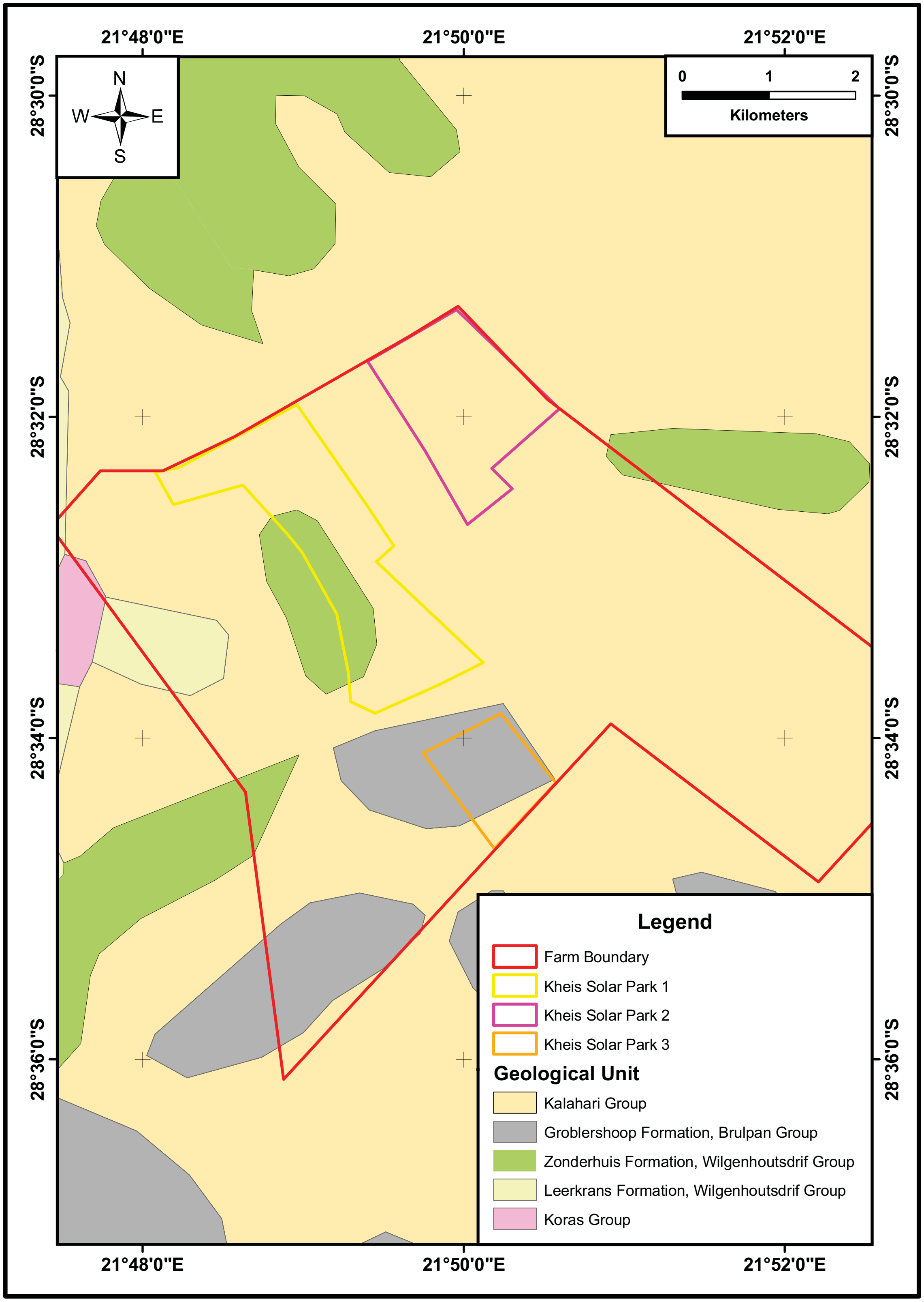

Figure 3: Map of the geology underlying the project areas and their surrounding environs.

7.1 Zonderhuis Formation

7.1.1 Geology

The 300 m thick, light purple colored sequence of quartzites comprising the Zonderhuis Formation constitutes the basal unit of the Wilgenhoutsdrif Group. The unit also contains lenses of ferruginous or manganiferous quartzite siderite dolomite and argillaceous limestone occur in scattered localities throughout its aerial extent. The continuity of the formation and its mylonite texture suggests that it accompanies a thrust fault which represents a major crustal detachment zone (Cornell *et al*., 2006). Extensive outcrops of this unit were identified in the southwestern quadrant of Solar Park 1 (Figure 4). No outcrops of this formation were identified in Solar Park 2; however, rock float of presumably Zonderhuis Formation origin was observed throughout the area located to the southeast of Solar Park 2 and appears to originate from erosion of the nearby Tier Kop.

7.1.2 Palaeontological potential

The Mesoproterozoic age of the formation, non-carbonate lithology and metamorphic grade of the formation suggest a negligible potential for the preservation of any palaeontological materials. No fossil materials were identified in any of the rock float that was inspected.

7.2 Groblershoop Formation

7.2.1 Geology

The approximately 2000 m thick unit consists essentially of quartz-muscovite schist and schistose quartzite. Muscovite makes up to 1–30 % of the rock and chlorite, biotite, plagioclase and epidote are common accessories. The unit contains poikiloblastic garnet and subhedral hornblende needles up to 10 mm long present in places (Cornell *et al*., 2006). This unit forms the bedrock throughout Solar Park 3.

7.2.2 Palaeontological potential

The Mesoproterozoic age of the unit, non-carbonate lithology and metamorphic grade of the formation suggest a negligible potential for the preservation of any palaeontological materials.

7.3 Calcrete

7.3.1 Geology

A layer of grey, occasionally laminated calcrete is present within the wider region containing Solar Parks 1-3, where it caps the Mesoproterozoic bedrock units and immediately underlies the unconsolidated sands of the Gordonia Formation (Figures 5 and 6). The calcrete is best exposed in the northern portions of the study area within Solar Parks 1 and 2, but is present throughout the entire region of all three Solar Parks. There are extensive areas of either sand dunes or extensive, flat exposures of reworked Gordonia Formation sands located between the sand dunes within Solar parks 1 and 2 (Figure 7, 8 and 9). It is presumed that these reworked sands cover and hide any underlying calcrete.

7.3.2 Palaeontological potential

Where exposures of the calcrete were encountered during the site investigation they were without exception unfossiliferous. It is believed that this stratigraphic unit has no palaeontological potential within the study area.

7.4 Gordonia Formation

7.4.1 Geology

The stratigraphic units comprising the Kalahari Group constitute the most extensive body of terrestrial sediments of Cenozoic age in southern Africa. The Kalahari Group is composed (in order of decreasing stratigraphic age) of the Wessels, Budin, Eden, Obobogorob, Gordonia and Lonely Formations (Partridge *et a*l., 2006).

The Late Pliocene/Early Pleistocene to Recent age Gordonia Formation consists of red aeolian sands covering most of the underlying stratigraphic units within the region and usually rests on a calcrete surface (Figure 7). The unit is up to 30 m thick and consists of rounded quartz grains colored red by a thin coating of hematite. Aeolian overprinting of sands originally deposited by streams and sheet wash is evident in some places. A considerable area of the Gordonia Formation is covered by linear dunes which are now stabilized by vegetation. These dunes may have formed as early as the Late Pleistocene or Early Pleistocene (Moore and Dingle, 1998).

Sands of the Gordonia Formation are widely distributed throughout entire area. Well developed longitudinal sand dunes are present along the western margin of Solar Parks 1 and the northwestern portion of Solar Park 2. These sand dunes consist of orange, red colored unconsolidated aeolian sand (Figures 7, 8 and 9). In between the sand dunes and within the flatter regions of the general region which are devoid of sand dunes these

Figure 4: vertical north-south trending cleavage in phyllites of the Zonderhuis Formation (Waypoint Khe 7, Figure 2).

Figure 5: Scattered outcrop of grey, unfossiliferous calcrete with a thin veneer of unconsolidated orange red coloured Gordonia Formation sand (Waypoint Khe3, Figure 2).

Figure 6: Calcrete cropping out with a very thin veneer of Gordonia Formation sands covering the land surface (Waypoint Khe 5, Figure 2).

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Figure 9: Unconsolidated aeolian sands of the Gordonia Formation (stabilised by plant growth) form a low rounded dune. The large animal burrow situated above the hammer indicates that the sand deposit is thick here (Waypoint Khe 10, Figure 2).

Gordonia Formation sands form a thin veneer of material up to several centimeters thick (Figures 5 and 6).

7.4.2 Palaeontological potential

The sediments of the Gordonia Formation are not noted for containing either an abundant or diverse palaeontological heritage. Indeed, no fossil occurrences are recorded in the region in a recent compilation of geological data from the general area (Moen, 2007). This paucity of palaeontological materials within the formation is possibly due to two causes. Firstly, the sand dunes that comprise the formation were deposited under dry conditions (Moen, 2007) and active, extensive dune fields are not noted for their abundance of either flora or fauna. Secondly, the unit is composed of unconsolidated, porous sands. The high porosity and permeability of the sands facilitates ready inflow and through-flow of oxidizing meteoric water flowing through these sands is not conducive to the preservation of most biological materials as fossils. Cumulatively there was low potential for biological materials to be incorporated into the sediments and a high probability for the subsequent destruction of any biological materials that may have been contained within the sands by oxidizing ground waters.

The presence of fossils within the sequence in the project area cannot, however, be completely discounted as they are known to be present in similar aged sediments elsewhere in the northwestern portion of South Africa; examples of such fossil occurrences are discussed below.

Occurring commonly within reddish aeolian sands of the Quaternary superficial deposits at Bosluis Pan are spherical, calcretised termitarea up to 250 cm across. These termitarea resemble nests constructed by the extant harvester termite *Hodotermes* (Macey *et al*., 2011). There are also smaller nests (8 cm in diameter) resembling those of *Psammatermes* present (De Wit, 1990).

Sediments of Pleistocene and younger age within the Koa River Valley palaeodrainage system at Bosluis Pan and elsewhere in the region contain fragments of egg shells of the modern ostrich as well as shells of the desert snail *Trigonepherus* (Senut and Pickford, 1995; Senut *et al*., 1996).

In the Brandvlei Area (south-east of the project area) and within calcretised basal alluvial facies of the Geelvloer Palaeovalley are bones of anthracotherids (extinct *Hippopotomus*-like artiodactyles) (Macey *et al*., 2011).

Abraded Plio-Pleistocene fossil woods from relict alluvial terraces from the Sak River (just to the north of Brandvlei) includes specimens from the family Polygalaceae (Bamford and De Wit, 1993).

Thick (2 m) shelly coquinas of the small freshwater gastropod *Tomichia ventricosa* occur at elevations up to 10 m above the present day floor of the Swartkolkvloer, approximately 50 km south-west of Brandvlei (Kent and Gribnitz, 1985). These shells have been radiocarbon dated to latest Pliocene (Macey *et al*., 2011). These snails are characteristic of brackish to saline ponds.

No fossil materials of any kind were located during the extensive foot traverse of the Kheis Solar Parks 1-3 or the expanses of Gordonia Formation sands located to the southeast of Solar Park 2 and east of Solar Park 3.

8 ENVIRONMENT OF THE PROPOSED PROJECT SITE

The area of each of the three proposed Solar Park sites is large; being approximately 359 ha for Solar Park 1, approximately 232 ha for Solar Park 2 and approximately 106 ha for Solar Park 3 (Figure 2).

Topographically the region containing the three Solar Park sites predominantly consists of a flat, featureless land surface (Figures 10, 11, 12, 13 and 14) dominated by the presence of sub-parallel, northwest-southeast oriented linear sand dunes sets in the areas of Solar Parks 1 and 2 and low, rounded hills in the south western portion of Solar Park 2 (Figure 13). A prominent hill (Tier Kop) is located near, but exterior to, the south eastern margin of Solar Park 2 (Figure 13). A range of elongate northwest-southeast oriented ridges lie parallel to, but exterior to, the western boundaries of Solar Parks 1 and 3.

A number of small ephemeral stream systems flow from Tier Kop and flow across the region to the south of Solar park 2, but not transect the site itself (Figure 14). A separate drainage ephemeral drainage system drains the hills located o the immediate west of Solar Parks 1 and 3, but only a singly tributary of this system transects the western part of Solar Park 1 (Figure 14). This later drainage system eventually flows into the Orange River which is located immediately to the west of the project area.

Mucina and Rutherford (2006) indicate that the vegetation cover of the three Solar park sites are vegetated with a cover of the Gordonia Duneveld vegetation type, with subordinate proportions bearing Bushmanland Arid Grassland (Figure 15). In particular, the three Solar Park areas bear the following vegetation types:

- Solar Park 1: This area is predominantly vegetated with Gordonia Duneveld vegetation, but much of the north western quadrant as well as the margin of the south western corner of the site bears a cover of Bushmanland Arid Grassland.
- Solar Park 2: This project area is completely vegetated with Gordonia Duneveld vegetation type.

- Solar Park 3: This Solar Park area is almost completely covered with the Gordonia Duneveld vegetation type. Plants of the Bushmanland Arid Grassland veld type are only located along the northern margin of the project area.

The conservation status of both the Bushmanland Arid Grassland and Gordonia Duneveld veld types is listed as least threatened by Mucina and Rutherford (2006).

It was apparent during the field investigation that the entire Developable Area (including the total extents of Kheis Solar Parks 1-3 is utilised for grazing and game farming. The Orange River lies immediately to the western margin of the project area and the margins of the river are extensively cultivated.

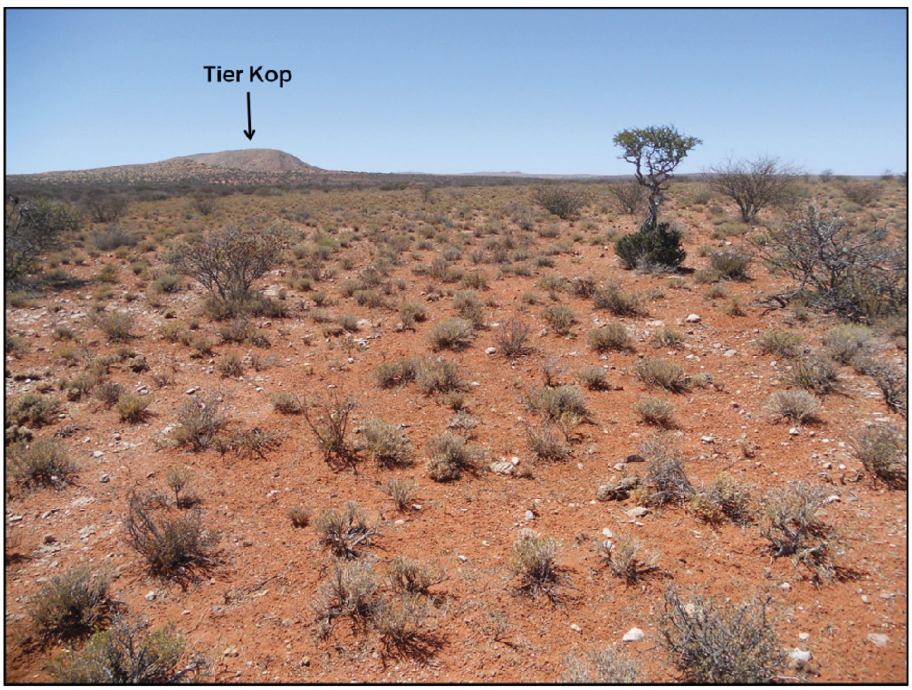

Figure 10: Photograph of the Solar Park 1 area from Waypoint Khe1 (see Figure 2). Visible in the background is Tier Kop (view is to the south).

Figure 11: View to the southwest across the Kheis Solar Park 1. The topography in this project area is extremely flat (Waypoint Khe 5, Figure 2).

Figure 12: View to the southwest across the Kheis Solar Park 3. The topography in this project area is extremely flat (Waypoint Khe 9, figure 2).

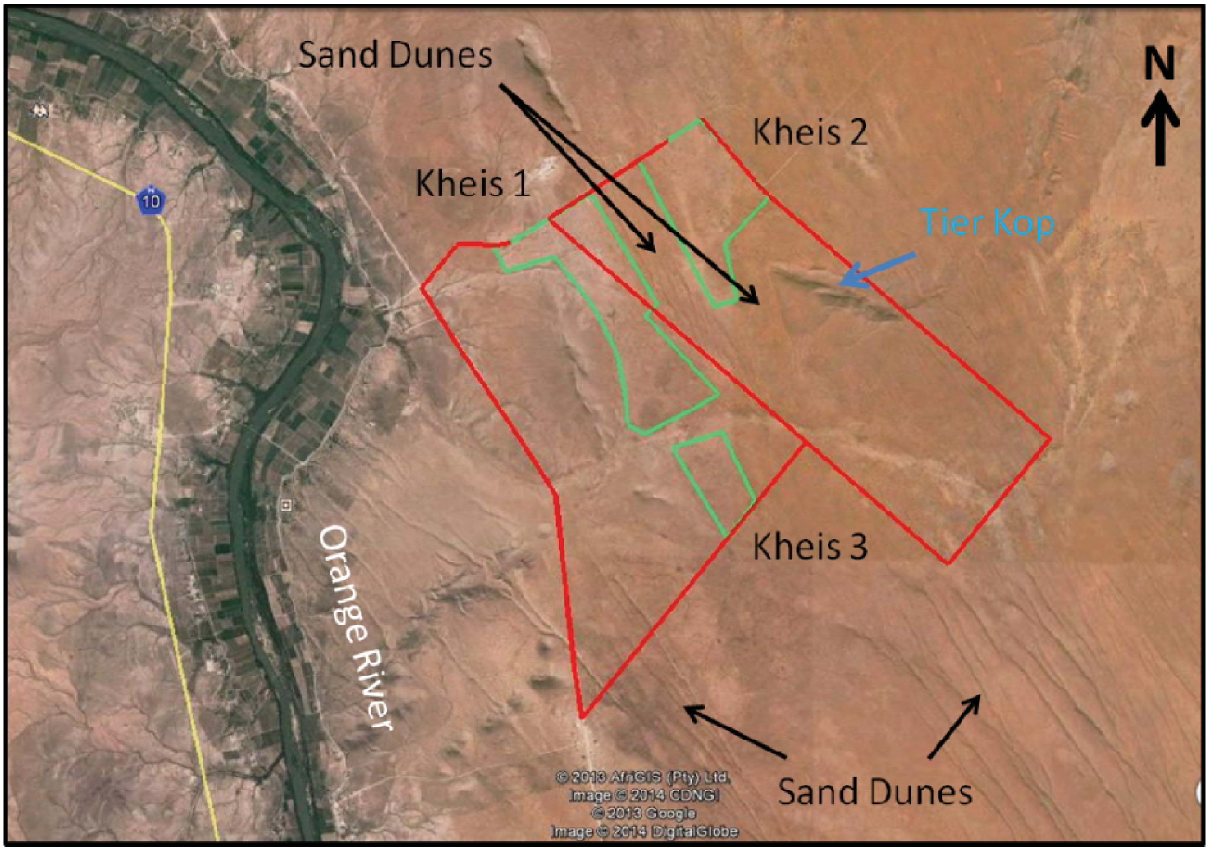

Figure 13: Google earth image of the location of Kheis Solar Parks 1-3 (green polygons). Evident from the image is that that the several extents of the region are dominated by northwest-southeast oriented elongate, sub-parallel sand dunes of the Gordonia Formation. The north-eastern margin of the project area contains a prominent elongate ridge known as Tier Kop. Located to the west of Solar Parks 1 and 3 are a range of northwest-south east oriented hills. The area is utilised for grazing and game farming.

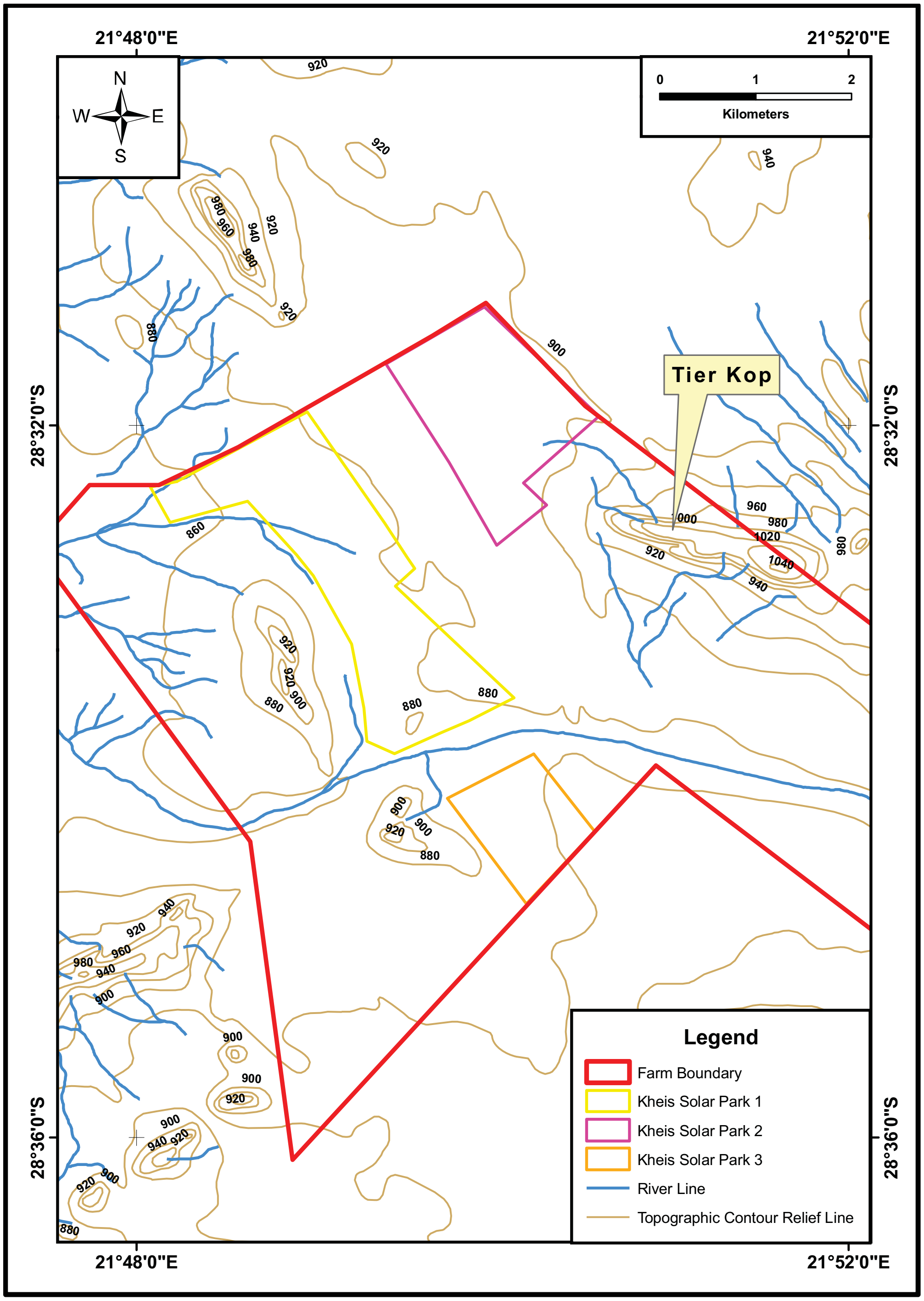

Figure 14: Map of the project area with topographic contours superimposed. It is evident that the area containing the proposed Solar Parks 1-3 consists predominantly of a flat to gently undulating topography. A small, elongate hill (Tier Kop) exists to the southeast of Solar Park 2. Located on the western margins of Tier Kop are poorly developed ephemeral drainage systems flowing toward the west. Located along the western margins of Solar Parks 1 and 3 are line of northwest-southeast oriented hills. These hills also drain to the west via an ephemeral drainage system that eventually flows into the Orange River. The contour interval of the topographic contours is 20 m.

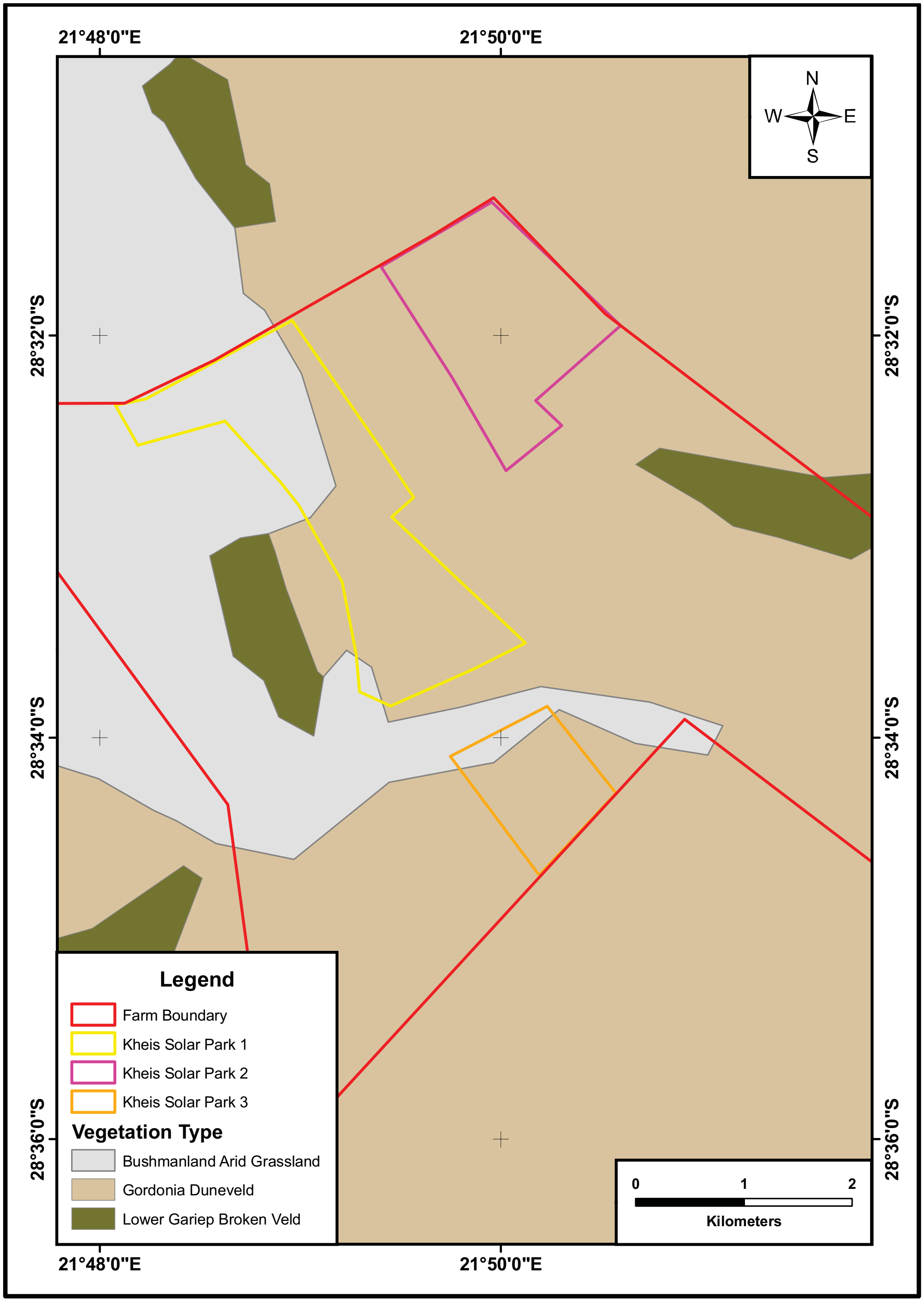

Figure 15: Map of the distribution of the vegetation veld types located within the three Solar Park areas and their surrounding environs (after Mucina and Rutherford, 2006).

9 OVERVIEW OF SCOPE OF THE PROJECT

The proposed power generation project will consists of a 225 MW solar energy generation facility to be constructed in three separate phases of 75 MW each (to be known as Kheis Solar Park 1-3) to connect to ESKOM's grid facility.

Each facility will include the following infrastructures:

- Arrays of photovoltaic (PV) panels,
- Appropriate mounting structures,
- Cabling between the project components, to be lain underground where practical.
- New on-site substation and power line to evacuate the power from the facility into the Eskom grid via the existing Garona-Gordonia 132 kV power line that traverses the site,
- Internal access roads and fencing,
- Workshop area for maintenance, storage, and offices.

9.1 Description of the technology elements proposed for the project

Solar energy facilities, such as those using PV panels use the energy from the sun to generate electricity through a process known as the Photovoltaic Effect. This effect refers to photons of light colliding with electrons, and therefore placing the electrons into a higher state of energy to create electricity. The solar energy facilities will comprise of the following components.

9.1.1 The photovoltaic cell

Individual PV cells (static or tracking) are linked and placed behind a protective glass sheet to form a photovoltaic panel (Figure 16). Other technologies that can be used include thin film and concentrated solar PV (CPV).

9.1.2 The inverter

The photovoltaic effect produces electricity in direct current. Therefore an inverter must be used to change it to alternating current.

9.1.3 The support structure

The PV panels will be attached to a support structure approximately 4 meters off the ground set at an angle so to receive the maximum amount of solar radiation (fixed technology), or set to track the sun (tracking technology) in order to increase the amount of energy produced. The angle of the panel is dependent on the latitude of the proposed facility and the angles may be adjusted to optimise for summer or winter solar radiation characteristics.

The PV panels are designed to operate continuously for more than 20 years, unattended and with low maintenance.

Figure 16: A photovoltaic (PV) panel similar to those that will be installed as part of the power generation system.

10 IMPACT ASSESSMENT

The potential impact of Gestamp Asetym Solar South Africa (Pty) Ltd's solar power generation facilities is categorised below according to the following criteria:-

10.1 Nature of Impact

The potential negative impacts of the proposed project on the palaeontological heritage of the Kheis Solar Parks 1-3 area are:

- Damage or destruction of fossil materials during the construction of project infrastructural elements to a maximum depth of those excavations. Many fossil taxa (particularly vertebrate taxa) are known from only a single fossil and, thus, any fossil material is potentially highly significant. Accordingly, the loss or damage to any single fossil can be potentially significant to the understanding of the fossil heritage of South Africa and to the understanding of the evolution of life on Earth in general. Where fossil material is present and will be directly affected by the building or construction of the projects infrastructural elements the result will potentially be the irreversible damage or destruction of the fossil(s).
- Movement of fossil materials during the construction phase, such that they are no longer *in situ* when discovered. The fact that the fossils are not *in situ* would either significantly reduce or completely destroy their scientific significance.
- The loss of access for scientific study to any fossil materials present beneath infrastructural elements for the life span of the existence of those constructions and facilities.

10.2 Extent of Impact

The possible extent of the permanent impact of the proposed project on the palaeontological heritage of South Africa is restricted to the damage, destruction or accidental relocation of fossil material caused by the excavations and construction of the necessary infrastructure elements forming part of the project. The possible source of a less permanent negative impact on the palaeontological heritage is the loss of access for scientific research to any fossil materials that become covered by the various infrastructural elements that comprise the project. The extent of the area of potential impact for each of Solar Parks 1-3 is, accordingly, **categorised as local** (i.e., restricted to the project site). As the three project areas are relatively large a scoring **value of 2** is applied, herein, to the extent of the impact.

10.3 Duration of Impact

The anticipated duration of the identified impact is assessed as potentially **permanent to long term**. This is assessment is based on the fact that, in the absence of mitigation procedures (should undiscovered fossil material be present within the area to be affected) the damage or destruction of any palaeontological materials will be **permanent**. Similarly, any fossil undiscovered materials exist in the subsurface below the structures and infrastructural elements that will constitute the power generation facility will be unavailable for scientific study for the life of the existence of those features (i.e., **long term** > 15 years). Using the worst case scenario for the duration of the impact (i.e., permanent) a **scoring value of 5** is assigned for the duration of the impact.

10.4 Magnitude of Impact

No fossil materials were located during the conduct of the field investigation. All stratigraphic units appear to be unfossiliferous within Solar Parks 1-3, but there remains a small possibility of undiscovered fossil materials occurring within the subsurface portions of the Gordonia Formation. Should such fossils exist they would potentially be of significant scientific importance. Accordingly, the magnitude of the impact of the three proposed solar parks upon the palaeontological heritage of the area is assessed as **high** (**= a scoring value of 8**). Should the mitigation procedures suggested, herein, be performed no fossil materials of any significance should be negatively impacted. Accordingly, the magnitude of the resultant impacts will be **small (= a scoring value of 0)**.

10.5 Probability of Impact

The Zonderhuis and Groblershoop Formations are considered to be unfossiliferous, herein, due to the combination of their Mesoproterozoic age (preceding the advent of macrofossils) and elevated metamorphic grade. Similarly, the calcrete is unfossiliferous everywhere where it was observed within the three Solar Park areas as well as the surrounding environs. As such the probability of the proposed project causing any negative impact on the palaeontological heritage within these three geological units is **nil**.

The sands of the Gordonia Formation are not noted for possessing either an abundant or diverse palaeontological heritage, but similar aged strata within the Northern Cape Province do contain scattered fossil assemblages. Despite the fossiliferous potential of the unit no fossil material of any description was located during within the study area during the field visit and it appears that the Gordonia Formation is unfossiliferous within the Developable Area. There remains a possibility that there may be fossil material within the subsurface of this geological unit. Thick deposits of the Gordonia Formation are aerially extensive in Solar Park 2 and widely present throughout the western portions of Solar Park 3, but are effectively absent from Solar Park 3 (except for a very thin veneer of reworked material in the extreme south of the site). However, due to the large aerial extent of the Gordonia Formation investigated during this study no fossil material was identified. Accordingly, the probability of any development negatively impacting a fossil within the unit in Solar Parks 1-3 is assessed as **improbable (= a scoring value of 1)**.

10.6 Significance of the Impact

The fossils potentially contained within the Gordonia Formation are geologically young and as such, are most significant in terms of information that they may provide concerning insight they may provide into the historical climatic and ecological status of the immediate region. However, due to the young age of the unit many of the taxa present could be expected to be extant, but a number of extinct taxa are also known to be present within similarly aged sediments elsewhere in South Africa; their significance is potentially **high**. As no fossil materials are expected to be present within either the calcrete or the Zonderhuis and Groblershoop Formations the severity of any negative effects on the palaeontological heritage of these formations is categorised as being **nil**.

The scientific and cultural significance of fossil materials is underscored by the fact that many fossil taxa (particularly vertebrate taxa) are known from only a single fossil and, thus, any fossil material is potentially highly significant. Accordingly, the loss or damage to any single fossil can be potentially significant to the understanding of the fossil heritage of South Africa and to the understanding of the evolution of life on Earth in general. Where fossil material is present and will be directly affected by the building or construction of project infrastructural elements the result will potentially be the irreversible damage or destruction of the fossil(s).

The certainty of the exact *in situ* location of fossils and their precise location within the stratigraphic sequence is essential to the scientific value of fossils. The movement of any fossil material during the construction of the facility that results in the exact original location of the fossil becoming unknown will either greatly diminish or destroy the scientific value of the fossil.

The significance of the impacts resulting from the proposed developments in Kheis Solar Parks 1-3 is the same and is calculated as follows:

S = (E+D+M)P

Where

S = Significance
E = Extent
D = Duration
M = Magnitude
P = Probability

Accordingly, the significance of any impacts posed by the three solar park projects upon the palaeontological heritage of the area is calculated as being,

Unmitigated
S = (2+5+8)1
S = 15

The calculated significance value of 15 equates to a Significance Weighting of **Low** (i.e., <30 points) if no mitigation processes are performed.

Mitigated
S = (2+5+0)1
S = 7

The calculated significance value of 7 equates to a Significance Weighting of **Low** (i.e., <30 points) if mitigation processes are performed.

10.7 Severity / Benefit Scale

The proposed project is categorised, herein, as being potentially **beneficial**. This classification is based on the intention that the project will provide a long term benefit to the community in terms of the provision of renewable electricity to an increasingly stressed national power grid. This positive benefit will continue throughout the life of the project. The probability of a negative impact on the palaeontological heritage of the project area has been categorised as low for the Gordonia Formation and nil for the calcrete or the Zonderhuis and Groblershoop Formations if appropriate mitigation procedures are put into place.

The low likelihood of fossils being directly affected by the planned project must be weighed in conjunction with the severity of any negative impact that may result. Many fossil taxa (particularly vertebrate forms) are known from only a single fossil and, thus, any fossil material is potentially highly significant. This potential significance is highlighted by the fact that the sediments of the Gordonia Formation may contain important or unique fossils. Thus, it is possible that there are fossils of scientific and cultural significance present within the sediments underlying the project area. Accordingly, the loss or damage to any single fossil or fossil locality can be potentially significant to the understanding of the fossil heritage of South. Thus, **although the likely hood of any disturbance of palaeontological materials is improbable, the severity of any impact is potentially high**. The possibility of a negative impact on the palaeontological heritage of the area can, however, be minimised by the implementation of adequate damage mitigation procedures. If damage mitigation is properly undertaken the benefit/severity scale for the project will lie within the beneficial category.

A potential secondary benefit of the project would be that the excavations resulting from the progress of the project may uncover fossils materials that were hidden beneath the surface exposures and, as such, would have remained unknown to science. If the planned excavations are inspected, while they are occurring, with a view to identifying any possible palaeontological materials present the possibility would be generated of being able to study and excavate fossil materials that would otherwise be hidden to scientific study.

10.8 Status

Given the combination of factors discussed above, it is anticipated that as long as adequate mitigation processes are emplaced little to no negative effect on the palaeontological heritage of the area is anticipated. As the proposed project would supply electricity to the stressed South African national power grid the project is determined as having a **positive status** herein.

11 DAMAGE MITIGATION, REVERSAL AND POTENTIAL IRREVERSABLE LOSS

The degree to which the possible negative effects of the proposed project can be mitigated, reversed or will result in irreversible loss of the palaeontological heritage can be determined as discussed below.

11.1 Mitigation

No fossil materials were identified within the study area during the site visit, but the possibility exists that fossils may be present within the subsurface portions of the Gordonia Formation. It is recommended that a close examination of all excavations be made while they are occurring within the Gordonia Formation sands. Should any fossil materials be identified, the excavations should be halted and SAHRA informed of the discovery (as per legislation outlined in Section 3.3 herein). A significant potential benefit of the examination of the excavations associated with the construction of the project is that currently unobservable fossils may be uncovered. As long as the construction process is closely monitored it is possible that potentially significant fossil material may be made available for scientific study. Such monitoring should be

Should scientifically or culturally significant fossil material exist within the project area any negative impact upon it could be mitigated by its excavation (under permit from SAHRA) by a palaeontologist and the resultant material being lodged with an appropriately permitted institution. In the event that an excavation is impossible or inappropriate the fossil or fossil locality could be protected and the site of any planned construction moved.

11.2 Reversal of Damage

Any damage to, or the destruction of, palaeontological materials or reduction of scientific value due to a loss of the original location is **irreversible**.

11.3 Degree of Irreversible Loss

Once a fossil is damaged, destroyed or moved from its original position without its geographical position and stratigraphic location being recorded the **damage is irreversible and total**.

Fossils are usually scarce and sporadic in their occurrence and the chances of negatively impacting on a fossil in any particular area are low. However, any fossil material that may be contained within the strata underlying the project area is potentially of the highest scientific and cultural importance. Thus, the potential always exists during construction and excavation within potentially fossiliferous rocks for the permanent and irreversible loss of extremely significant or irreplaceable fossil material. This said, many fossils are incomplete in their state of preservation or are examples of relatively common taxa. As such, just because a fossil is present it is not necessarily of great scientific value. Accordingly, not all fossils are necessary significant culturally of scientifically significant and the potential degree of irreversible loss will vary from case to case. The judgement on the significance of the fossil must be made by an experienced palaeontologist.

12 ASSUMPTIONS, UNCERTAINTIES AND GAPS IN KNOWLEDGE

Fossils occur sporadically within geological units and their location cannot be accurately predetermined. Despite a comprehensive investigation of the project areas by foot it was impractical (within time and budgetary constraints) to visit all locations with the Kheis Solar Parks 1-3. The possibility remains that there may be fossil materials occurring at the surface that were not located, or within the subsurface of the Gordonia Formation that could not be observed in the field.

13 ENVIRONMENTAL IMPACT STATEMENT

A comprehensive, foot-based investigation of the palaeontological potential of the proposed Kheis Solar Parks 1-3 as well as portions of the surrounding environs has been conducted. This study forms part of a Heritage Impact Assessment Report that is a component of a larger Scoping and Environmental Impact Assessment to identify and assess all potential environmental impacts associated with the proposed project for the area as identified, and propose appropriate mitigation measures in an Environmental Management Programme.

The areas reported upon herein known as Kheis Solar Parks 1-3 are each relatively large; the aerial extents being Kheis Solar Park 1 (approximately 359 ha), Kheis Solar Park 2 (approximately 232 ha) and Kheis Solar Park 3 (approximately 106 ha). It is probable that the area that will be affected by the proposed project infrastructure in each of the Solar Park areas will be smaller than the total area of each solar park area reported on herein, but the final extent and location of the infrastructure elements required for each is yet to be finalised. Any negative impacts to the palaeontological heritage of the region will be limited to the footprint area of the construction of the projects infrastructural elements that are constructed within the project area; the extent of any impact is accordingly characterised as local. It is anticipated, herein, that most infrastructural elements will only directly affect the surface of the site to a relatively shallow depth (1-2m). Any fossil materials that remain undiscovered after the construction of the project and which are located beneath the maximum depth of the anticipated excavations will only be negatively affected in so far as they will be unavailable for scientific study for the life expectancy of the infrastructural elements that comprise the project.

This study has identified that of the geological units that underlie the project area only the Gordonia Formation is potentially fossiliferous and may be negatively impacted. **No fossil materials were identified within the environs of Kheis Solar Park 1, Kheis Solar Park 2 or Kheis Solar Park 3**. However, the presence of fossil assemblages is documented within sediments coeval with the Gordonia Formation elsewhere within the Northern Cape Province and these have provided valuable insights into the paleoclimate and paleoecology of the region.

There is a potential for negative impact on the palaeontological heritage of the project area throughout most of Solar Park 2 the eastern portion of Solar Park 1 due to the extensive coverage of thick deposits of the Gordonia Formation in those locations. The Gordonia Formation is present within Solar Park 3, but only as a thin veneer of reworked sand. The potential risk for any negative impact on the palaeontological heritage in Solar Parks 1 and 2 is categorised as improbable due to the general scarcity of fossils in the unit and as no fossil materials were located within the project area. The potential risk of any negative impact within Solar Park 3 is also categorised as improbable, but is markedly less likely that in Solar Parks 1 and 2 due to the absence of substantial thicknesses of Gordonia Formation sands in that project area. However, the fossils that may be anticipated to be present within the Gordonia Formation are potentially highly significant to the cultural and scientific heritage of South Africa. As such, the risk of a negative impact is improbable, but the significance of any negative impact on the fossil assemblages could potentially be high. Any damage that occurs to such fossil material during the excavation and construction phase of the project would be permanent and irreversible.

The potential negative impact to the palaeontological heritage of the area can be substantially mitigated by the implementation of appropriate mitigation processes. A thorough and ongoing examination should be made of all excavations as they are being performed. Should any fossil materials be identified, the excavations should be halted and SAHRA informed of the discovery. Should scientifically or culturally significant fossil material exist within the project area any negative impact upon it could be mitigated by its excavation (under permit from SAHRA) by a palaeontologist and the resultant fossil material being lodged with an appropriately permitted institution. In the event that an excavation is impossible or inappropriate the fossil or fossil locality could be protected and the site of any planned construction moved.

A potential positive outcome of these mitigation protocols could be that fossil materials become available for scientific study that would otherwise have been hidden within or beneath the regolith. Should such new palaeontological material be located as a result of this site investigation this could prove to have a positive effect on the understanding of the fossil record of South Africa and positively affect the palaeontological heritage of the country.

The possible impacts resulting from Solar Parks 1-3 proposed projects have been assessed individually and found to be identical when compared against a set of standardised criteria (Appendix A). The relative weightings of any impacts upon the palaeontological heritage of the three Solar Park projects, as measured against the various evaluation criteria, is presented in Table 1.

Nature: Destruction, damage and loss of provenance of fossil materials		
	Without Mitigation	**With Mitigation**
Extent:	Low (2)	Low (2)
Duration:	Permanent (5)	Permanent (5)
Magnitude:	High (10)	Minor (2)
Probability:	Improbable (1)	Improbable (1)
Significance:	**Low (17)**	**Low (8)**
Status:	Positive	Positive
Reversibility:	Impossible	Impossible
Irreplaceable loss of resources:	Low	Low
Can impacts be mitigated:	Yes	
Mitigation: All excavations must be inspected for fossil content. Should fossils be located the relevant exaction must be halted and SAHRA informed of the find. SAHRA may instruct that a palaeontologist should evaluate the fossil material and suggest appropriate protocols to either excavate or protect the fossil material.		
Cumulative impacts: None		
Residual impacts: Permanent loss of fossil heritage		

Table 1: Summary palaeontological heritage impact assessment table for the proposed Kheis Solar Park 1, Kheis Solar Park 2 and Kheis Solar Park 3.

The social benefits of the three projects known as Kheis Solar Parks 1-3 have been individually assessed and have been classified as beneficial, herein, as the projects aim to provide a renewable source of energy to the South Africa power grid. The power generation capacity of South Africa is presently under significant pressure. As such **this study has not identified any palaeontological reason to prejudice the progression of any of Kheis Solar Parks 1-3, subject to adequate mitigation programs suggested, herein, being put in place**.

14 REFERENCES

Bamford, M.K. and De Wit, M.C.J. (1993). Taxonomic description of fossil wood from Cainozoic Sak River terraces, near Brandvlei, Bushmanland, South Africa. *Palaeontologia africana*, 30, pp. 71-80.

Cornell, D.H., Thomas, R.J., Moen, H.F.G., Reid, D.L. Moore, J.M., and Gibson, R.L. (2006). *The Namaqua-Natal Province*. In Johnson, M.R., Anhaeusser, C.R. and Thomas, R.J. (eds) *The Geology of South Africa*, Johannesburg: Council for Geoscience, Pretoria: Geological Society of South Africa, pp. 325-379.

De Wit, M.C.J. (1990). Palaeoenvironmental interpretation of Tertiary sediments at Bosluispan, Namaqualand. *Palaeoecology of Africa and the Surrounding Islands*, 21, pp. 101-118.

Geological Survey of South Africa (1979). 1: 250 000 geological map series 2820 Upington.

Kent, L.E. and Gribnitz, K.H. (1985). Freshwater shell deposits in the northwestern Cape Province: further evidence for a widespread wet phase during the Late Pleistocene in Southern Africa. South African Journal of Science, 61, pp. 361-370.

Macey, P.H., Siegfried, H.P., Minnaar, H., Almond, J. And Botha, P.M.W. (2011). The geology of the Loerisfontein Area. Explanation of 1: 250 000 Geology Sheet 3018. Council for Geoscience, 139 pp.

Moen, H.F.G. (1980, Unpublished). *Petrology and geological setting of the Wilgenhoutsdrif Formation, northern Cape Province*. M.Sc thesis, University of the Orange Free State, Bloemfontein, 287 pp.

Moen, H.F.G. (2007). *The geology of the Upington area*. Explanation: Sheet 2820 Scale 1: 250 000. Council for Geoscience. 160 pp.

Moore, A.E. and Dingle, R.V. (1998). Evidence of fluvial sediment transport of Kalahari sands in central Botswana. *South African Journal of Geology*, 101, pp: 143-153.

Mucina, L. and Rutherford, M.C. (Eds) 2006. The vegetation of South Africa, Lesotho and Swaziland. *Strelizia* 19. South African National Biodiversity Institute, Pretoria.

Partridge, T.S., Botha, G.A., and Haddin, I.G. (2006). *Cenozoic deposits of the interior*. In Johnson, M.R., Anhaeusser, C.R. and Thomas, R.J. (eds) *The Geology of South Africa*, Johannesburg: Council for Geoscience, Pretoria: Geological Society of South Africa, pp. 585-604.

Republic of South Africa (1998). National Environmental Management Act (No 107 of 1998). Pretoria: The Government Printer.

Republic of South Africa (1999). National Heritage Resources Act (No 25 of 1999). Pretoria: the Government Printer.

Senut, B. and Pickford, M. (1995). Fossil eggs and Cenozoic continental biostratigraphy of Namibia. Palaeontologia africana, 32, pp. 33-37.

Senut, B., Pickford, M., Ward, J., De Wit, M., Spaggiari., R. and Morales, J. (1996). Biochronology of the Cainozoic sediments at Bosluis Pan, Northern Cape Province, South Africa. South African Journal of Science, 92, pp. 249-251.

Dr B.D. Millsteed

12th February 2014

Appendix A

Standard Conventions for Assessing Impacts

Assessment of Impacts

Direct, indirect and cumulative impacts of the issues identified as a result of this study have been assessed in terms of the following criteria:

- The **nature**, which shall include a description of what causes the effect, what will be affected and how it will be affected.
- The **extent**, wherein it will be indicated whether the impact will be local (limited to the immediate area or site of development) or regional, and a value between 1 and 5 will be assigned as appropriate (with 1 being low and 5 being high):
- The **duration**, wherein it will be indicated whether:
  - the lifetime of the impact will be of a very short duration (0–1 years) – assigned a score of 1;
  - the lifetime of the impact will be of a short duration (2-5 years) - assigned a score of 2;
  - medium-term (5–15 years) – assigned a score of 3;
  - long term (> 15 years) - assigned a score of 4; or
  - permanent - assigned a score of 5;
- The **magnitude**, quantified on a scale from 0-10, where 0 is small and will have no effect on the environment, 2 is minor and will not result in an impact on processes, 4 is low and will cause a slight impact on processes, 6 is moderate and will result in processes continuing but in a modified way, 8 is high (processes are altered to the extent that they temporarily cease), and 10 is very high and results in complete destruction of patterns and permanent cessation of processes.
- The **probability** *of occurrence*, which shall describe the likelihood of the impact actually occurring. Probability will be estimated on a scale of 1–5, where 1 is very improbable (probably will not happen), 2 is improbable (some possibility, but low likelihood), 3 is probable (distinct possibility), 4 is highly probable (most likely) and 5 is definite (impact will occur regardless of any prevention measures).
- the **significance**, which shall be determined through a synthesis of the characteristics described above and can be assessed as low, medium or high; and
- the **status**, which will be described as either positive, negative or neutral.
- the degree to which the impact can be reversed.
- the degree to which the impact may cause irreplaceable loss of resources.
- the *degree* to which the impact can be *mitigated.*

The **significance** is calculated by combining the criteria in the following formula:

S=(E+D+M)P

Where

S = Significance weighting

E = Extent

D = Duration

M = Magnitude

P = Probability

The **significance weightings** for each potential impact are as follows:

- < 30 points: Low (i.e. where this impact would not have a direct influence on the decision to develop in the area),
- 30-60 points: Medium (i.e. where the impact could influence the decision to develop in the area unless it is effectively mitigated),
- > 60 points: High (i.e. where the impact must have an influence on the decision process to develop in the area).