Appendix D

SPECIALIST REPORTS

JAKHALS VALLEY
(SUTHERLAND)

BIODIVERSITY IMPACT ASSESSMENT REPORT
FOR A PROPOSED PHOTOVOLTAIC ENERGY FACILITY

PREPARED FOR THE ENVIRONMENTAL EVALUATION UNIT (UCT)

JULY 2011

CONSERVATION MANAGEMENT SERVICES – KEN COETZEE
4 CHESTNUT STREET, HEATHER PARK
GEORGE, 6529
TEL / FAX: 044 – 8708472

CONTENTS

1. INTRODUCTION AND PROJECT INFORMATION

1.1 INTRODUCTION

Ken Coetzee of *Conservation Management Services* was appointed on 06-05-2011 by Ms Sandra Rippon of the Environmental Evaluation Unit (UCT) on behalf of her client, INCA Sutherland Solar (Pty) Ltd, to carry out a basic biodiversity sensitivity analysis of the Jakhals Valley site near Sutherland for which a solar energy facility has been proposed. (See Figure 1).

The brief was to carry out a biodiversity study of the site to determine whether the proposed solar development will have a negative impact on the local biodiversity, particularly the more sensitive and rare species, and to propose mitigatory measures, if necessary.

The layout detail of the proposed development area was provided with the affected area clearly marked as shown in Figure 2.

Fieldwork was carried out between the 24th and 27th of May 2011. The combined biodiversity approach for field evaluation is especially valuable because of the importance of vegetation type in the determination of fauna habitat characteristics.

1.2 DECLARATION OF INDEPENDENCE AND COMPETENCY

I hereby declare that I, Ken Coetzee trading as Conservation Management Services, comply with all the conditions of PWC: DA&DP for a person appointed in terms of the NEMA EIA Regulations to compile a specialist report, viz:

- I am independent;
- Have the required expertise, including knowledge of the NEMA, the EIA Regulations and any guidelines that have relevance to the proposed activity and specialist input or study;
- Perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant;
- Comply with NEMA, the EIA Regulations and all other applicable legislation;
- Disclose to the applicant, EAP and the Department all material information in the possession of the person that reasonably has or may have the potential of influencing –
  - (i) any decision to be taken with respect to the application by the competent authority in terms of these Regulations; or
  - (ii) the objectivity of any report, plan or document to be prepared by the person in terms of these Regulations for submission to the competent authority;
- Ensure EIA best practice and clear communication on the methodologies used, and the assumptions, uncertainties and gaps in knowledge; and
- Adhere to the National Environmental Management principles contained in Section 2 of NEMA and the general objectives of Integrated Environmental management contained in Section 23 of NEMA.

1.

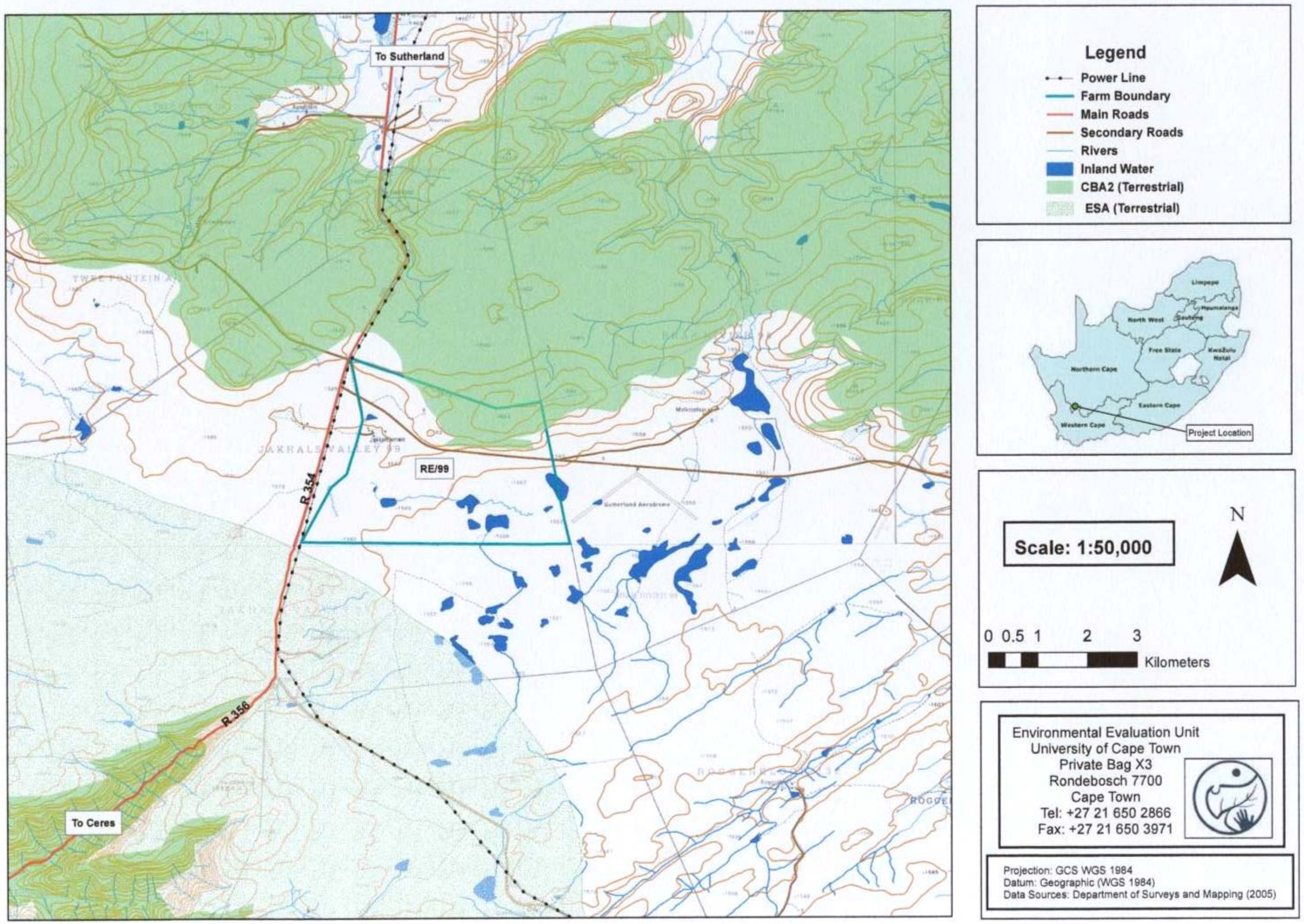


Figure 1: Sutherland Solar Facility Proposed Site

2.

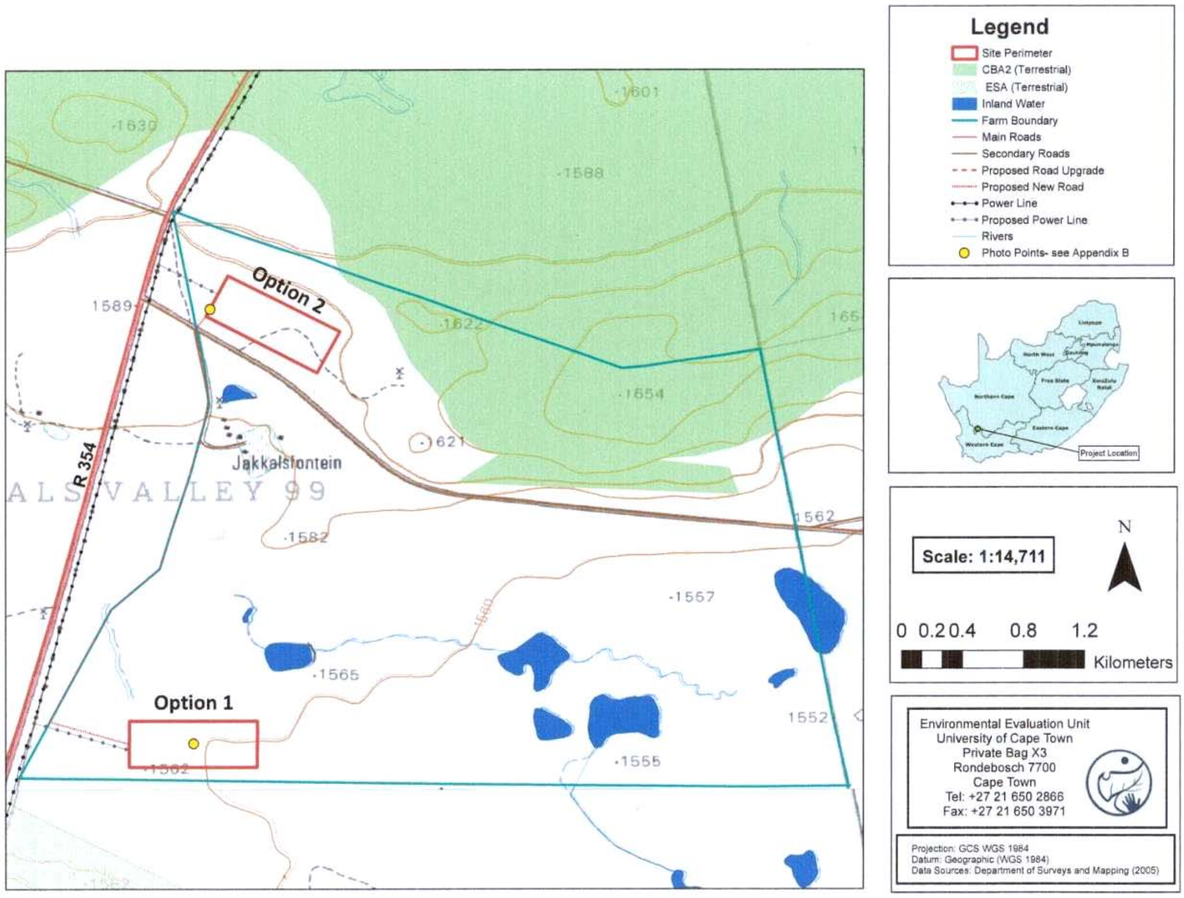


FIGURE 2: Solar Facility Proposed Site Options

2. PROJECT INFORMATION

2.1 LEGISLATIVE FRAMEWORK

The national legislation protecting environmental and biodiversity resources include the following, which ensure the protection of natural systems, ecological processes and biotic diversity in the natural environment:

- Environmental Conservation Act (Act 73 of 1989).
- National Environmental Management Act, 1998 (Act 107) (NEMA).
- National Environmental Management Biodiversity Act, 2004 (Act 10 of 2004) (NEMBA).

It has been ensured in this report that the provisions of this legislation have been considered in terms of the project proposal and the mitigation of potential impacts on both the vertebrate fauna and its habitats.

2.2 METHODOLOGY AND APPROACH

STUDY AREA: The study area on the Jakhals Valley consists of two separate study sites, the northern study site and the southern study site as shown Figure 2.

SITE VISITS: The study area was visited on 25 and 26 May 2011 to collect the biophysical information required for the biodiversity impact report. A photographic record was also made of the relevant habitat aspects.

STUDY APPROACH: In order to determine biodiversity sensitivity to negative impact, it was necessary, first to determine what vegetation and vertebrate fauna potentially occur on the property. As it was not possible to locate all of the fauna for such a survey, use was made of the published information to determine geographical distribution and the habitat requirements for all of the vertebrates likely to occur in the general study area and surrounds. This information was augmented with personal knowledge of the Karoo habitats and the vertebrates typical in them, as well as a detailed investigation of the study area habitats. Plant species were identified on both the study sites and a collection was made of the species not known and submitted to Karoo botanical expert, Prof Sue Milton, for identification. A plant checklist per study site was then drawn up.

Vertebrate checklists in which occurrence per species were recorded as either confirmed, likely, possible or unlikely were drawn up. From these checklists, the Red Data listed species were identified and further used to determine overall habitat sensitivity.

A list of potential impacts was then identified in terms of the observations made in the study area and the probability of occurrence of the Red Data Book listed vertebrate species in the study area. The potential impacts were then assessed in terms of their severity and significance and mitigatory measures were proposed.

LIMITATIONS: The occurrence of vertebrate fauna is predicted by means of the described method. There is no other way in which to produce accurate occurrence data other than by means of long term detailed collecting and inventorizing of the fauna on site. Similarly, there is no more accurate rapid method for verifying the occurrence of the Red Data listed species.

The assumption is that if the habitat is suitable and the geographic range of a particular species correlates with the study area, then that species is likely to occur.

A degree of credibility is given to these predictions by the extensive personal knowledge of the author of both Karoo habitats and the fauna that occur in them.

A further limitation is that it was not possible to make a complete record of all of the plants that occur on both of the study sites. Most, if not all of the larger and smaller plants were located, but it was not possible at the time of the fieldwork to list the geophytes. Only two were identified, but there are certainly many species that were underground and without any above-ground leaves or flowers.

3. DESCRIPTION OF THE STUDY AREA

3.1 LOCALITY OF THE STUDY AREA

The locality of the study area with its two study sites on the farm Jakhals Valley is shown in Figure 1. The study area is approximately 10 km due south of Sutherland and is located next to the R354 on the eastern side of the road.

3.2 GEOLOGY AND SOILS

The lithology of the study area, inclusive of both study sites, consists of mudstone, sandstone and thin cherty beds of the Abrahamskraal Formation which is part of the Beaufort Group of Rocks.

There is some dolerite intrusion at the northern and eastern edges of the northern study site. The soils of the two study sites are derived from the mudstones, siltstones and sandstones. The sandy soils at the northern study site are relatively deep, while at the southern study site, clayey silt soil overlies sheetrock over part of the site (western part), while in the eastern part, the substrates are deep and sandy with rocky outcrops of sandstone.

3.3 VEGETATION

The vegetation of the study area lies within a transition zone of the Succulent Karoo Biome (to the north) and the Fynbos Biome (to the south). The transition is a consequence by die escarpment edge, a short distance to the south the dominant vegetation type is Roggeveld Shale Renosterveld, a subunit of Shale Renosterveld of the Fynbos Biome (Mucina & Rutherford, 2006).

Within the Renosterveld are plant elements that are typical of the Roggeveld Karoo which are part of the Trans-Escarpment Succulent Karoo of the Succulent Karoo Biome.

The study area consists of two different sites, each with its own differences in plant composition, which is more due to the underlying physiography and grazing history than any other factor. The sites are described separately as follows:

3.3.1 NORTHERN SITE

The northern study site lies on a broad, flat, sandy valley which drains to the south-east. It is bounded to the east by a low stony ridge to the north-east. (See Figure 3).

<u>FIGURE 3</u>: The northern study site clearly showing the relatively homogenous nature of the habitat.

The vegetation can be simply described as homogenous dwarf shrubland for the entire study area. (See Plates 1 & 2). Typical plant species are:

Aloinopsis rosulata
Asparagus capensis
Bulbine torta
Chrysocoma ciliata
Dimorphotheca cuneata
Elytropappus rhinocerotis
Erodium cicutarium
Euphorbia clavarioides
Euryops imbricatus
Euryops lateriflorus
Gnidia sp
Karoochloa purpurea
Monsonia sp
Osteopsermum leptolobum
Oxalis comutata
Pentzia punctata
Pteronia mucronata
Pteronia sordida
Rosenia glandulosa
Scirpoides dioecus
Selago sp.

<u>PLATES 1 & 2</u>: The relatively homogenous dwarf shrubland of the northern study site.

3.3.2 SOUTHERN SITE

The southern study site also lies in a broad, shallow valley bounded to the north and south by low, rocky outcrops. (See Plate 3). In the western part underlying areas of sheetrock are exposed and extend upwards to the south (see Plate 4), and in the eastern part there are small stony outcrops within the flat valley floor. Pan-like formations are prevalent (see Plate 5), probably due to underlying impervious sub-surfaces and in some areas there are indications of more permanent moisture sites (see Plate 6), presumably where water persists as it is unable to drain away. (See Figure 4). Typical plant species include the following:

Aloinopsis rosulata
Asparagus capensis
Bulbine torta
Chrysocoma ciliata
Cleretum herrei
Cleretum pappulosum
Dimor photheca cuneata
Diospyros austro-africana
Drimia sp
Elytropappus rhinocerotis
Eriocepahlus africanus
Eriocepahlus eriocoides
Eriocephalus spinescens
Euryops annae
Euryops imbricatus
Euryops lateriflorus
Euryops subcarnosus
Gnaphalium sp
Karoochloa purpurea
Lycium cinereum
Melolobium candicans
Monsonia sp
Moraea serpentine
Nenax michrophylla
Osterospermum leptolobum
Othonna auriculifolia
Oxalis comutata
Pentaschistis sp
Pteronia erythrochaeta
Pteronia mucronata
Pteronia sordida
Rosenia glanulosa
Rosenia humilus
Rosenia oppositifolia
Scirpoides dioecus
Selago albida
Stomatium resedolens
Zygophyllum spinosum.

<u>PLATE 3</u>: Rocky outcrop on the northern side of the southern study site.

<u>PLATE 4</u>: Exposed areas of sheet rock underlie the western part of the southern study site. These sites are the habitat of *Stomatium resedolens*.

<u>PLATE 5</u>: Pans are prevalent at the western end of the southern study site.

<u>PLATE 6</u>: Small wetland area with a dense cover of the sedge *Scirpoides dioecus*.

3.3.3 HABITAT CONDITION

Both sites are part of a commercial sheep farm and are consequently in a typically "grazed" condition. The main difference between the two sites is that the northern site is in a historically poor condition due to many decades of over-utilization with livestock.

NORTHERN SITE:

The site is more "karroid" than "renosterveld" in its general plant cover make-up. This site has a low plant diversity, probably die to the continuous over-utilization of the palatable dwarf shrubs. Many of the dwarf shrubs are on pedestals (see Plate 7), indicating topsoil loss as a result of the reduction of the plant cover through over-utilization with livestock. Small active rills and gullies have formed in some areas, indicating accelerated soil erosion conditions. (See Plate 8). Due to the loss of topsoil, pedestalling and minor gullies, advanced aridification of the soil has occurred, which has resulted in the death of some shrubs. Patches of bare, exposed soil are typical in between the shrubs. There is little or no living soil crust and the prevalent coloniser of these bare patches is the tiny alien plant *Erodium cicutarium* (horlosiewysterbos). (See Plate 9). The only interesting plant found on this site was the "cushion" Euphorbia (*Euphorbia clavarioides*) which is "unique but widespread" (Court, 1981).

PLATE 7: Dwarf shrubs on pedestals due to the loss of topsoil.

PLATE 8: Rills and small gullies forming due to a reduced plant cover.

PLATE 9: The widespread alien pioneer *Erodium cicutarium*.

SOUTHERN SITE:

Signs of sheep grazing are clearly visible, although not to the extent that it will modify the habitat as was the case at the northern site. This are is clearly in a much better condition in terms of grazing management history.

The southern site also has greater plant diversity due to the variety of micro-habitat sites including rock sheets (see Plate 10), stone outcrops (see Plate 11), “wetland”, seasonal silty pans and deep sandy deposits. (See Figure 4).

The ground is well covered in most areas, by both plants and organic mulch and no soil erosion was observed. Only the pan areas are devoid of vegetation, possible due to accumulations of salts of other minerals. One small succulent plant (*Stomatium resedolens*) that was collected from the exposed rock sheet areas is reported to be “quite rare”. (J Vlok, pers comm 29/06/2011).

PLATES 10 & 11: Rocky sheets and rocky outcrops introduce plant habitat variability.

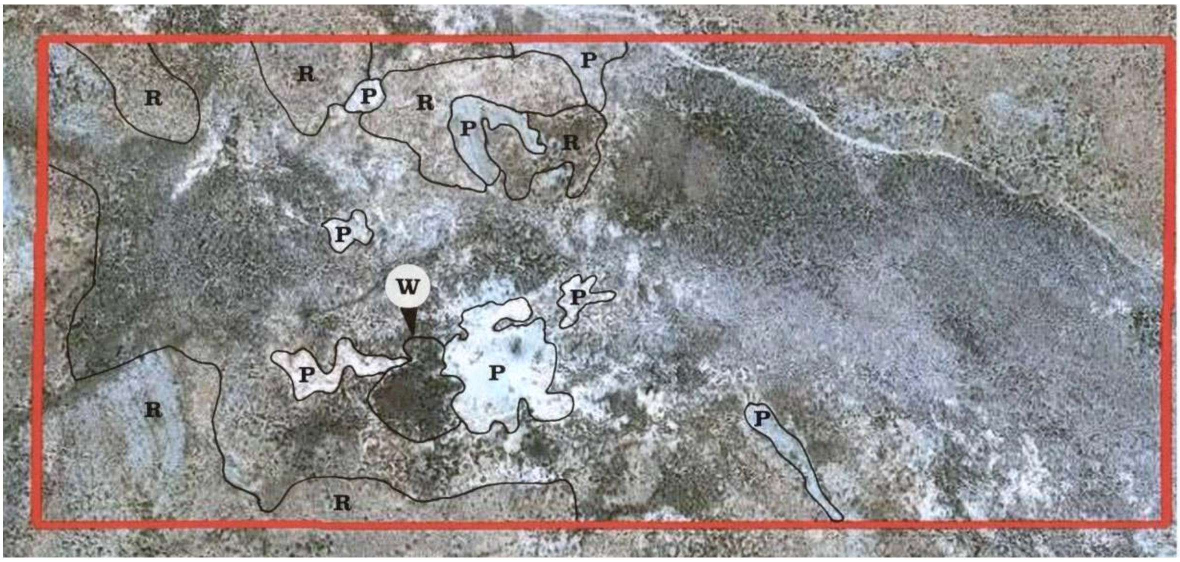


FIGURE 4: The southern study site showing broad physiographic habitat types.
W = wetland / P = Pans / R = Rock sheets, exposed rock, rocky ridges.

3.4 VEGETATION SENSITIVITY

The study area lies within the Hantam-Roggeveld Centre (HRC) of plant endemism (Van Wyk & Smith, 2001). These authors state that "very little detailed work has been carried out on the vegetation of the HRC of endemism", except for the Bokkeveld plateau and the Niewoudtville area. Very high endemic diversity has been recorded for the *Hesperantha, Bulbinella, Romulea, Liliaceae, Asteraceae, Fabaceae, Scrophulariaceae* and *Poaceae*, but this endemism and diversity is mostly recorded from the western part of the HRC (Niewoudtville/Calvinia).

The grass *Secale africanum* which is thought to have once been common in the HRC is now at the brink of extinction (Van Wyk & Smith, 2001). The two study areas were carefully searched for grasses and only the very small tufted *Karoochloa* and *Pentaschistis* species were found. *Secale* may occur in the general area, but it does not occur on either of the study sites.

Very few succulent plants were found on the two sites and Van Wyk & Smith (2001) state that the HRC is relatively poor in *Mesembryanthemaceae* diversity and endemism when compared to the Succulent Karoo below the escarpment.

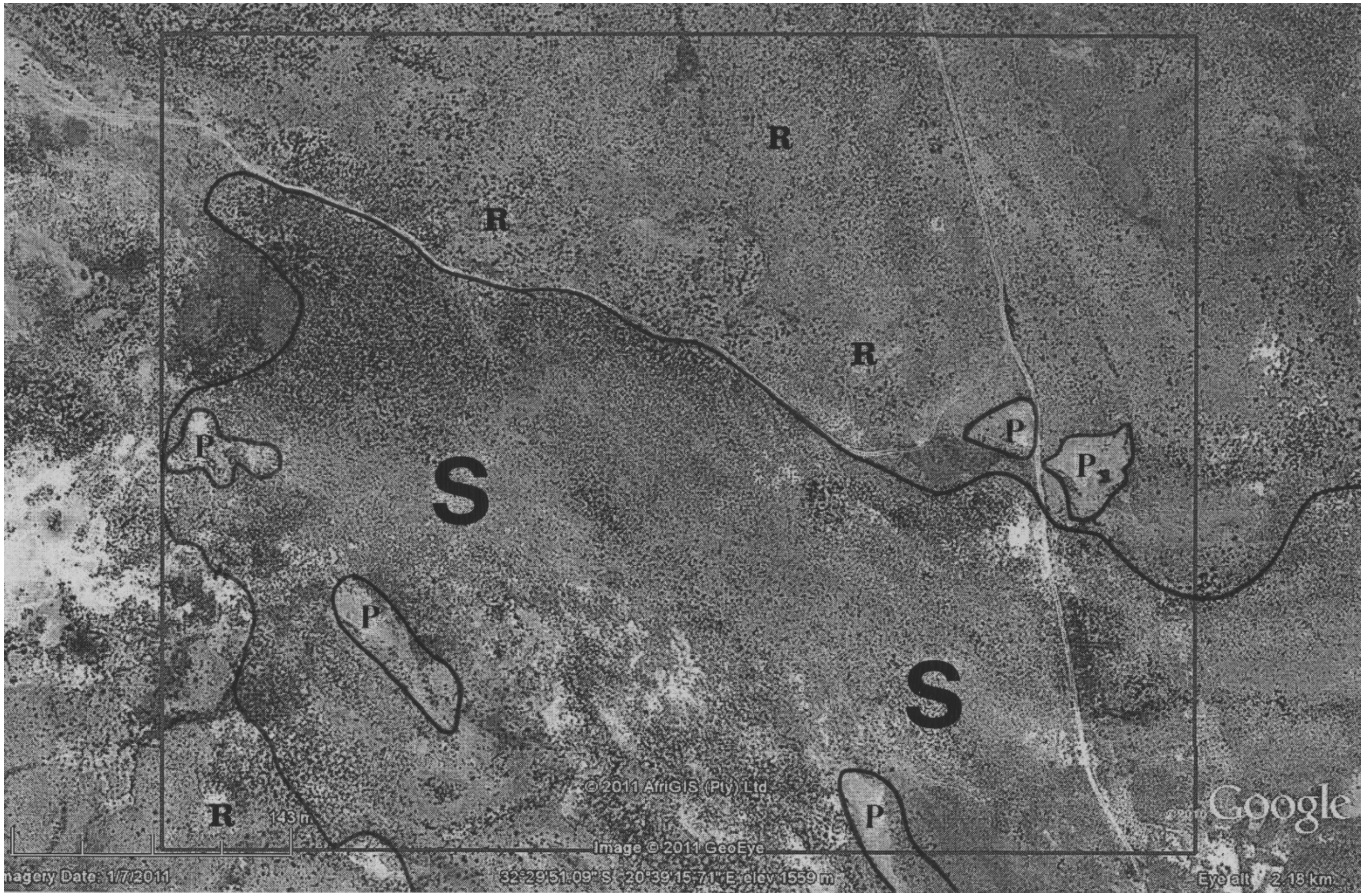
The most prevalent succulent plant found (*Aloinopsis rosulata*) is not a Red Data Book listed species (Hilton-Taylor, 1996). *Stomatium resedolens* is fairly rare and *Euphorbia clavarioides* is unique but neither species is listed in the South African Red Data book of plants (Hilton-Taylor, 1996). (See Plate 12).

Based on the habitat description and the prevalent plant species found on the two study sites, the sites are not considered to be particularly sensitive.

The northern site is in a relatively poor condition and from a plant biodiversity point of view, is the best option for the intended solar power facility. The southern site contains a diversity of plant habitats with a consequent higher diversity of plants. The poor drainage in parts of the site contributes to its biological uniqueness, making it more sensitive to disturbance.

The more sensitive plant habitats at the southern study site consist of wetland, pans, rock sheets and exposed rock and rocky ridges. These habitats should all be avoided, if possible, and the development restricted mostly to the areas of deep sand deposits. This would require a shift of the whole development envelope a little to the east and centered on the sandy plain area. (See Figure 5). By shifting the development envelope to the east, a greater area of the less sensitive deeper sandy deposits becomes available for the development and the more sensitive rocky, pan and wetland habitats can be avoided and conserved. It would be advisable for an ecologist/botanist to verify the final positioning of the development footprint prior to commencement with construction.

It is not possible to grade the more sensitive habitats, each has its own biodiversity appeal - it would be better practice to simply avoid any permanent negative impact on either of them.



<u>FIGURE 5</u>: REVISED DEVELOPMENT SITE: OPTION 1
R = Rock sheets, exposed rock, rocky ridges.
P = Pans.
S = Sandy area suitable for solar development.

<u>PLATE 12</u>: Small *Stomatium resedolens* that is restricted to rock sheet sites.

3.5 VERTEBRATE FAUNA: OCCURRENCE AND SENSITIVITY

The occurrence of vertebrates was assessed by comparing the known distribution of the mammals, amphibians, reptiles and birds with the locality of the study sites. Species that were likely to occur, or that possibly could occur within the study sites were then evaluated in terms of their sensitivity, using the latest available Red Data Book per group.

3.5.1 MAMMALS

The mammals that are likely to occur on the two study sites are the ubiquitous species that occur throughout most of the Karoo. On-site positive identifications were made for some of these species, including dassie (*Procavia capensis*) (see Plate 13), Cape hare (*Lepus capensis*), African wildcat (*Felis silvestris*), spring hare (*Pedetes capensis*), vlei rat (*Ottomys irrorattus*) and suricate (*Suricata suricata*).

Rocky outcrops along the edges of both study sites provide cover habitat for a wide variety of small mammals and deep sandy substrates provide opportunity for a variety of subterranean species.

<u>PLATE 13</u>: Rock outcrops occupied by "digging" dassies.

Table 1 provides a list of the Red Data listed species likely, and possibly occurring. The limited scale of the actual footprint of the proposed solar panel installation is unlikely to permanently impact local populations of any of the listed species, all of which are relatively widespread. The northern study site does not contain any unique or special habitat. The entire site is on deep sand with a low dwarf shrub cover.

The riverine rabbit is unlikely to occur on the study area due to the complete absence of its preferred habitat type (Coetzee, 1994; Duthie, 1989). The honey badger is unlikely to occur on either study site, as it would generally be restricted to more densely vegetated parts of the area where there is more food. The two study sites are also too small to sustainably support a population of badgers. Leseur's wing-gland bat will not be affected by the solar panel arrays and nor will its rock crevice roosting sites be negatively impacted by the development.

The other listed species are listed as 'data deficient' and are thus not particularly vulnerable or threatened. Suitable habitat for these species beyond the proposed development area is also extensive.

The proposed development is thus unlikely to have a lasting negative impact on any of the more sensitive mammals.

COMMON NAME	SCIENTIFIC NAME	OCCUR-RENCE	RED DATA CLASSIFICATION*
Honey badger	*Mellivora capensis*	Possible	N T
African weasel	*Poeciloalbinucha*	Possible	D D
Leseur's wing-gland bat	*Cistugo leseuri*	Likely	N T
Cape golden mole	*Chrysochloris asiatica*	Likely	D D
Reddish-grey musk shrew	*Crocidura cyanea*	Likely	D D
Lesser dwarf shrew	*Suncus varilla*	Likely	D D
Riverine rabbit	*Bunolagus monticularis*	Unlikely	C E

TABLE 1: Red Data Book listed mammals for which known distributions and the location of the study sites overlap (Friedman & Daly, 2004).
***Red Data Book classifications:**
N T - Near Threatened
D D - Data Deficient
C E - Critically Endangered.

3.5.2 AMPHIBIANS

Neither of the study sites contains suitable habitat for sustained occupation by water-dependent species. The common Karoo toad (*Bufo gariepensis*) and the Cape sand frog (*Tomopterna delalandii*) are exceptions and occur throughout the general area (Minter et al, 2004).

Only one Red Data listed frog species, the Karoo caco (*Cacosternum karooicum*) could possible occur.

COMMON NAME	SCIENTIFIC NAME	OCCUR-RENCE	RED DATA CLASSIFICATION*
Karoo caco	*Cacospernum karooicum*	Possible	D D

<u>TABLE 2</u>: Red Data Book listed amphibian species for which known distribution and the location of the study sites overlap (Minter et al, 2004).

Little is known about the Karoo caco and its known distribution is actually well to the west of Sutherland. Given that there are not really any permanent or even seasonal water bodies on either of the study sites, it is unlikely that the Karoo caco would be negatively impacted by the proposed development. Occurrence on the southern study site is more likely than on the northern study site.

3.5.3 REPTILES

The rocky outcrops and stony hills of the general area are certainly the domain of a large variety of lizards, snakes and geckos. (See Plate 3). Of the listed species, Fisk's house snake and the Namaqua plated lizard occupy sandy Karooveld/Renosterveld while the armadillo girdled lizard is confined to rocky outcrops where it takes refuge in cracks between the rocks.

Populations of the Fisk's house snake and the Namaqua plated lizard that possibly occur within the proposed development area will be affected by the development. Extensive habitat of the same kind, however, occurs beyond the affected area at both sites.

Due to the limited, localised footprint of the development, it is considered unlikely that populations of either species in the area will be negatively impacted by the solar power development. The armadillo girdled lizard will remain completely unaffected in its rocky outcrop habitat at the edges of both the study areas.

COMMON NAME	SCIENTIFIC NAME	OCCUR-RENCE	RED DATA CLASSIFICATION*
Armadillo girdled lizard	*Codylus cataphractus*	Possible	V
Fisk's house snake	*Lamprophis fiskii*	Possible	V
Namaqua plated lizard	*Gerrhosaurus typicus*	Likely	NT

<u>TABLE 3</u>: Red Data Book listed reptiles for which known distribution and the location of the study sites overlap (Branch, 1998; Alexander & Marais, 2007).

3.5.4 BIRDS

The Karoo escarpment area supports a surprising diversity of bird species. A total of 170 species have been recorded at the Karoo National Park (Beaufort West) to the east of the study area. The diversity relates to habitat variety, particularly wooded kloofs in the escarpment edge. Barnes (1998) lists the Cedarberg-Koue Bokkeveld Complex (to the west) as an important bird area of the Western Cape, but does not include the general Sutherland area in his list of 25 important bird areas.

Bird diversity can be attributed to macro and micro habitat diversity. Both the study sites consist of relatively homogenous low shrubland with little variety in habitat. The southern site does contain additional rocky outcrops, rock sheets and a "wetland" area with sedges. The habitat of both study sites is open, arid, sparsely vegetated and impacted by sheep grazing.

Table 4 lists the sensitive bird species that may occur in the study area. For the martial eagle, Ludwig's bustard, secretary bird and the black harrier, the most important impact that could result from the development is the increased potential for collisions with associated power lines. As mitigation, these power lines must be fitted with "flappers" that increase the visibility of the power lines, so that the larger birds can easily avoid flying into them.

It is unlikely that the proposed development will impact any of the listed birds in any other way. The limited scale and compact nature of the installations will not be an obstruction or represent a significant loss of foraging habitat for any of the listed species, all of which are highly mobile and make use of extensive ranges in arid habitats.

Martial eagles are also threatened by electrocution when they nest on high tension power line pylons. Suitable measures should be installed to prevent electrocution when perching and nesting.

COMMON NAME	SCIENTIFIC NAME	OCCUR-RENCE	RED DATA CLASSIFICATION*
Martial eagle	*Polemaetus bellicosus*	Likely	V
Ludwig's bustard	*Neotis ludwigii*	Likely	V
Black harrier	*Circus maurus*	Likely	N T
Secretary birds	*Saggitarius serpentarius*	Possible	N T

<u>TABLE 4</u>: Red Data Book listed avian species for which known distribution and the location of the study sites overlap (Barnes, 2000).

4. BIODIVERSITY SENSITIVITY: COMPARISON OF THE TWO ALTERNATIVES FOR DEVELOPMENT

In terms of the vegetation, it has been shown that the southern study site contains a higher diversity of plant species than the northern study site. It also contains a number of different plant habitats, resulting in a wider range of plant types. (See Table 5).

Physically, the northern study site was found to be in a relatively poor condition with the loss of topsoil and active soil erosion occurring due to a reduction in plant cover as a result of historical continuous overgrazing.

In terms of the fauna, the southern study site was found to contain more diverse animal habitat options, with small rocky outcrops providing fissures between the rocks, burrowing opportunities under the rocks and a higher diversity of plant cover types. (See Table 5). The micro-habitats at the northern study site were comparatively less diverse and more homogenous. Substrate differed little and soil surface conditions are degraded. (See able 5).

From a vegetation and vertebrate animal point of view, the southern study site is distinctly more diverse and contains more potential for animal micro-habitats.

It can thus be summarised that the northern study site is better suited, from a biodiversity point of view, for the proposed solar power generation installation.

There is, however, no need to exclude the option to establish the solar power facility on the southern site. It does contain more diverse plant habitats, but with a shift of the development envelope a short distance to the east, the slightly more sensitive rock sheet, wetland and rock outcrops can be completely avoided and thus preserved intact.

HABITAT CRITERIA	NORTHERN STUDY SITE	SOUTHERN STUDY SITE
Plant species number	22	38
Vegetation type diversity	-Uniform dwarf shrubland	-Dwarf shrubland -Rocky outcrop shrubs -Rock sheet plants -Seasonal pan plants
Vegetation condition	-Degraded, dominated by unpalatable plants	-Undegraded -Recruiting
Physical condition	-Plants on pedestals -Loss of topsoil -Rills and gullies active	-Intact soil surfaces -Unvegetated pans
Diversity of animal habitat	-Sandy dwarf shrubveld	-Dwarf shrubveld -Rocky outcrops -Rock sheet outcrops -Open pans -"Wetland" -Medium height shrubland
Animal cover conditions	-Sparse -Homogenous	-Dense -Varied
Substrates	-Deep sandy	-Underlain by rock -Isolated rock outcrops -Deep sandy
Drainage	-Well drained	-Poorly drained

TABLE 5: Summary of plant and habitat diversity, condition and animal habitat conditions for both of the study sites.

5. CUMULATIVE IMPACTS

The INCA Energy solar energy facility proposed for Jakhals Valley was compared to the closest similar installations. These facilities are as follows:

A. Suurplaat REF (Savannah S A & Moyeng Energy)
50 km south-east of Sutherland.

B. Roggeveld REF (ERM & G7 Renewables)
45 km south of Sutherland.

C. Sutherland REF (ERM & Mainstream)
25 km south-east of Sutherland.

Of the three renewable energy facilities, only the Sutherland REF at 25 km south-east of Sutherland is of significance. The other two facilities are well below and beyond the escarpment and consequently are located within very different ecosystems to those on top of the escarpment.

The Sutherland REF is located on the escarpment at its edge 25 km to the south-east. It is estimated that 25 km is well beyond the range of dispersal for most of the study site biodiversity, with the possible exception of the three large birds listed. The cumulative loss of biodiversity and landscape function can be considered to be negligible with the intervening natural and untransformed landscape over 25 km. The minimal local footprint of the Jakhals Valley solar energy facility precludes any concern for impact on landscape connectivity.

6. IMPACT ASSESSMENT

The estimated impacts at both site options are given in Tables 1 and 2.

DESCRIPTION OF THE IMPACT	NATURE / STATUS	EXTENT	DURATION	INTENSITY	PROBABILITY	SIGNIFICANCE (WITHOUT MITIGATION)	MITIGATION	SIGNIFICANCE (WITH MITIGATION)
PLANNING AND DESIGN								
N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
CONSTRUCTION								
Unnecessary destruction of habitat	Negative	Local	Long-term	Medium	Probable	Medium	Establish minimum permanent footprint prior to construction	Medium
Damage to habitat may result in permanent landscape scars	Negative	Local	Long-term	Medium	Probable	Medium	Implement rehabilitation plan	Medium
OPERATION								
Risk of bird collision with power lines	Negative	Provincial	Long-term	Medium	Highly probable	Medium	Flappers to improve visibility of power lines	Medium
Cumulative impacts may result in ecosystem malfunction	Negative	District	Long-term	Medium	Improbable	Low	Distance prevents significant impact	Low
Shading by solar panels will result in death of plants & wind erosion	Negative	Local	Medium-term	Medium	Definite	Medium	Cover shaded area with wood chip mulch or crushed stone	Medium
Security fence will prevent animal movement	Negative	District	Long-term	Medium	Highly probable	Medium	Leave a 150mm gap in fence at ground level	Low
DECOMMISSIONING								
Decommissioning the site and removing the infra-structure may result in soil surfaces vulnerable to soil erosion	Negative	Local	Permanent	Medium	Probable	Medium	Implement basic soil erosion control measures prior to abandoning the site	Low

TABLE 1: Significance of biodiversity impacts - Northern Site.

DESCRIPTION OF THE IMPACT	NATURE / STATUS	EXTENT	DURATION	INTENSITY	PROBABILITY	SIGNIFICANCE (WITHOUT MITIGATION)	MITIGATION	SIGNIFICANCE (WITH MITIGATION)
PLANNING AND DESIGN								
N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
CONSTRUCTION								
Unnecessary destruction of habitat	Negative	Local	Long-term	Medium	Probable	Medium	Establish minimum permanent footprint prior to construction	Medium
Damage to habitat may result in permanent landscape scars	Negative	Local	Long-term	Medium	Probable	Medium	Implement rehabilitation plan	Medium
Solar panel installation will result in the loss of sensitive plant habitats	Negative	Local	Long-term	High	Highly probable	Medium	The whole solar development can be moved to the east to avoid damage to the more sensitive plants habitats	Low
OPERATION								
Risk of bird collision with power lines	Negative	Provincial	Long-term	Medium	Highly probable	Medium	Flappers to improve visibility of power lines	Medium
Cumulative impacts may result in ecosystem malfunction	Negative	District	Long-term	Medium	Improbable	Low	Distance prevents significant impact	Low
Shading by solar panels will result in death of plants & wind erosion	Negative	Local	Medium-term	Medium	Definite	Medium	Cover shaded area with wood chip mulch or crushed stone	Medium
Security fence will prevent animal movement	Negative	District	Long-term	Medium	Highly probable	Medium	Leave a 150mm gap in fence at ground level	Low
DECOMMISSIONING								
Decommissioning the site and removing the infrastructure may result in soil surfaces vulnerable to soil erosion	Negative	Local	Permanent	Medium	Probable	Medium	Implement basic soil erosion control measures prior to abandoning the site	Low

TABLE 2: Significance of biodiversity impacts - Southern Site.

7. CONCLUSION AND RECOMMENDATIONS

CONCLUSION:

While few potential negative impacts on biodiversity have been identified, the evaluation has shown that, from a biodiversity point of view, the northern study site is the marginally preferred site for the proposed solar energy facility development. Alternatively, if the southern study site is preferred in terms of other considerations (heritage, visual impact, etc), then it is important that the final positioning of the solar panel arrays is sensitive to the more special plant habitats described. This can be easily achieved by simply shifting the positions of the panels slightly to the east, with the help of a specialist ecologist/botanist, to avoid the more sensitive habitats.

The overall vegetation sensitivity is considered to be relatively low at both sites, but it is important to appreciate that the geophytes could not be listed at the time of the fieldwork.

The only fauna likely to be impacted by the proposed development and its infrastructure are the larger birds which may collide with the additional power lines and martial eagles which may be electrocuted when nesting on high tension pylons. Both impacts can be suitably mitigated using well known and tested methods that have been developed and implemented by Eskom.

RECOMMENDED MITIGATIONS:

The following mitigations are recommended for inclusion in the EMP for the solar energy facility:

i. Install visibility “flappers” on all new power lines that are associated with the solar energy facility in order to reduce bird collisions with the power lines. Implement existing Eskom standards for this mitigation.

ii. Install “safe” perch or nesting sites at or around the live electric sites on power line pylons so that large perching birds like eagles will not be electrocuted when perching or nesting on these parts of the pylons.

iii. Establish a minimum permanent footprint for the solar panel arrays, and access to them, prior to construction and restrict all construction activity to this minimum footprint area.

iv. Areas that are unavoidably, or temporarily, disturbed by construction and that are not a part of the permanent minimum footprint area must be rehabilitated using locally indigenous plant species.

v. Cover the entire area that will be “shaded out” by the solar panel arrays with either stone chips/gravel or a heavy grade of wood chip mulch to prevent wind erosion of the soil from under the panels.

vi. An Environmental Control Officer should be appointed to ensure that there is compliance with the recommended mitigations.

vii. Allow a 150mm gap at ground level under the security fence around the solar power installations so that small fauna can continue to disperse naturally.

viii. If the southern site is preferred for the development, it is recommended that the entire development be shifted a short distance to the east so that it is positioned over a sandy area of low plant diversity.

ix. For the southern site, it is recommended that a biodiversity specialist should assist with the final placement of the solar panel arrays.

8. REFERENCE LIST

Alexander, G & Marais, J. 2007. A guide to the Reptiles of Southern Africa. Struik Publishers, Cape Town.

Barnes, K N (ed) 1998. The Important Bird Areas of Southern Africa. BirdLife South Africa, Johannesburg.

Barnes, K N (ed) 2000. The Eskom Red Data Book of Birds of South Africa, Lesotho and Swaziland. BirdLife South Africa, Johannesburg.

Branch, W R. 1998. Field guide to snakes and other reptiles of Southern Africa. Struik Publishers, Cape Town.

Coetzee, K. 1994. The riverine rabbit *Bunolagus monticularis* and its habitat: Conservation implications of an unnaturally fragmented distribution. Unpublished M. Sc. dissertation, Saasveld School of Forestry, Port Elizabeth Technikon.

Court, D. 1981. Succulent Flora of Southern Africa. A A Balkema, Cape Town.

Duthie, A G. 1989. The ecology of the riverine rabbit (*Bunolagus monticularis)*. M.Sc. Thesis, University of Pretoria.

Friedman Y & Daly B. 2004. Red Data Book of the Mammals of South Africa: A Conservation Assessment: CBSG Southern Africa, Conservation Breeding Specialist Group (SSC/IUCN), Endangered Wildlife Trust. South Africa.

Hilton-Taylor, C. 1996. Red Data List of Southern African Plants. National Botanical Institute, Claremont.

Minter, L R; Burger, M; Harrison, J A; Braack, H H; Bishop, P J & Kloepfer, D., eds. 2004. Atlas and Red Data Book of the Frogs of South Africa, Lesotho and Swaziland. SI/MAB Series #9. Smithsonian Institute, Washington DC.

Mucina, L & Rutherford, M C. (eds) 2006. The Vegetation of South Africa, Lesotho and Swaziland. Strelitzia 19. South African National Biodiversity Institute, Pretoria.

Van Wyk, A E & Smith, G. 2001. Regions of Floristic Endemism in Southern Africa. Umdaus Press, Hatfield, South Africa.

Vlok, J H J. 29-06-2011. Pers comm regarding *Stomatium resedolens*. Regalis Environmental Services, Oudtshoorn.

HERITAGE IMPACT ASSESSMENT FOR THE PROPOSED PHOTOVOLTAIC SOLAR ENERGY FACILITY ON THE REMAINDER OF FARM JAKHALSVALLEY 99, SUTHERLAND MAGISTERIAL DISTRICT, WESTERN CAPE

(Assessment conducted under Section 38 (8) of the
National Heritage Resources Act (No. 25 of 1999) as part of an EIA)

Prepared for

Environmental Evaluation Unit
University of Cape Town, Private Bag X3, Rondebosch, 7701
Phone (021) 650 2866 Fax (021) 650 3791
Email: Sandra.Rippon@uct.ac.za

16 June 2011

Prepared by

Jayson Orton & Dave Halkett

Archaeology Contracts Office
Department of Archaeology
University of Cape Town
Private Bag
Rondebosch
7701

Phone (021) 650 2357
Fax (021) 650 2352
Email Jayson.Orton@uct.ac.za

EXECUTIVE SUMMARY

The UCT Archaeology Contracts Office was requested by the Environmental Evaluation Unit to assess the impacts to heritage resources that might occur as a result of a proposed solar energy facility to be constructed on the remainder of farm Jackhals Valley No. 99, some 10 km south of Sutherland, in the Sutherland Magisterial District. The proponent is wishing to construct a 10 MW photovoltaic solar energy facility which would occupy an area of approximately 20 hectares. A power line would link the facility to an existing power line that runs past the site along the R354. Two alternative locations have been chosen for assessment, although exact final footprints have yet to be decided.

A background survey of existing literature was conducted to provide a heritage context. The site was then visited by two archaeologists and inspected. Finds were photographed and GPS locations taken.

The two site options are both fairly uniform and consist of flat, sandy areas with low bushes. Ephemeral pans are frequent and the vegetation cover is predominantly below knee-height. The sites are currently used for small stock grazing.

A diverse selection of finds was made, but very few were actually located within the areas likely to be impacted. The finds include extensive remains pertaining to the Anglo-Boer War, several scatters of historic and pre-colonial artefacts, historic and pre-colonial walled sites, a rock art site and one rock shelter with abundant pre-colonial artefacts. The Anglo-Boer War sites are most significant in that they are unusually numerous and taken together represent a significant cultural landscape.

The Northern Site option will pose far more significant impacts to heritage resources, primarily in the form of visual impacts to the R354 scenic route and impacts to the Anglo-Boer War cultural landscape. The Southern Site is better shielded through natural topography and is generally far better suited to the proposed development.

Subject to the approval of the South African Heritage Resources Agency, it is recommended that the project be allowed to proceed but with the following site specific recommendations:

- Southern Site: No further assessments are suggested. However, the ECO should ensure that the historical ruin and associated artefacts are protected from damage during the construction phase of the project. This alternative is strongly favoured.

- Northern Site: Should this site be chosen then it is recommended that a Visual Impact Assessment be carried out to properly determine the significance of the impacts that would be experienced there. During construction the ECO would need to ensure that no historical artefacts are collected and removed from the site or its surroundings.

Contents

1. INTRODUCTION

The UCT Archaeology Contracts Office was requested by the Environmental Evaluation Unit to assess the impacts to heritage resources that might occur as a result of a proposed solar energy facility to be constructed on the remainder of farm Jackhals Valley No. 99, some 10 km south of Sutherland, in the Sutherland Magisterial District (Figure 1).

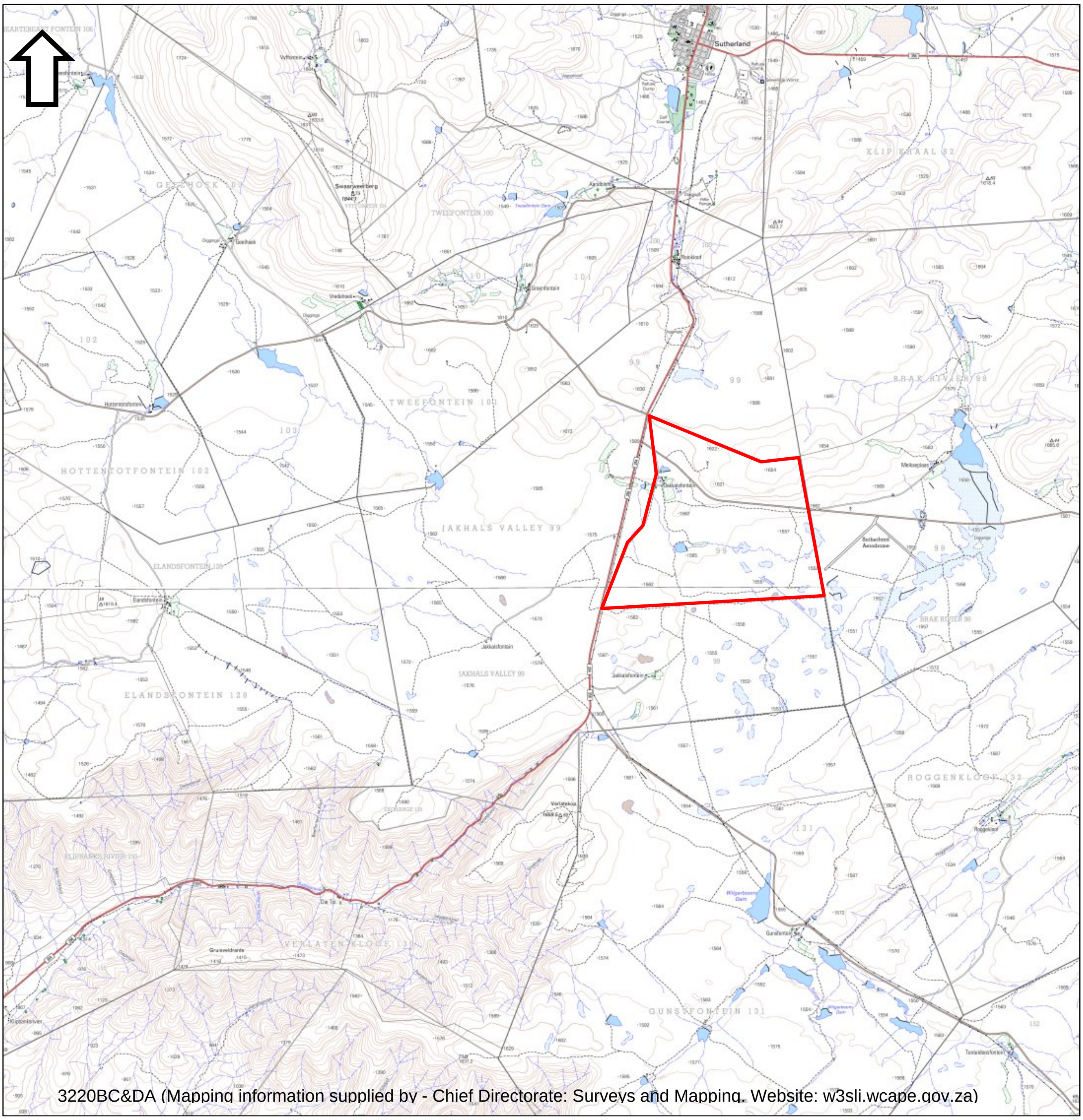


Figure 1: Map showing the location of the property in question (red polygon) relative to the town of Sutherland (in the far north of the map). The red road running alongside the farm and into Sutherland is the R354.

The proponent is wishing to construct a 10 MW photovoltaic solar energy facility which would occupy an area of approximately 20 hectares. Two alternative locations have been chosen for assessment, although exact final footprints have yet to be decided (Figure 2). These are referred to as the “Northern Site” and the “Southern Site” with the latter being the favoured alternative. The facility would need to be within approximately 1 km of the existing power line which runs along the main road (R354) to the west of the site.

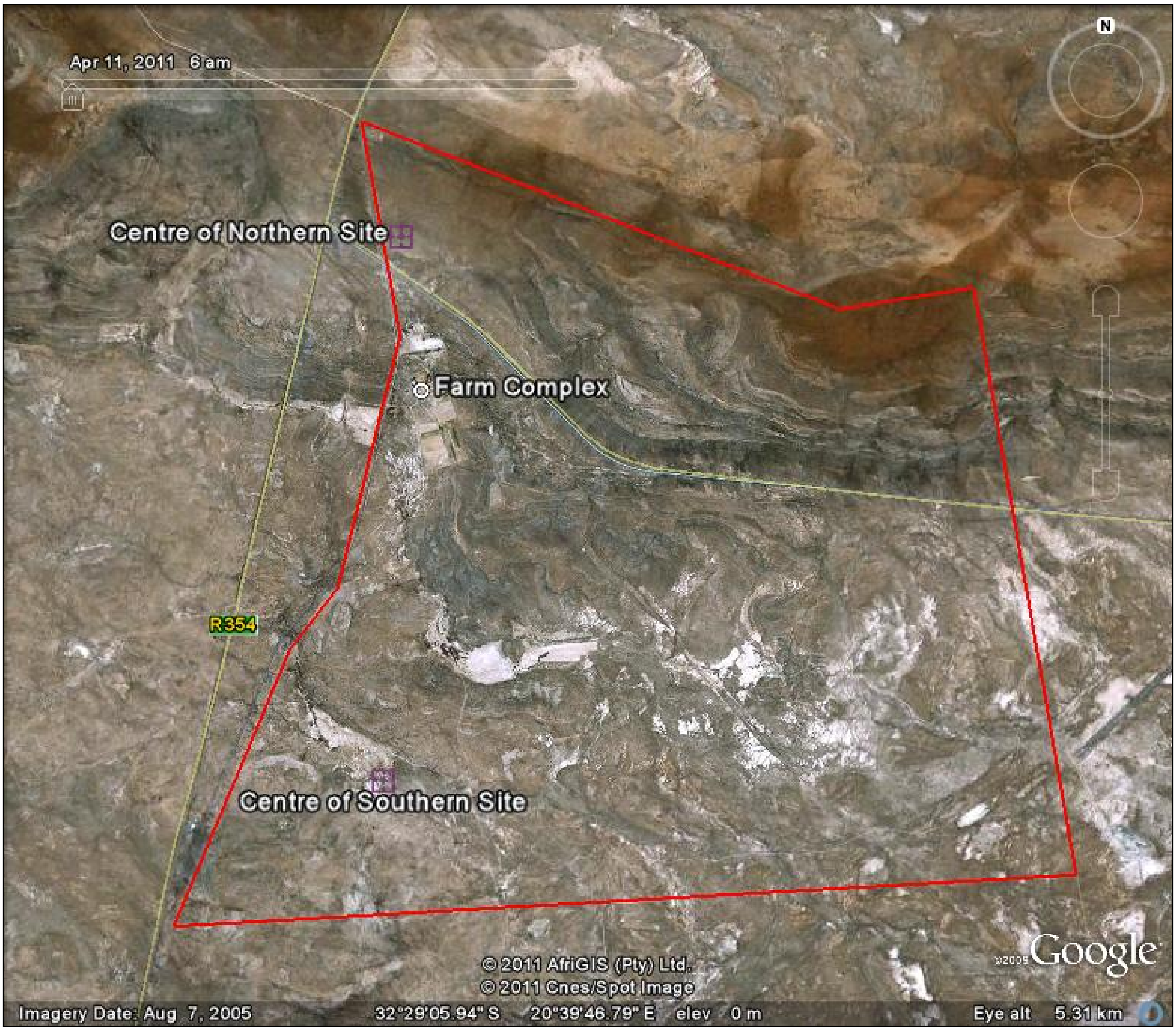


Figure 2: Aerial view of the farm showing the approximate locations of the Northern and Southern site options in relation to the farm complex and local roads. Sutherland lies some 10 km north of the site up the R354, while Merweville lies 85 km to the east.

2. LEGISLATIVE FRAMEWORK

The National Heritage Resources Act (NHRA) No. 25 of 1999 protects a variety of heritage resources including palaeontological, prehistoric and historical material (including ruins) more than 100 years old (Section 35), human remains older than 60 years and located outside of a formal cemetery administered by a local authority (Section 36) and non-ruined structures older than 60 years (Section 34). Landscapes with cultural significance are also protected under the definition of the National Estate (Section 3 (3.2d)). Section 38 (2a) states that if there is reason to believe that heritage resources will be affected then an impact assessment resource must be submitted. This report fulfils that requirement.

Since the project is subject to a Basic Assessment, the South African Heritage Resources Agency (SAHRA) is required to provide comment on the proposed project in order to facilitate final decision making by the Department of Environmental Affairs (DEA).

3. METHODODOLOGY AND APPROACH

A background survey of existing literature and commercial impact assessment reports was conducted prior to the site visit. This alerted us to the types of heritage resources that might be encountered in the area. The site was then visited by Jayson Orton and David Halkett on the 2nd and 3rd of June 2011. Given that the final footprint had yet to be finalised, we elected to cover as much appropriate ground as possible within about 1 km of the farm boundary in order to allow some flexibility in final site selection in terms of heritage resources. On the ground we in fact ranged more widely in an attempt to better understand some of the resources located.

The site was examined on foot (Figure 3), recording the positions of all heritage resources on hand-held GPS receivers set to the WGS84 datum. All finds were described, some had sketch plans drawn and the vast majority were also photographed.

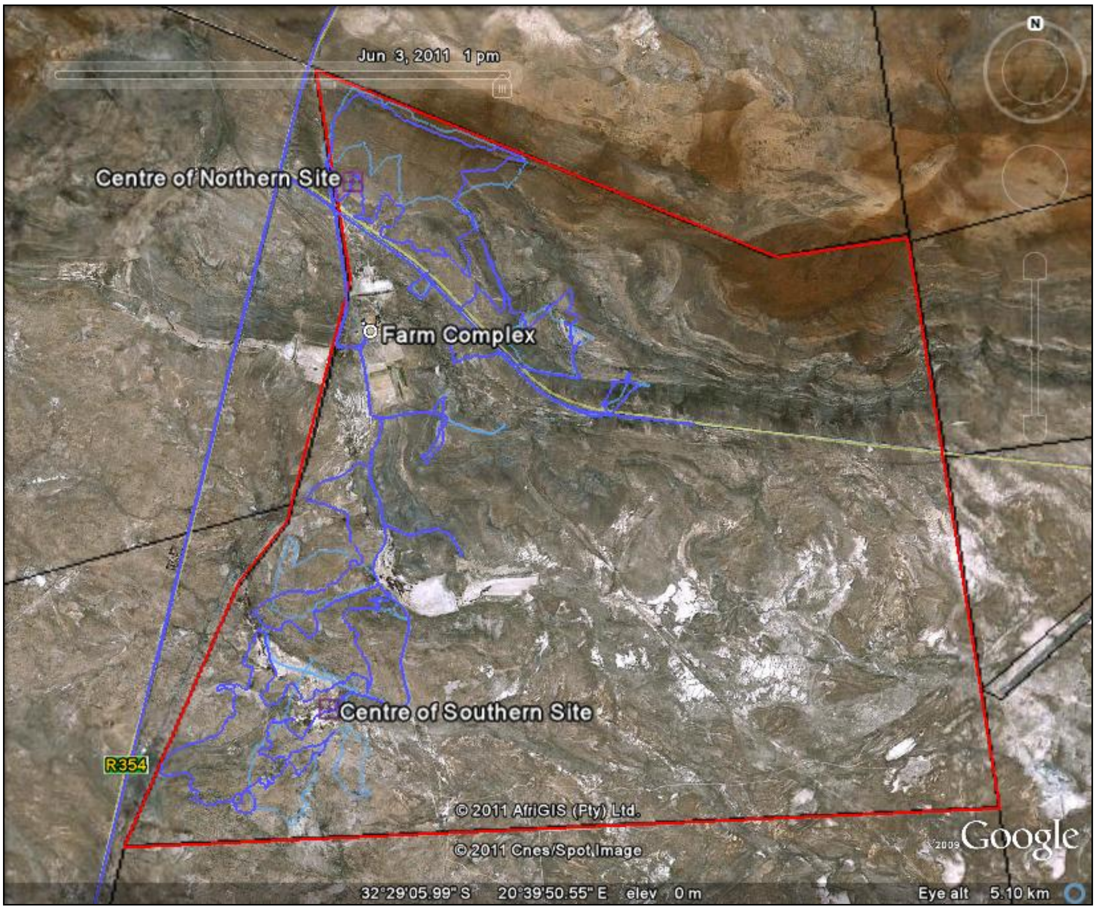


Figure 3: Aerial view of the farm showing the walk and drive paths recorded during the survey.

The sites are listed in Appendix 1 and assigned numbers preceded by JKV (abbrieviated from Jackals Valley). As such they are refreed to as JKV1, JKV2, etc. in the text.

3.1. Limitations

The areas concerned were very uniform in terms of their topography and vegetation cover and many seasonal pans were present. We elected not to search these areas in great detail but rather to focus on areas most likely to yield heritage resources. This approach worked well as it resulted in a better understanding of the landscape distribution of heritage resources. We are thus confident that the unsearched gaps will not contain anything significant. A further advantage of this approach is that should other assessments result in the need to alter the project footprint then we would be able to provide input to this process based on our existing data.

4. BASELINE ENVIRONMENTAL CONDITIONS

The farm lies on the top of the Great Escarpment, just north of where the R354 exits Verlatekloof. The terrain is generally flat but with low rocky ridges in places. Much of the ground surface is silty as a result of the occurrence of extensive seasonal pans. The land is used primarily for small stock grazing, although ploughed fields exist close to the farm complex. Figures 4 to 8 illustrate the environmental context of the site.

Figure 4: View across the Southern Site showing silty pans and generally flat terrain.

Figure 5: View east across the southern part of the Southern Site showing the rocky ridge abutting the general study area.

Figure 6: View of one of the many pans in the Southern Site.

Figure 7: One of the bedrock outcrops that occurs near, but not within, the Southern Site.

Figure 8: View south across the northern site from the rocky ridge to its north. The farm complex is visible in the far east (left).

5. HERITAGE CONTEXT

5.1. Pre-colonial background

In this area hunter-gatherers and, more recently, herders, followed a nomadic way of life dependent on environmental conditions, water, grazing and the movement of the game. Prior to European encroachment, there was abundant game in the area. Very little archaeological research has been undertaken within the immediate vicinity but several commercial impact assessment studies have led to a number of observations being made. These latter are along the edge of the escarpment including both land above and below the crest.

Evans et al. (1985) excavated a small rock shelter on the grounds of the South African Astronomical Observatory in Sutherland. It contained a Later Stone Age assemblage with small scrapers, thin-walled potsherds, ostrich eggshell beads and some *Nassarius kraussianus* beads. The latter are estuarine shells that would have to have been obtained from the coast.

Perhaps the most significant aspect of pre-colonial archaeology in the Karoo is the presence of numerous stone-walled kraals. These have been extensively documented in the eastern Karoo, primarily in the vicinity of the Seacow River Valley (Hart 1989; Sampson 1985, 2008). Hart (2005) described a significant complex of 13 interlocking kraals on the southern edge of

Sutherland. A nearby rock shelter was also noted to contain many stone artefacts on its floor surface.

In general, artefact scatters pertaining to the Early (ESA), Middle (MSA) and Later Stone Age (LSA) are found distributed over the local landscape (Hart *et al.* 2010; Halkett *et al.* 2011). Only one proper ESA site has been found. This contained many small hand-axes ascribable to the Fauresmith period of the ESA and was located below the escarpment (Hart *et al.* 2010). A number of pre-colonial kraals were located in an area some 25 km southeast of the present study area. Most were atop the escarpment. The kraals (which are distinct from the rectangular colonial period stock kraals) tend to be found along the leeward slopes of low ridges. They typically consist of piled stone-walled enclosures in a roughly circular configuration, sometimes interlocking but not more than half a meter high, and ranging from three to 9 metres in diameter. In the past they are likely to have been associated with reed mat huts or brush shelters which were probably erected a few meters away from the main kraal where sheep and goats were kept. Associated with these kraals are stone artefacts, red burnished, thin-walled pottery, and ostrich egg shell. Hart *et al.* (2010) point to the kraal complexes as significant heritage sites, which have the potential to gain status as more and more "coloured" people become aware of their Khoisan ancestry. The sites represent a heritage that is poorly understood due to the fragmented nature of information from the great Karoo.

Hart *et al.* (2010) identified another form of archaeological site below the escarpment. These are interpreted to be open Khoekhoen encampments situated among the Kameeldoring trees along the dry river beds in the bottom of valleys. The sites are typically quite large (80 – 80m in diameter), rich with very fine thin walled and burnished Cape Coastal pottery. There are numerous stone features, informal stone artefacts, grinding surfaces as well as a number of graves, some of which have broken grinding stones placed on top. Also evident were discreet ash middens and animal bone. Hart *et al.* (2010) noted European goods (19th century glass and ceramics) on some of the sites which may indicate continuous use of the area by Khoekhoen herders into the colonial period. Such contact period sites are rare in the Western Cape, although several have been described from the southern and central Namaqualand and the Richtersveld.

5.2. Built environment and historical archaeology

Various types of built environment heritage resources have been recorded in the area. Hart *et al.* (2010) reported a selection of boundary markers comprising stone cairns, or beacons, generally not more than two meters high, and constructed with layered flat rocks. They are usually located on the tops of ridges or slopes for good visibility. They may have been built in association with the original farm surveys that took place in the 19^{th} century.

Farm houses and their associated structures, and farm workers buildings occur widely. Houses are usually built from slabs of partially dressed stone. Almost all of them have grave yards associated with them, as well as dry stone kraals and walls, many of which are beautifully built. Halkett et al (2011) commented on numerous graveyards, generally associated with homesteads and with abandoned settlements. Ruins are quite numerous and range from ruined farm complexes to stock posts, historic kraals and boundary walls (Hart *et al.* 2010; Halkett *et al.* 2011; Kaplan 2009).

Historic middens are frequently found at ruined homesteads. These middens appear to be early 18^{th} to mid-late 19^{th} century judging by the ceramics which range from oriental coarse porcelain to European sponge and annular ware. Since the middens contain the material remnants of domestic life on these frontier farms, they are considered to be archaeologically important.

There are also many tracks which are likely to have their origins in the 19th century wagon routes between farms, although these are perhaps better regarded as elements of the cultural landscape.

5.3. Historical background

Schoeman (1986) has described the early settlement of the Roggeveld and Sutherland area which commenced soon after 1750. The early farmers found the escarpment, which enjoys the highest rainfall, particularly suitable for small stock farming during the summer months but they moved down into the valleys and plains of the Karoo to escape the extreme winters. Robert Jacob Gordon travelled through the Roggeveld in 1786 and he mentions farms belonging to the Van Wyks and the Louws; both are families who have lived in the area for generations.

Initially, the population of the area remained small, because many of the early loan farms were merely “stock posts” and the owners lived elsewhere. Many farmers had more than one loan farm.

European settlement was initially fraught with danger, as indigenous groups, called “Boschiesman Hottentoten” (Khoekhoen and San) attempted to drive them out of their lands. In 1754, attacks from the Khoisan are reported to have increased as flocks of sheep and herds of cattle belonging to the Trekboers were driven out of the area. This increased to the extent that it is described as a type of guerrilla warfare. Livestock was stolen, Khoisan herders and slaves killed, and Trekboer farms attacked. From about 1774 the authorities started calling up commando groups comprising local farmers and they moved through the area, attacking kraals and killing hundreds of Khoisan. The latter defended their positions in the mountains with bow and arrow and hurled rocks down from cliff tops. Further commandoes were sent during the second half of the 18th century. The Khoisan was gradually driven from the Roggeveld northward. By 1809 there is reported to have been only one “Bushmen” kraal left in the area.

Settlement became more permanent from the beginning of the 19th century. The farmers’ main source of income was small stock, wheat could only be grown with great difficulty in isolated and protected valleys. There was very little grazing and standing water for cattle.

Schoeman (1986) notes that during the early years of settlement in the Roggeveld, many of the Trekboers were living in grass huts or Matjies houses, or even in tents – some travellers found farmers living in Matjies houses until 1839. Attempts at constructing more permanent structures were inhibited by the lack of building wood. Most houses comprised a “small oblong low hut” built of slabs of “leiklip” piled on top of each other, unplastered, with a reed roof. A single window was covered with white linen and a doorway covered with a panel of reeds. The floor was of clay smeared with dung. Generally houses comprised two rooms, with an entrance into living room/kitchen and a second room serving as a communal sleeping/storeroom.

Some had a free standing “kookhuis”. There were also a number of kraals, with seven to eight not uncommon. Associated farm buildings also included the houses of the workers. A number of farm workers were slaves, brought by their owners from the Cape, as well as Khoisan comprising Bushmen taken into service, and dispossessed Khoekhoen.

During the South African War, the threat of Boer incursions led British forces to build fortifications at a number of strategic passes through the Roggeveld. A stone redoubt was constructed on the farm Gunsfontein at the top of the Brandkloof and Maleishoek passes. With the Boer leader Manie Maritz active in the Calvinia District, many young men from the Roggeveld joined the Boer cause. There appear to have been some skirmishes in the vicinity of Skietfontein (Komsberg) in 1901.

5.4. History of the farm Jackhals Valley

A brief synopsis of the archival history of the property is provided below.

The farm Jakhals Valley has included in its 1833 survey diagram (S.G. 491/1833), the circular shape of earlier loan farms (Figure 9). The loan farm of “De Jakhals Valley” dates back to October 1755 with its first owner listed as Johannes van der Westhuizen (Hopkins and Marais 2005). It is therefore one of the earliest loan farms in the region.

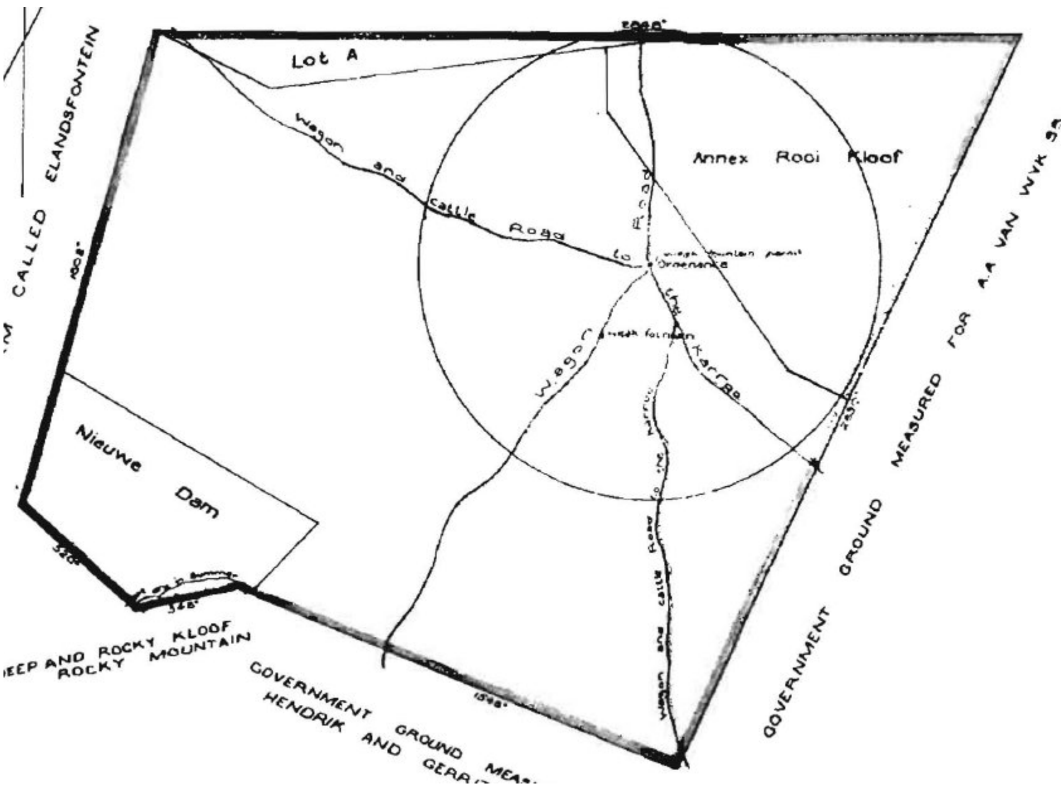


Figure 9: Extract from the 1833 survey diagram of the farm showing the circular loan farm.

A loan farm was given out after a person petitioned the government for permission to use a piece of land. They paid tithes to the government for the land but it was not generally recorded in title deeds with surveyor’s diagrams. Many of these loan farms were circular in shape because of a custom that allowed the farmer to take a measurement from a central spot, such as a homestead, spring or rock formation. The walking off distance was regarded as about 750 roods, amounting to an area of around 3000 morgen.

The fountain, which formed the centre of the original De Jakhals Valley loan farm, appears to have been the meeting place of a number of wagon routes, one being the wagon and cattle road to the “Karroo”.

The National Archives of South Africa indicate that a Johannes van der Westhuizen died in 1790 (KAB Vol:2644 Ref:4). The survey diagram for the farm dates to 1833 and the farm then belonged to Willem A Visser (S.G. 491/1833). According to the National Archives, W.A. Visser’s will was filed in 1838 (KAB Vol:7/1/145 Ref: 79). However, in 1839 a WA Visser (possibly his son) apparently complained to the authorities regarding the need to adopt some measures to prevent the depredations “committed by vagrants” (KAB Vol:4003 Ref: 127). Although we know that there were no more independent “Bushmen Kraals” in the area, there were still many dispossessed individuals in the Roggeveld. In 1843 a W A Visser asked for the reimbursement of transfer duties (KAB Vol: 4019 Ref: 691).

In 1939, there is a record in the Archives proposing the “closing of the trek path over the farm Jakhals Valley in the Sutherland Division” (KAB Vol:166 Ref: 77/22).

6. FINDINGS

A wide variety of heritage resources was recorded. It should be noted that very few were located within the immediate vicinity of either site option with most being focussed in the nearby rocky areas. A full listing of the heritage resources recorded is provided in Appendix 1 and here we only describe them more generally illustrating the discussion with representative examples for the record.

6.1. Pre-colonial archaeology

6.1.1. Artefact scatters

Several scatters of stone artefacts were recorded in open areas, all associated with rocky patches (Figures 10 to 15). None are in close proximity to the two site options and only one is considered archaeologically significant (JKV80). Most are from the LSA but one was MSA (JKV85). JKV80 occurred alongside a cluster of large, prominent boulders and contained abundant artefacts. Colonial period material was also evident and this may reflect very recent use of the site. Low stone walling has been built inside the shelter on the east side of the boulders. It is noted that a number of stone adzes were found during the survey, most notably at JKV48 and JKV80. These tools are typical of the surface assemblages of late Holocene sites in the Western Cape (Parkington 1980).

The following sites are included in this section: JKV3, 6, 10, 15, 18, 48, 49 and 80.

6.1.2. Rock art

One rock art site (JKV81) was found in the line of cliffs to the east of the Northern Site option. It lies in a long, shallow shelter which also contains some piled stone walling forming a small enclosure (Figure 16). During wet period water would run over and into the shelter and its rocky base is not comfortable for occupation. It consists of numerous finger smears with the motifs “I” and “+” being particularly common (Figures 17 to 19). Some other motifs are also present including two parallel lines that might even be interpreted as a snake, though this is perhaps doubtful. The paintings have been done on a band of rock that appears far more durable than the surrounding softer rocks. Such images are reasonably commonly encountered in the rock art of the area and similar finds from the north-eastern parts of South Africa have been ascribed to Khoekhoe herders.

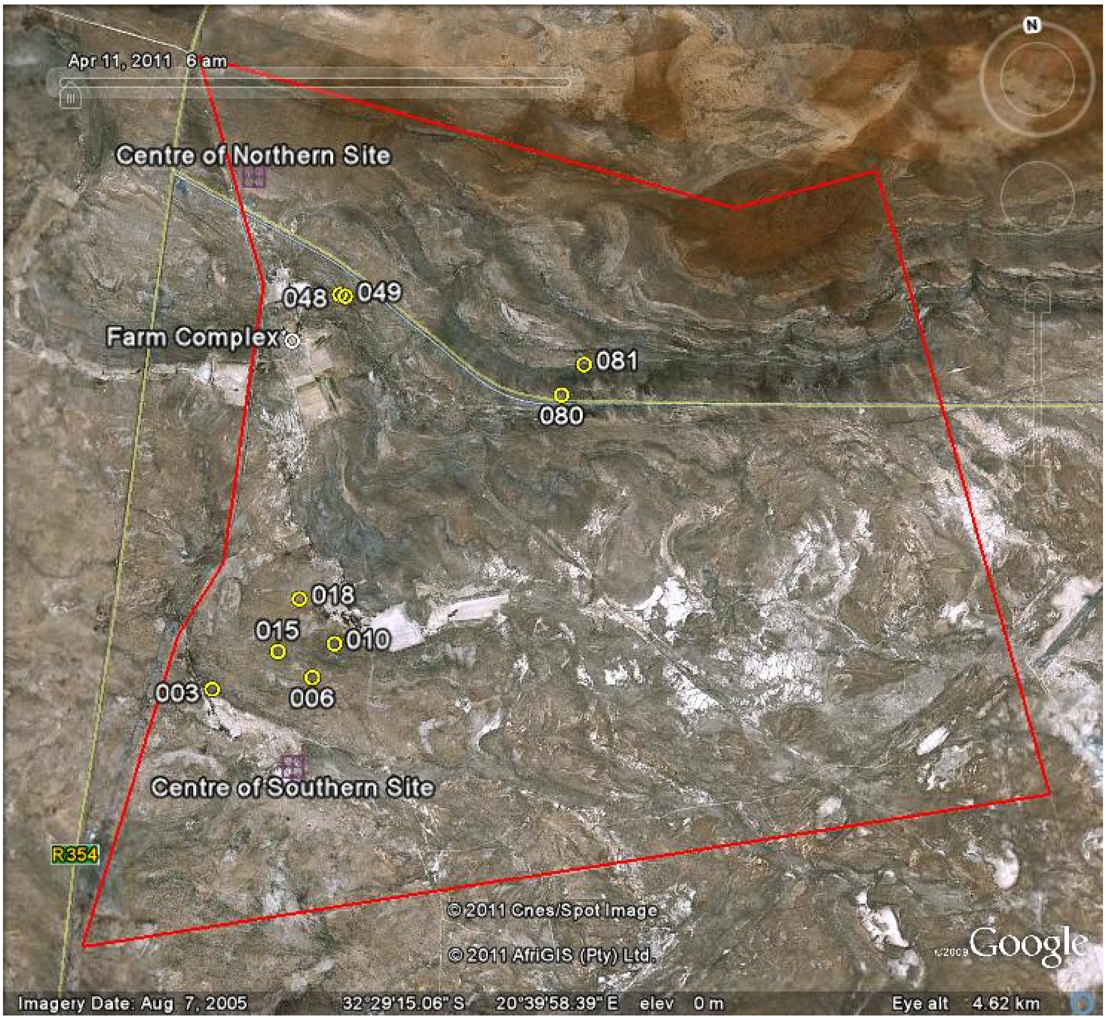


Figure 10: Aerial view of the farm showing stone artefact scatters and the one rock art site JKV81) located during the study.

Figure 11: Stone artefacts from JKV6. **Figure 12:** View southwest showing JKV80 in front of the boulders.

Figure 13: View of the rock shelter in front of which JKV80 was recorded. The piled walling is just visible in the shadows under the boulder.

Figure 14: Artefacts from JKV80.

Figure 15: Stone adze from JKV48. It is 5 cm long.

Figure 16: View of the shelter containing rock art and piled stone walling.

Figure 17: The snake-like motif.

Figure 18: Finger-smeared motifs.

Figure 19: Finger-smeared motifs overlying earlier smears of paint.

6.1.3. Pre-colonial stone-walled structures

Several pre-colonial stone walled structures were found (Figures 20 to 24). These are differentiated from historical structures in the nature of the walling (piled as opposed to layered courses) and the far more organic shape of the enclosures (Hart 1989). They too are located in rocky areas, perhaps largely due to the proximity of the construction materials. While some enclosures may be either pre-colonial or colonial, we have made a best estimate as to which is which.

The following sites include stone walling thought to be pre-colonial: JKV10, 11, 12, 13, ?14, 17, ?44, 81 and 96.

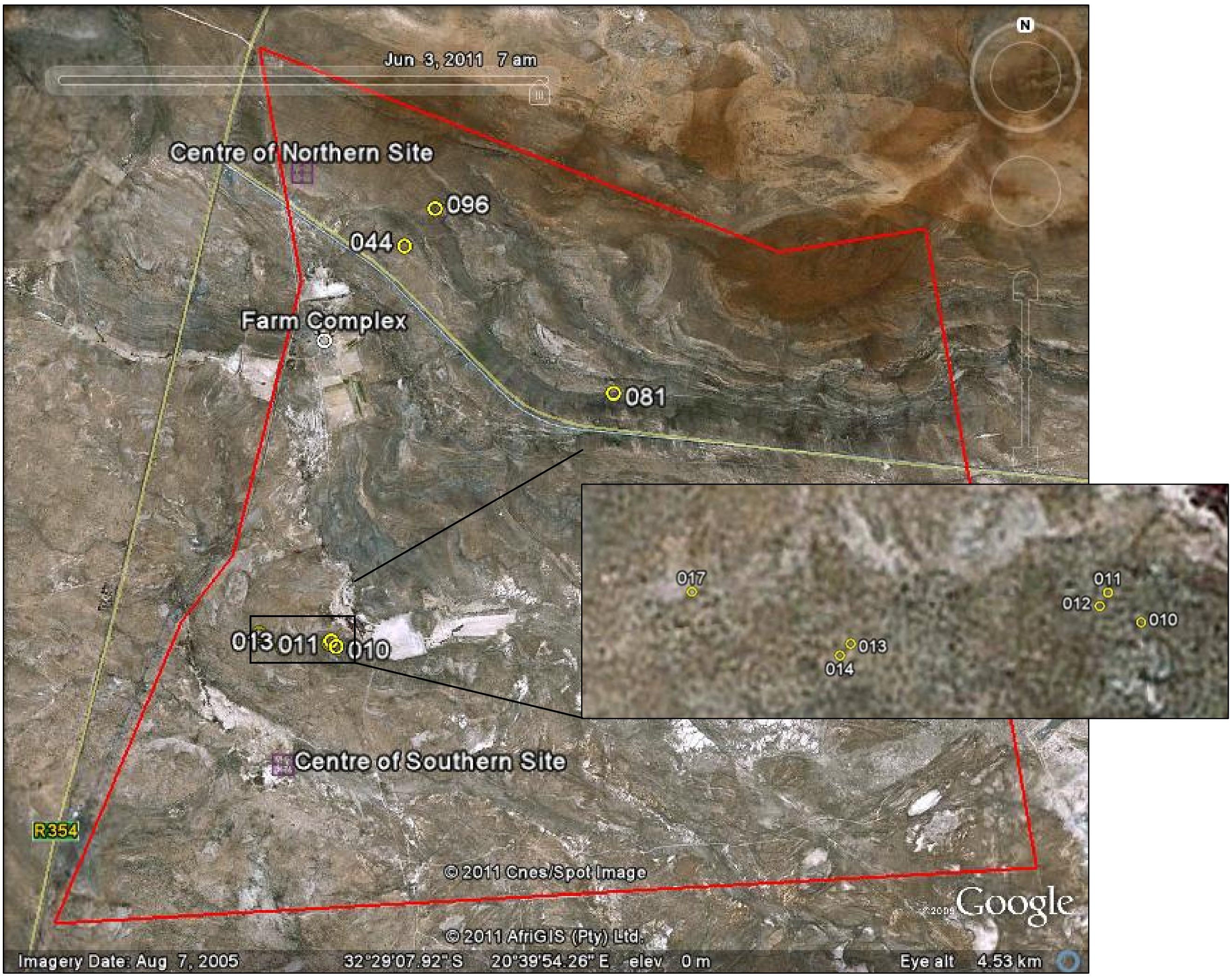


Figure 20: Aerial view of the farm showing pre-colonial stone walled structures located during the study.

Figure 21: Pre-colonial stone-walled enclosures at JKV10.

Figure 22: Pre-colonial stone walling at JKV12.

Figure 23: Pre-colonial stone walling at JKV17. This is a very typical example of a circular kraal.

Figure 24: Pre-colonial stone walling at JKV24. The only artefact present was a lower grindstone (inset).

6.2. Historical archaeology

6.2.1. Artefact scatters

Several sites were found with scatters of historical artefacts (Figures 25 to 30). These artefacts include fragments of glass, metal, ceramics and occasional other items. Some are no doubt associated with the historical use of the area, perhaps having been left by shepherds, but others are more likely connected with the Anglo-Boer War. JKV8 is a historical dump associated with a small structure which may have been lived in at some point. A wide variety of artefacts was found at this site including a fair quantity of burnt bone.JKV103 could also be quite significant. It is a dump of old food cans quite likely associated with the Anglo-Boer War.

The following sites have historical artefact scatters: JKV4, 5, 8, 16, 27, 28, 68, 79, 101, 103 and 104, although JKV4 represents only a single wine bottle base rather than a scatter.

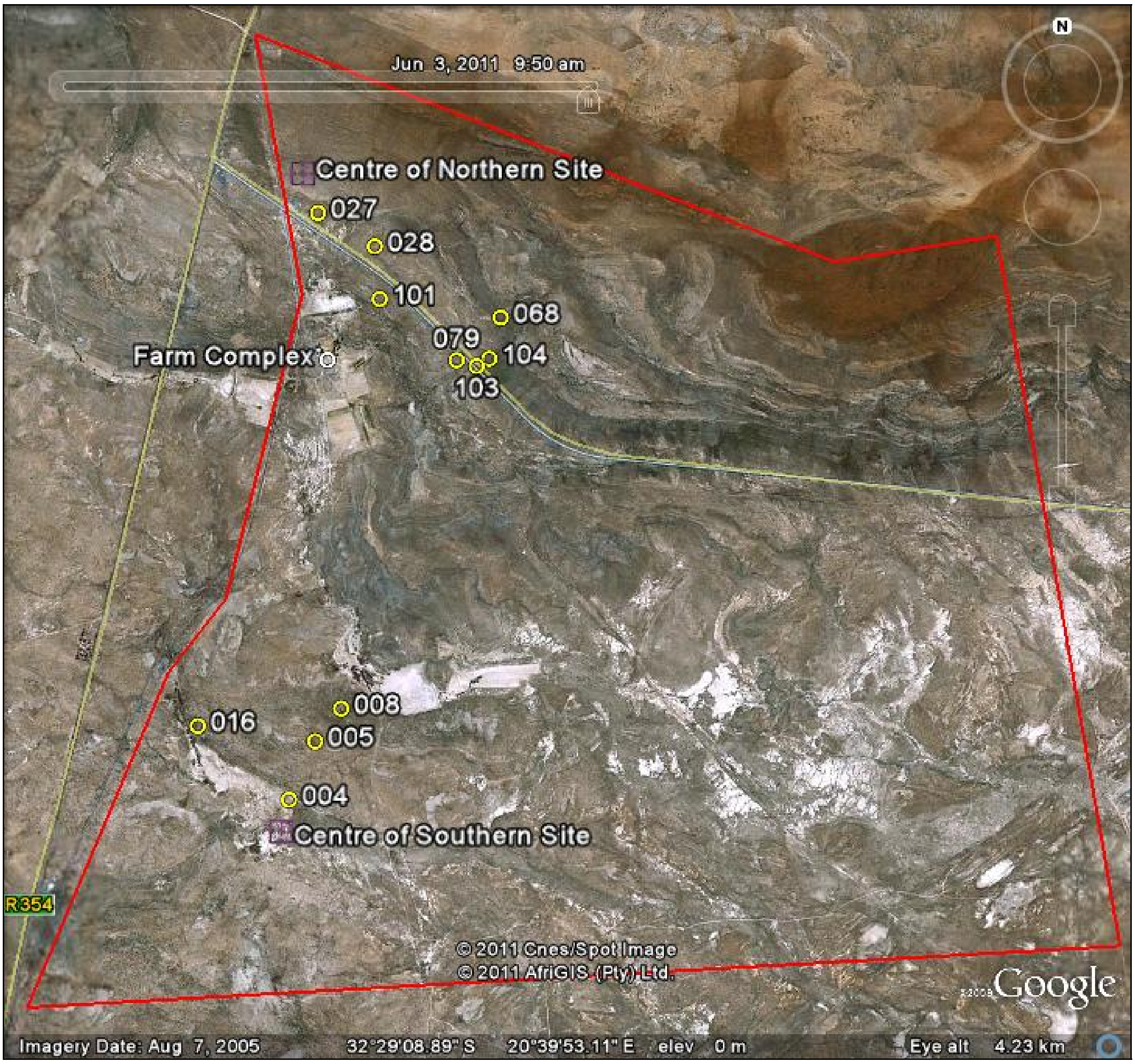


Figure 25: Aerial view of the farm showing historical artefact scatters located during the study. Note that JKV4 represents only a single bottle base.

Figure 26: Fragments of historical dark green bottle glass from JKV5.

Figure 27: Artefacts from JKV8.

Figure 28: Artefacts from JKV8.

Figure 29: Artefacts from JKV8.

Figure 30: A selection of old food cans that may well be associated with the Anglo-Boer War at JKV103.

Figure 30: Historical artefacts from JKV101.

Figure 31: Historical artefacts from JKV68. The upper left artefact is enlarged in Figure 32. These artefacts were associated with a small stone structure.

Figure 32: The back end of what appears to be a shot-gun cartridge made at the Powder Factory in Hasloch, Germany. It is inscribed with “Pulverfabrik 12 12 Hasloch A/Main”. The factory reportedly was destroyed by the end of World War II.

6.2.2. Historical stone-walled structures

A number of the stone-walled sites can be regarded as historical for the regularity of their shapes and the fact that the stones are relatively neatly placed on top of one another, often in courses. These sites were again associated with rocky areas, perhaps for ease of obtaining stones with which to build, and are scattered throughout the study area (Figure 33). One exception, however, is the old farm boundary wall of which extensive sections remain around the southern, eastern and northern sides of the farm (Figure 34). The small stone structures probably vary in use from small wind breaks to living enclosures. Only one well formalised structure was found (JKV9). It had two rooms of 2 m by 2.5 m and 2 m by 1.5 m with a less formal circular enclosure built onto either end. Despite its small size it may well have served as a house with the circular enclosures used for cooking or storage (Figures 35 – 36). It is outside this structure that the extensive historical dump was found and this points towards a residential function for it. Other stone-walled structures regarded as historical may have been used as small shepherd’s huts and related features (Figures 37 – 40). Also included within this category are two large historical kraals (Figure 41) and the extensive stone wall surrounding part of the farm on its northern, southern and eastern sides (Figures 42 – 45). The significance of this stone wall is not understood but it is clear that the boundary does not relate to the circular loan farm depicted in Figure 9. That circle has a far larger radius than what is implied by the stone wall. The wall has been built via a method typical of many historic stone structures – two skins are built up and the intervening space is filled by small rubble.

Stone-walled structures regarded as being historical are: JKV2, 7, 9, 16, 25, 26, 68, 83, 84, 86, 87, 89, 90, 92, 101, ?105. Note that JKV84 is included here despote its being so poorly preserved that it was not possible to tell what it was. The stone farm boundary wall is represented by JKV20, 21, 22, 23, 77, 78 and 102. This list excludes those walled structures thought to be from the Anglo-Boer War and those deemed to be markers or beacons. Both these types of structures are presented and discussed separately below.

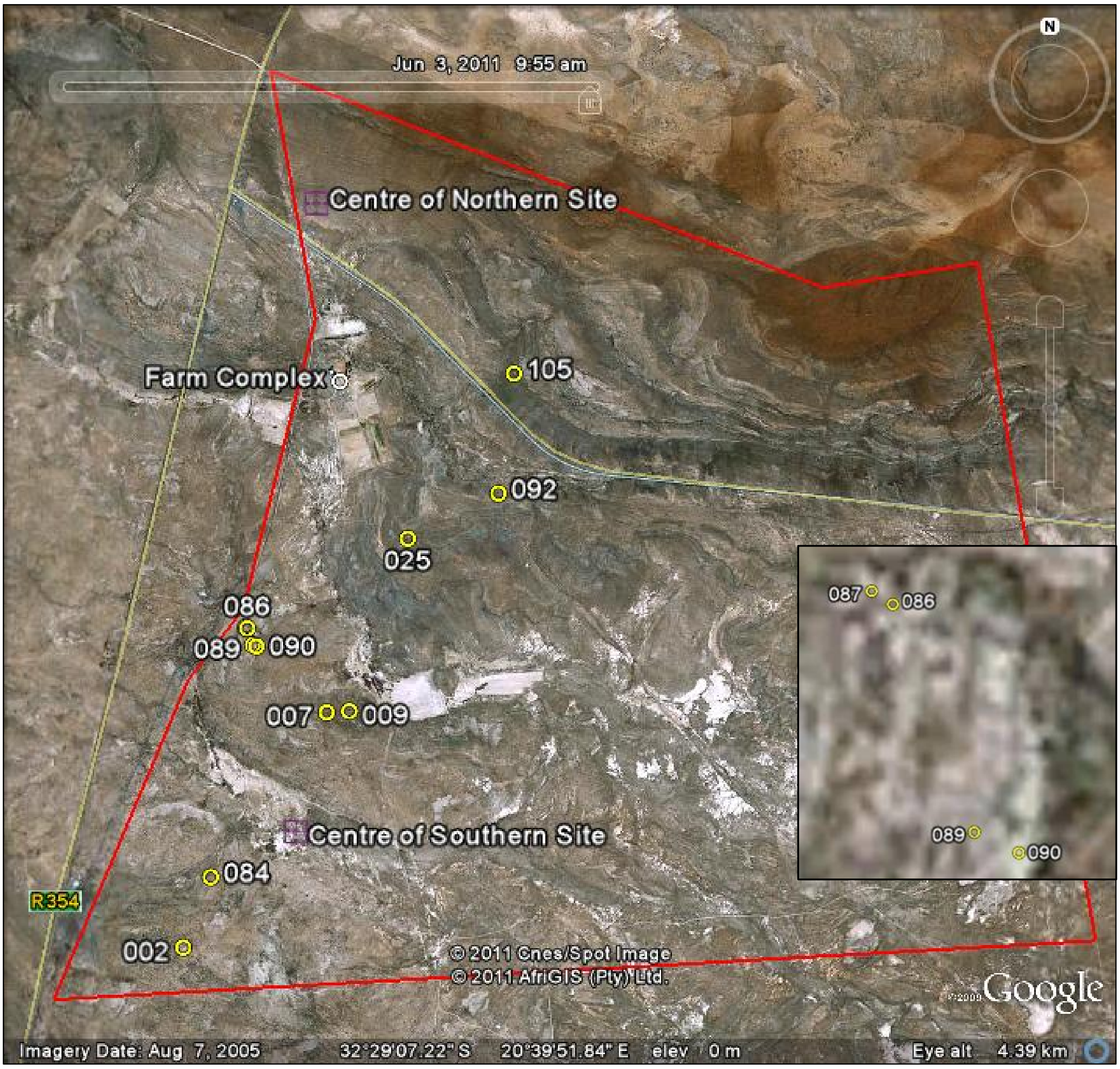


Figure 33: Aerial view of the farm showing historical walled sites located during the study. The inset shows the spatial arrangement at the cluster in the far western part of the property. This map excludes those sites thought to be Anglo-Boer War and also excludes the old farm boundary wall and historical kraals. The latter two, however, are mapped in Figure 34.

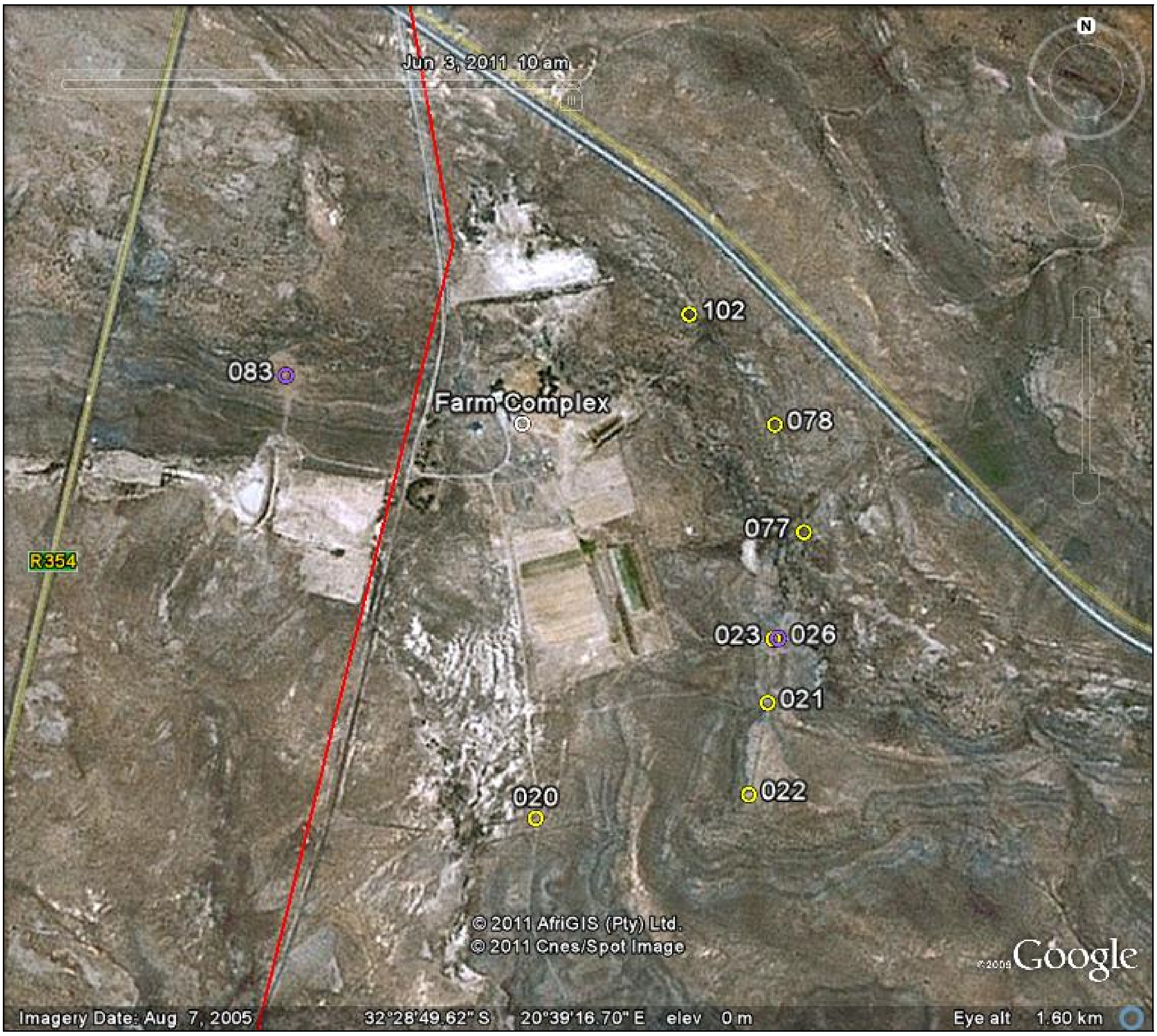


Figure 34: Aerial view of the farm showing points on the old farm boundary wall (yellow circles) and two large historical kraals (purple circles) recorded during the study.

Figure 35: Formal stone structure at JKV9.

Figure 36: Circular enclosure on one end of JKV9.

Figure 37: Informal stone structure at JKV2.

Figure 38: Stone structure at JKV7.

Figure 39: Stone walling at JKV16.

Figure 40: Small stone structure that could represent a small animal cage

Figure 41: Large historical stone kraal at JKV24.

Figure 42: The stone boundary wall at JKV20 showing poor preservation.

Figure 43: The stone boundary wall at JKV21 with slightly better preservation.

Figure 44: The stone boundary wall at JKV77, a very well preserved section.

Figure 45: Detail of the wall at JKV22 showing the construction method.

6.2.3. Anglo-Boer War and related stone-walled structures

A number of ruined structures relating to the second Anglo-Boer War were found. All were focused in the north-western part of the farm (Figure 46), although we feel that further searching east and west of this area would yield further remains. The war was fought from 1899 to 1902 and the war graves in the cemetery at Sutherland indicate that action took place in the area. Two types of structures obviously relate to the war. One group are circular walls filled in with soil and stone to create platforms on top of which once stood further walling. These upper walls were subsequently demolished and as a result piles of stones lie around the base of each of these structures (Figures 47 to 49). These platforms are slightly variable in diameter but all are in the region of 4 m to 4.5 m across. They might have once housed field guns but we cannot be certain. It is also possible that they had corrugated iron forts on top[1]. Although usually placed within stone walls and referred to as “Rice Circular Pattern” (see Tomlinson, n.d.), there may simply have been packed rocks around the outside of the corrugated iron to add extra protection. Another alternative is that the platforms were

[1] Johan van den Berg is thanked for discussion of these forts and their possible original form.

topped by drystone walls with gun ports as described below. Either way, the extra elevation must have been deemed important. The second group consist of sections of walling often preserving gun ports (Figures 50 – 54). Most are arcuate in form and face north but one, JKV76, is a circular structure with an opening to the south and gun ports all the way round (Figure 55). The gun ports are constructed through the placement of rocks with a triangular space and a slab on top (Figure 54). The final item in this group is a poorly preserved spiral-shaped stone-walled enclosure lying alongside the Merweville Road (JKV46). While no obvious sign of this being a fort is preserved, a local resident informed us that the well-known fort on top of Rebelskop is also spiral-shaped. The website Discover Sutherland (2011) describes Rebelskop as:

> "a hill topped by the ruins of a fort and named after a Boer division of 200 men that opposed the British forces. Under Commandant Abraham Louw, and reinforced by a further 50 men under the command of Albert Smith from Fraserburg, the rebels rained gunfire into the British-occupied town for 10 hours in a mini-siege."

Whether the structure at JKV46 is in fact a Boer fort is unknown, but if so it may have been used before the English took control of the area.

Figure 46: Aerial view of the farm showing walled sites relating to the Anglo-Boer War located during the study. Yellow circles denote circular fort platforms, purple circles are walls with gun ports, the orange circle is a spiral-shaped structure said to relate to the war by local people and the white circles represent other walling that quite likely relates to the war but preserves no evidence to confirm this.

The land owner claims that there are nine forts surrounding the farm but, according to another local, this number could even be twelve. It seems significant that five of the raised circular platforms recorded here make a V-shape around the eastern side of the farm and there does seem to be a suggestion that they may have been defending the farm. Because we did not search to the west of the farm we do not know whether there are forts there as well. Why this farm should have been so well defended is unknown.

Sites relating to the Anglo-Boer War are: JKV24, 45, 46, 47, ?50, 69, 73, 74, 75, 76, 93, 106 and 107.

Figure 47: The fort platform at JKV106.

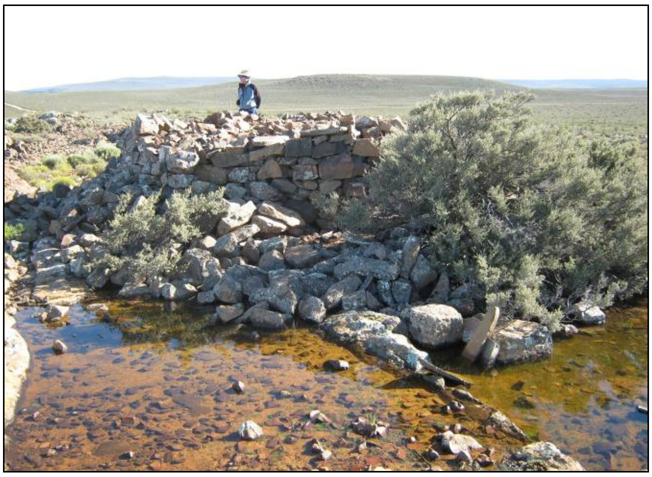


Figure 48: The fort platform at JKV45.

Figure 49: The fort platform at JKV47. Note the piles of rocks lying around the base both here and in Figures 34 and 35.

Figure 50: Arcuate stone walling at JKV50 that is assumed to have had gun-ports prior to its tumbling down.

Figure 51: Well preserved stone walling with gun ports alongside a bedrock outcrop at JKV73.

Figure 52: The fully preserved gun ports at JKV73.

Figure 53: The wall with gun ports at JKV74.

Figure 54: A gun port at JKV74.

Figure 55: The stone enclosure with gun ports at JKV76. The inset shows the remains of the gun ports immediately left of the entrance as seen in the main picture.

6.2.4. Stone boundary markers/cairns

A large number of stone cairns were noted in the northern part of the farm with just four in the south (Figures 56 – 57). One of the latter was an odd collection of six stones in an otherwise sandy area (Figure 58). It is not known what this is and, although unlikely, it might even represent a grave. With the exception of JKV100, which was described in the field as a probable stone marker, the other examples are all far more obvious. They are very heavily clustered in two areas in the north of the farm.

One cluster of 36 markers forms a large V-shape just north of the Merweville road (Figure 59) and should be beyond the area in question for the development. The cairns are not equally spaced and differ slightly in construction from one to the next (Figures 60 – 64). Their function remains entirely unknown. The second big cluster of markers occurs to the east above the small line of cliffs in the northern part of the farm. This cluster contains eleven cairns in a single straight line along the base of a large rocky outcrop and a further three in a line just to the north (Figure 65 - 68). Ten of the eleven are quite formally constructed while one in the middle of that line and the eastern one of the southern three are simpler being just a single tall stone standing on end in the ground. While these cairns are in the area occupied by several stone walls with gun ports, it seems unlikely that they relate to the Anglo-Boer War but this could still be a possibility.

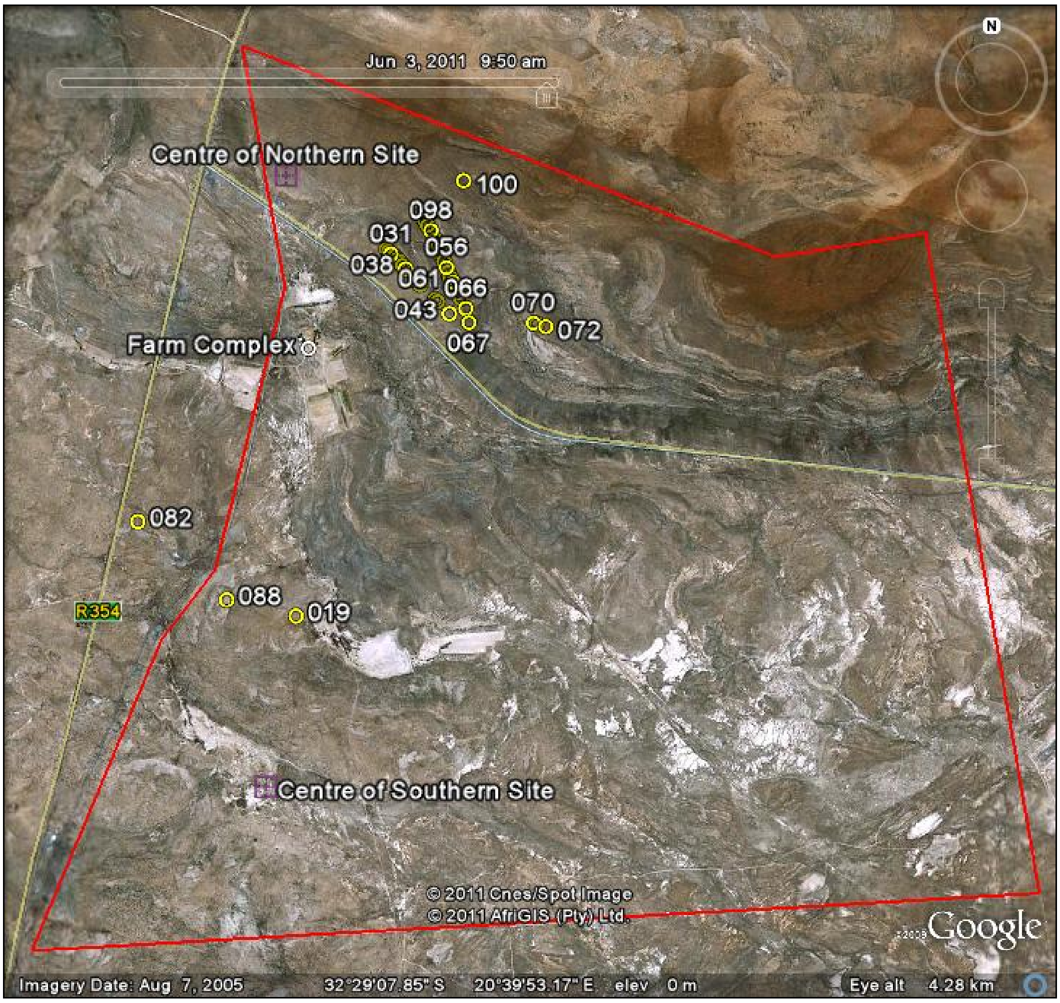


Figure 56: Aerial view of the farm showing stone markers/cairns located during the study. The cluster in the north is shown in greater detail in Figure 57.

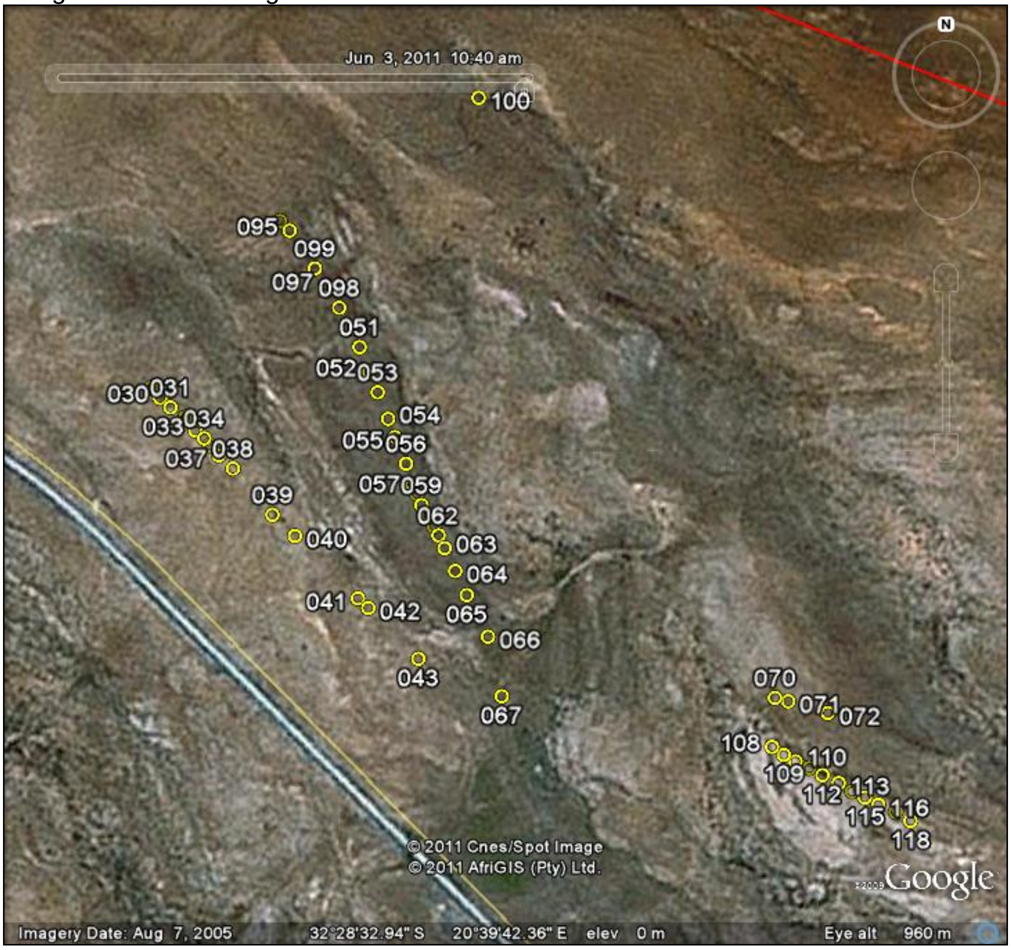


Figure 57: Aerial view of the farm showing stone markers/cairns located in the northern part of the study area.

Figure 58: The six stones in the cluster at JKV19.

Figure 59: Aerial view of the layout of the 36 markers just north of the Merweville road. The white bar for scale at the top represents 100 m.

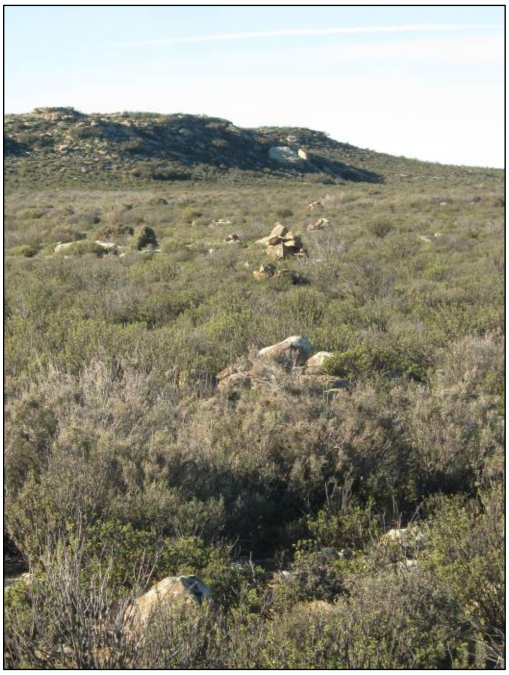


Figure 60: View east along the southern rows of cairns in the western cluster (JKV

Figures 61 – 64: Four of the cairns in the western cluster showing the varied construction.

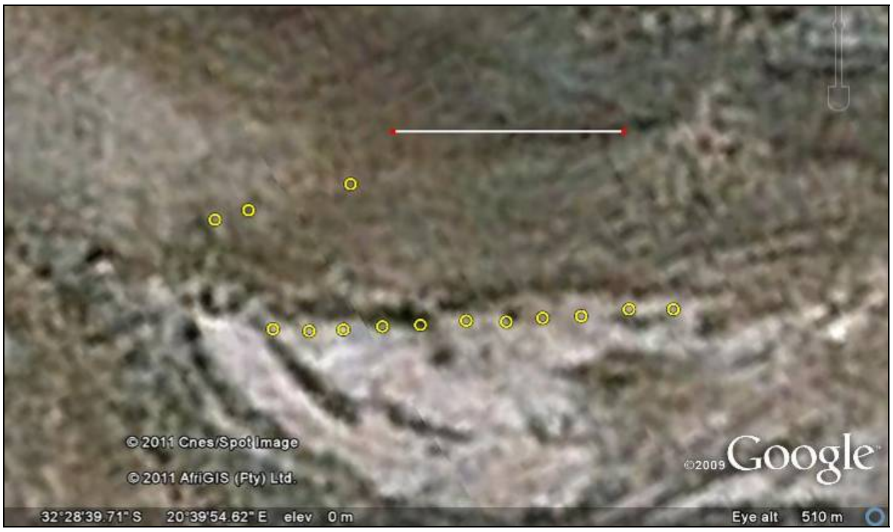


Figure 65: Aerial view of the layout of the fourteen markers above the line of small cliffs. The white bar for scale at the top represents 100 m.

Figure 66: View east along the line of eleven markers alongside the bedrock outcrop (JKV108 – JKV118).

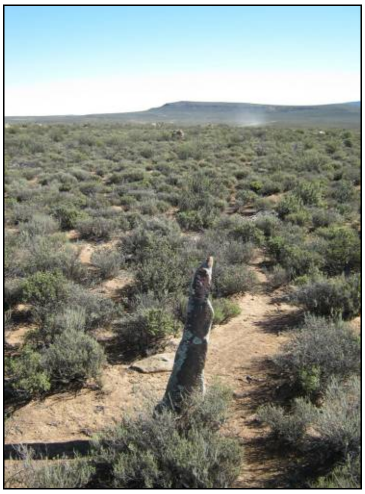


Figure 67: View towards the east showing the cairns at JKV70 (foreground) and JKV72 (middle ground). That at JKV72 lies further back.

Figure 68: View westwards of the cairn at JKV72. JKV71 is just visible in the middle of the picture.

6.3. Built environment

No structures occur within the project study areas and no direct impacts to the built environment will be experienced. However, for the sake of context, photographs of the farm complex, located at JKV1, are provided here (Figures 69 – 72). No foot survey of this complex was done. Most buildings probably date to at least the mid-19th century.

Figure 69: The farm house.

Figure 70: Barn.

Figure 71: Barn and stone walling.

Figure 72: Ruin and outbuilding.

6.4. Graves

A graveyard exists to the north of the farm complex but is well away from the potential development areas. The only possible isolated grave found was at JKV19 (described under markers/cairns above). Unmarked pre-colonial graves can occur anywhere where there is substrate soft enough to dig into.

6.5. Cultural landscapes

Two principal cultural landscape layers were identified. The first relates to the farm and includes the boundary walls, buildings, ruins and agricultural fields. This layer is focused on the central part of the farm, essentially between the two site options. As such, development at either site will not affect this landscape. Whether the many stone markers/cairns should be included in this layer or not is not known but they have, for now, been excluded.

The second, and arguably more significant, layer relates to the Anglo-Boer War. This layer includes the many fortifications dotted around the farm. No doubt other examples of similar fortifications exist in the immediate surroundings such that this landscape extends far more widely. One might even argue that much of the South African interior represents one extensive Anglo-Boer War landscape with its multitude of forts and block houses scattered across the land. At the smaller scale considered here, however, the war landscape is significant. The northern site option lies among the many Anglo-Boer War sites recorded here and use of this site will impact upon the integrity of this landscape.

6.6. Visual impacts and scenic routes

Visual impacts will differ for the two proposed options. Being located on flat land in the corner between the R354 and the subsidiary road to Merweville, the northern site is very easily visible to travellers proceeding in all directions (Figure 73). It is quite close to both roads and would have a high degree of visual impact. While the smaller road is predominantly only used by locals, the R354 is seen as an important scenic route that is used by tourists and others, particularly en route to the South African Astronomical Observatory.

Figure 73: View towards the southeast across the northern site option. The facility would be constructed within the area falling approximately behind and to the left of the power line pylon present in mid-picture. The R354 is visible on the right while the Merweville turn-off is indicated by the road signage.

The southern site, however, is partially screened by a low rocky ridge that lies between it and the R354, although the central and eastern parts of the site would be visible. The presence of this ridge and the low-lying nature of the site mean that the facility would be far less obvious on the landscape to passing motorists. It is also much further from the main road than the proposed northern site.

Figure 74: View towards the east over the southern site option. Although not readily visible in the photograph, a low rocky ridge exists between the site and the road.

7. IMPACT ASSESSMENT

The project will be carried out in four phases, each of which should be assessed separately. However, it is primarily with the construction phase that impacts to heritage resources occur and it is thus on this phase that the impact assessment focuses. The following should, however, be noted with regards to the four phases:

1. Planning and design: While no direct or indirect impacts are felt at this stage, it is at this point in the process that impacts can be reduced through sensitive design treatment of the facility.
2. Construction: see assessment details below.
3. Operation: No further impacts to heritage would occur during operation of the currently proposed facility, although any expansion to the facility (effectively a new construction phase) would necessarily introduce new impacts.
4. Decommissioning and closure: At this stage indirect impacts to heritage resources that were felt during construction and operation can be reduced or removed entirely with successful rehabilitation of the site. Direct impacts to heritage resources would, however, remain the same.

The impact assessment is presented in two tables, one for each of the Northern and Southern Site options. The tables only assess those aspects of heritage resources directly relevant to each site.

7.1. Northern Site

The northern site is seen as being far less desirable. This is largely because of the prevalence of Anglo-Boer War-related structures and ruins in the vicinity. These structures taken together comprise a cultural landscape that should be (and is) treated as a single entity during assessment of impacts. No direct impacts to war-related structures would occur, although one ruined structure is located in close proximity to the road east of the site (JKV46). The number of war-related structures and ruins is unusually high in this location and this makes the area significant. Mitigation of impacts to this cultural landscape cannot be carried – the site is seen as inappropriate and should not be used for the proposed development. Similarly, the exposed nature of the site in terms of the local roads is important. The main road (R354) past the site is seen as a significant scenic route and impacts of medium to high significance can be expected. Again, mitigation of such impacts is not possible since the topography means that the development could not be completely shielded from view through construction of a berm. A berm would in term impose its own impacts on the landscape and is probably best avoided. Visual impacts are reversible, but only if proper rehabilitation of the site is achieved post-decommissioning. Note that no pre-colonial sites were located within the immediate vicinity of the northern site and only a few isolated artefacts were seen. Their destruction or movement has negligible significance.

Table 1: Assessment of impacts to heritage resources associated with the construction phase for the Northern Site.

DESCRIPTION OF THE IMPACT	NATURE / STATUS	EXTENT	DURATION	INTENSITY	PROBABILITY	SIGNIFICANCE (WITHOUT MITIGATION)	MITIGATION	SIGNIFICANCE (WITH MITIGATION)
Destruction or movement of pre-colonial artefacts	Direct / Negative	Local	Permanent	Low	Improbable	Very low	n/a	Very low
Impacts to quality of the Anglo-Boer War cultural landscape setting	Direct / Negative	Local	Long term	Medium	Definite	Medium	n/a	Medium
Destruction or movement of historical artefacts	Direct / Negative	Local	Permanent	Low	Improbable	Low	ECO to ensure that no-one removes any artefacts from the area	Very low
Visual impacts to the R354 (scenic route)	Indirect / Negative	Local	Long term	High	Definite	Medium-High	n/a	Medium-High

Table 2: Assessment of impacts to heritage resources associated with the construction phase for the Southern Site.

DESCRIPTION OF THE IMPACT	NATURE / STATUS	EXTENT	DURATION	INTENSITY	PROBABILITY	SIGNIFICANCE (WITHOUT MITIGATION)	MITIGATION	SIGNIFICANCE (WITH MITIGATION)
Destruction or movement of pre-colonial artefacts	Direct / Negative	Local	Permanent	Low	Improbable	Very low	n/a	Very low
Destruction or movement of historical artefacts	Direct / Negative	Local	Permanent	Low	Improbable	Low	ECO to ensure that no-one removes any artefacts from the area	Very low
Damage to historical structures and related features in vicinity	Direct / Negative	Local	Permanent	Low	Improbable	Low-Medium	ECO to ensure that no-one damages the sites	Very low
Visual impacts to the R354 (scenic route)	Indirect / Negative	Local	Long term	Medium	Definite	Low	n/a	Low

7.2. Southern Site

This alternative is seen as being far more appropriate since it will not impinge on any significant cultural landscape and its visibility is markedly less than the northern option. Particularly relevant here is the presence of a low rocky ridge between the site and the R354 which obscures the western part of the proposed development area. This means that only the eastern part, more than 500 m from the road, would be visible. The low significance rating assigned to the visual impacts is due to both this distance as well as the fact that the development is of such a nature that the impact is concentrated in a small area. Visual impacts are reversible, but only if proper rehabilitation of the site is achieved post-decommissioning. Although several examples of pre-colonial walling do occur on the rocky ridge to the north of the site, these are very difficult to locate without a trained eye and no impacts to these sites by wandering construction workers are anticipated. However, a ruined historical structure (JKV9) with an extensive dump of artefacts and food refuse occurs to the north of the southern option. This structure is well preserved and easily visible from the surrounding landscape and could easily be frequented by workers during lunch times. Mitigation would involve ensuring that the site is not visited such that disturbance or damage is avoided completely. Both historical and pre-colonial artefacts were noted in the vicinity but none of the recorded finds are expected to be impacted directly by the proposed development. Where isolated artefacts occur these will not carry any significance.

7.3. No-go option

Should the development not proceed then no impacts to heritage resources, either direct or indirect, will be felt. The status quo would be retained.

7.4. Mitigation measures

During the <u>design phase</u> the final proposed footprint area should be made available to the archaeologist to ensure that no significant material will be affected. Also, if the Southern Site is chosen, the responsible people should try to ensure that the facility is located as close to the rocky ridge between it and the R354 as possible so as to reduce the degree of visibility of the development.

During the <u>construction phase</u> (and assuming the Southern Site is chosen) the responsible ECO should ensure that no-one visits the historical ruin (JKV9) and collects material from it. Furthermore, any other artefacts or “rubbish” that might be found on the site and does not pertain to the construction of the facility should be left where they are since they might relate to the historical occupation of the area or even the Anglo-Boer War.

7.5. Need for a Visual Impact Assessment

No Visual Impact Assessment (VIA) has been planned for this project. However, it is felt that should the Northern Site be chosen then it should be subjected to a VIA as the visual impacts there are potentially very high. These impacts relate primarily to the R354 which is considered a significant scenic route.

The Southern Site, on the other hand, is seen as being far less visually sensitive and is partly obscured from the R354 road. It is not considered necessary to conduct a VIA for this site.

7.6. Cumulative impacts

Cumulative impacts are not seen as a major concern here. The other three renewable energy projects currently under consideration in the general area are all wind energy facilities. By their nature they have far higher impacts and are visible from far greater distances. Should any of those be constructed and be visible from the proposed solar facility then it is considered likely that the increased cumulative from the current project will be very limited.

8. CONCLUSION

The Northern Site is seen as being a poor option as it will result in significant negative impacts to both the scenic qualities of the area and R354 road as well as to the Anglo-Boer War cultural landscape. Although it might still be considered as an option, the Northern Site is probably best omitted from any further planning. The southern site will result in impacts of far lower significance and is supported as the preferred option for this development.

9. RECOMMENDATIONS

Subject to the approval of the South African Heritage Resources Agency, it is recommended that the project be allowed to proceed but with the following site specific recommendations:

- Southern Site: No further assessments are suggested. However, the ECO should ensure that the historical ruin and associated artefacts are protected from damage during the construction phase of the project. This alternative is strongly favoured.

- Northern Site: Should this site be chosen then it is recommended that a Visual Impact Assessment be carried out to properly determine the significance of the impacts that would be experienced there. During construction the ECO would need to ensure that no historical artefacts are collected and removed from the site or its surroundings.

10. REFERENCES

Discover Sutherland. 2011. http://www.discoversutherland.co.za/see_and_do/places_of_interest/. Website accessed 13th June 2011.

Eastwood, E.B. & Smith, B.W. 2005. Fingerprints of the Khoekhoen: geometric and handprinted rock art in the Central Limpopo Basin, Southern Africa. South African Archaeological Society Goodwin Series 9: 63-76.

Evans, T.L., Thackeray, A.I. & Thackery, J.F. 1985. Later Stone Age Rescue Archaeology in the Sutherland District. The South African Archaeological Bulletin 40:106-108.

Halkett, D., Bluff, K. & Pinto, H. 2011. Heritage Impact Assessment: proposed renewable energy facility at the Sutherland site, Western and Northern Cape Provinces. Unpublished report for ERM, SA.

Hart, T.J.G. 1989. Haaskraal and Volstruisfontein: Later Stone Age events at two rockshelters in the Zeekoe Valley, Great Karoo, South Africa. Unpublished M.A. dissertation, University of Cape Town.

Hart, T. 2005. Heritage Impact Assessment of a proposed Sutherland Golf Estate, Sutherland, Northern Cape Province.

Hart, T., Bluff, K., Halkett, D & Webley, L. 2010. Heritage Impact Assessment: Proposed Suurplaat Wind Energy facility near Sutherland, Western Cape and Northern Cape. Unpublished report for Savannah Environmental Services

Hopkins, H.C. & Marais, G.V. 2005. Kudde onder the suidersterre: Ned Gereformeerde Kerk Sutherland se geskiedenis die afgelope 150 jaar.

Kaplan, J. 2009. Phase 1 Archaeological Impact Assessment of the Proposed Driefontein Resort (Driefontein Farm No. 127), Sutherland, Northern Cape Province. Unpublished report for EnviroAfrika.

Parkington, J. 1980b. Time and place: some observations on spatial and temporal patterning in the Later Stone Age sequence in Southern Africa. South African Archaeological Bulletin 35: 73-83.

Sampson, C.G. 1985. Atlas of Stone Age settlement in the central and upper Seacow Valley. Memoirs of the National Museum (Bloemfontein) 20: 1-116.

Sampson, CG 2008. Chronology and dynamics of Later Stone Age herders in the upper Seacow River valley, South Africa

Schoeman, K. 1986. Die wereld van die digter: ‘n boek oor Sutherland en die Roggeveld ter ere van N.P. van Wyk Louw. Human & Rousseau: Cape Town

Tomlinson, R. n.d. Three centuries of fortificationsin South Africa 1652 to 1958. Accessed online on 27th June 2011 at: http://www.fsgfort.com/DB/F034/04/Text.htm.

11. INVESTIGATION TEAM

Fieldwork and report: J. Orton & D. Halkett

Literature survey: L. Webley

12. APPENDIX 1: LIST OF HERITAGE RESOURCES

Field number	Final number	GPS co-ordinates	Description
J001	1	S32 28 44.6 E20 39 11.7	Farm Complex
J002	2	S32 30 08.1 E20 38 45.9	Stone-walled enclosure (historical)
J003	3	S32 29 37.7 E20 38 52.0	Ephemeral LSA artefact scatter
J004	4	S32 29 46.6 E20 39 06.9	Single bottle base
J005	5	S32 29 38.4 E20 39 11.2	Scatter of dark green bottle glass
J006	6	S32 29 37.4 E20 39 10.8	LSA artefact scatter
J007	7	S32 29 33.5 E20 39 11.0	Stone-walled enclosure (historical)
J008	8	S32 29 33.8 E20 39 15.5	Historical dump (=D003)
J009	9	S32 29 33.3 E20 39 14.9	Stone-walled structure (=D003)
J010	10	S32 29 32.5 E20 39 15.5	Interlinking stone-walled enclosures and artefact scatter (pre-colonial)
J011	11	S32 29 31.6 E20 39 14.5	Stone-walled enclosure (pre-colonial)
J012	12	S32 29 32.0 E20 39 14.2	Stone-walled enclosure (pre-colonial)
J013	13	S32 29 32.3 E20 39 06.1	Possible stone-walled enclosure (pre-colonial)
J014	14	S32 29 32.6 E20 39 05.7	Stone-walled enclosure (?pre-colonial) and walling (?pre-colonial)
J015	15	S32 29 32.9 E20 39 04.9	Ephemeral LSA artefact scatter
J016	16	S32 29 36.2 E20 38 51.7	Stone-walled enclosure and historical artefacts (historical)
J017	17	S32 29 30.5 E20 39 01.2	Stone-walled enclosure (pre-colonial)
J018	18	S32 29 25.0 E20 39 09.9	Ephemeral LSA artefact scatter
J019	19	S32 29 25.2 E20 39 11.0	Stone marker (?grave or cairn)
J020	20	S32 29 05.2 E20 39 14.1	Farm boundary wall
J020A	21	S32 28 59.2 E20 39 28.4	Farm boundary wall
J020B	22	S32 29 04.0 E20 39 27.2	Farm boundary wall corner
J020C	23	S32 28 55.9 E20 39 28.7	Farm boundary wall end against bedrock boulders
J022	24	S32 29 06.4 E20 39 24.7	Stone ABW fort foundation with two adjoining stone-walled enclosures
J023	25	S32 29 07.9 E20 39 25.1	Stone-walled enclosure (historical)
J024	26	S32 28 55.9 E20 39 29.0	Historical stone kraal
J025	27	S32 28 24.1 E20 39 11.7	Ephemeral scatter of glass and food cans
J026	28	S32 28 28.8 E20 39 21.1	Scatter of green bottle glass
J027	29	S32 28 29.8 E20 39 27.3	Stone beacon
J027A	30	S32 28 30.2 E20 39 27.7	Stone beacon
J027B	31	S32 28 30.5 E20 39 28.1	Stone beacon
J027C	32	S32 28 30.9 E20 39 28.8	Stone beacon
J027D	33	S32 28 31.4 E20 39 29.2	Stone beacon
J027E	34	S32 28 31.6 E20 39 29.6	Stone beacon
J027F	35	S32 28 31.9 E20 39 29.8	Stone beacon
J027G	36	S32 28 31.9 E20 39 29.8	Stone beacon
J027H	37	S32 28 32.2 E20 39 30.2	Stone beacon
J027I	38	S32 28 32.7 E20 39 30.8	Stone beacon
J027J	39	S32 28 34.4 E20 39 32.5	Stone beacon
J027K	40	S32 28 35.1 E20 39 33.4	Stone beacon
J027L	41	S32 28 37.4 E20 39 36.1	Stone beacon
J027M	42	S32 28 37.7 E20 39 36.5	Stone beacon
J027N	43	S32 28 39.5 E20 39 38.7	Stone beacon
J028	44	S32 28 30.0 E20 39 28.1	Stone-walled enclosure (?pre-colonial)
J029	45	S32 28 05.1 E20 39 15.7	Stone ABW fort foundation
J030	46	S32 28 34.2 E20 39 25.1	Stone ABW spiral shaped enclosure
J031	47	S32 28 37.1 E20 39 20.9	Stone ABW fort foundation
J032	48	S32 28 38.3 E20 39 22.9	LSA artefact scatter
J032B	49	S32 28 38.6 E20 39 23.9	LSA artefact scatter and collected stones
J033	50	S32 28 39.4 E20 39 34.1	Stone walling (historical, ?ABW)

J034	51	S32 28 28.4 E20 39 36.2	Stone beacon
J034A	52	S32 28 29.3 E20 39 36.6	Stone beacon
J034B	53	S32 28 30.0 E20 39 36.9	Stone beacon
J034C	54	S32 28 30.9 E20 39 37.4	Stone beacon
J034D	55	S32 28 31.6 E20 39 37.7	Stone beacon
J034E	56	S32 28 32.5 E20 39 38.1	Stone beacon
J034F	57	S32 28 33.3 E20 39 38.4	Stone beacon
J034G	58	S32 28 33.6 E20 39 38.6	Stone beacon
J034H	59	S32 28 34.0 E20 39 38.8	Stone beacon
J034I	60	S32 28 34.4 E20 39 39.1	Stone beacon
J034J	61	S32 28 34.8 E20 39 39.3	Stone beacon
J034K	62	S32 28 35.1 E20 39 39.5	Stone beacon
J034L	63	S32 28 35.6 E20 39 39.8	Stone beacon
J034M	64	S32 28 36.4 E20 39 40.2	Stone beacon
J034N	65	S32 28 37.2 E20 39 40.7	Stone beacon
J034O	66	S32 28 38.7 E20 39 41.6	Stone beacon
J034P	67	S32 28 40.9 E20 39 42.2	Stone beacon
J035	68	S32 28 38.8 E20 39 42.1	Stone-walled enclosure (historical) and historical artefacts
J036	69	S32 28 41.5 E20 39 44.7	Stone-walled enclosure with gun ports on cliff edge, ABW
J037	70	S32 28 40.9 E20 39 53.8	Stone beacon
J037A	71	S32 28 41.0 E20 39 54.4	Stone beacon
J037B	72	S32 28 41.5 E20 39 56.0	Stone beacon (single vertical slab of rock)
J038	73	S32 28 45.4 E20 39 55.0	Stone wall with gun ports, ABW
J039	74	S32 28 46.9 E20 39 55.7	Stone wall with gun ports, ABW
J040	75	S32 28 52.3 E20 39 56.6	Stone ABW fort foundation
J041	76	S32 28 48.9 E20 39 33.3	Stone-walled enclosure with gun ports, ABW
J042	77	S32 28 50.4 E20 39 30.6	Farm boundary wall
J042A	78	S32 28 44.8 E20 39 28.8	Farm boundary wall
J043	79	S32 28 44.8 E20 39 34.7	Scatter of glass and metal
J044	80	S32 28 57.3 E20 40 02.2	LSA rock shelter and artefact scatter
J045	81	S32 28 53.0 E20 40 06.8	LSA rock art and stone walling (pre-colonial)
J046	82	S32 29 10.1 E20 38 38.9	Two stone beacons approx. 100 m east of road
J047	83	S32 28 41.9 E20 38 46.9	Historical kraal approx. 300 m east of road
D001	84	S32 29 57.7 E20 38 50.7	Collapsed stone structure (? wind-break or boundary marker)
D002	85	S32 29 33.4 E20 39 17.8	Ephemeral MSA artefact scatter
D003	-	(see #9 above)	Stone structure, historical dump (=J008 & J009)
D004	86	S32 29 21.1 E20 38 57.1	Stone-walled enclosure (historical)
D005	87	S32 29 21.0 E20 38 56.8	Stone walling (?historical)
D006	88	S32 29 22.8 E20 38 58.5	Stone beacon
D007	89	S32 29 23.6 E20 38 58.1	Stone structure/enclosure (historical)
D008	90	S32 29 23.8 E20 38 58.7	Stone enclosure (historical)
D009	91	S32 29 23.3 E20 39 05.9	Stone quarry for slabs
D010	92	S32 29 01.3 E20 39 40.9	Stone-walled enclosure (historical)
D011	93	S32 29 00.9 E20 39 41.4	Stone ABW fort foundation
D012	94	S32 28 23.9 E20 39 32.8	Stone beacon
D013	95	S32 28 24.2 E20 39 33.2	Stone beacon
D014	96	S32 28 24.2 E20 39 33.8	Ephemeral stone-walled enclosure and lower grindstone (pre-colonial)
D015	97	S32 28 26.2 E20 39 34.7	Stone beacon
D016	98	S32 28 27.0 E20 39 35.3	Stone beacon
D017	99	S32 28 25.6 E20 39 34.3	Stone beacon
D018	100	S32 28 19.4 E20 39 41.2	Possible stone beacon
D019	101	S32 28 36.2 E20 39 21.9	Stone-walled enclosure (historical) and historical artefacts
D020	102	S32 28 39.1 E20 39 23.5	Farm boundary wall corner
D021	103	S32 28 45.6 E20 39 38.1	Dump of old food cans and glass
D022	104	S32 28 44.6 E20 39 40.2	Dump of old glass
D023	105	S32 28 43.6 E20 39 43.6	Stone-walling in small shelter under boulder (?historical)
D024	106	S32 28 42.5 E20 39 44.5	Stone ABW fort foundation

D025	107	S32 28 39.9 E20 39 50.7	Two stone walls with gun ports, ABW
D026	108	S32 28 42.7 E20 39 53.7	Stone beacon
D027	109	S32 28 43.0 E20 39 54.2	Stone beacon
D028	110	S32 28 43.2 E20 39 54.7	Stone beacon
D029	111	S32 28 43.4 E20 39 55.3	Stone beacon
D030	112	S32 28 43.7 E20 39 55.8	Stone beacon
D031	113	S32 28 44.0 E20 39 56.5	Stone beacon
D032	114	S32 28 44.3 E20 39 57.1	Stone beacon (single vertical slab of rock)
D033	115	S32 28 44.5 E20 39 57.6	Stone beacon
D034	116	S32 28 45.0 E20 39 58.9	Stone beacon
D035	117	S32 28 45.3 E20 39 59.6	Stone beacon
D036	118	S32 28 45.9 E20 39 56.6	Stone beacon
D037	119	S32 28 32.2 E20 39 30.2	Ephemeral LSA artefact scatter

UNIVERSITY OF CAPE TOWN

Archaeology Contracts Office

Dept of Archaeology · University of Cape Town
Private Bag · Rondebosch · 7701
Tel: (021) 650 2357 Fax: (021) 650 2352

Sandra Rippon & Kirsten Scott
By email: Sandra.Rippon@uct.ac.za
Kirsten.Scott@uct.ac.za

17 August 2011

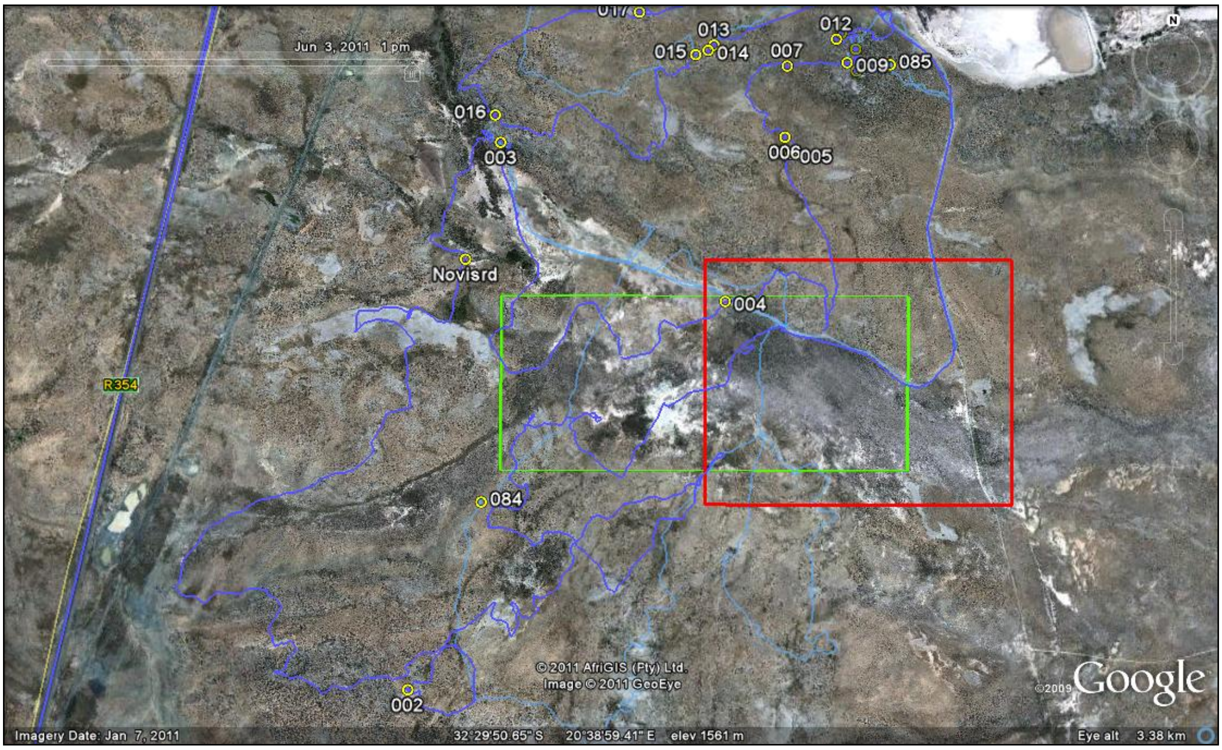
ADDENDUM TO HERITAGE IMPACT ASSESSMENT: SUTHERLAND INCA SOLAR FACILITY

Dear Sandra and Kirsten

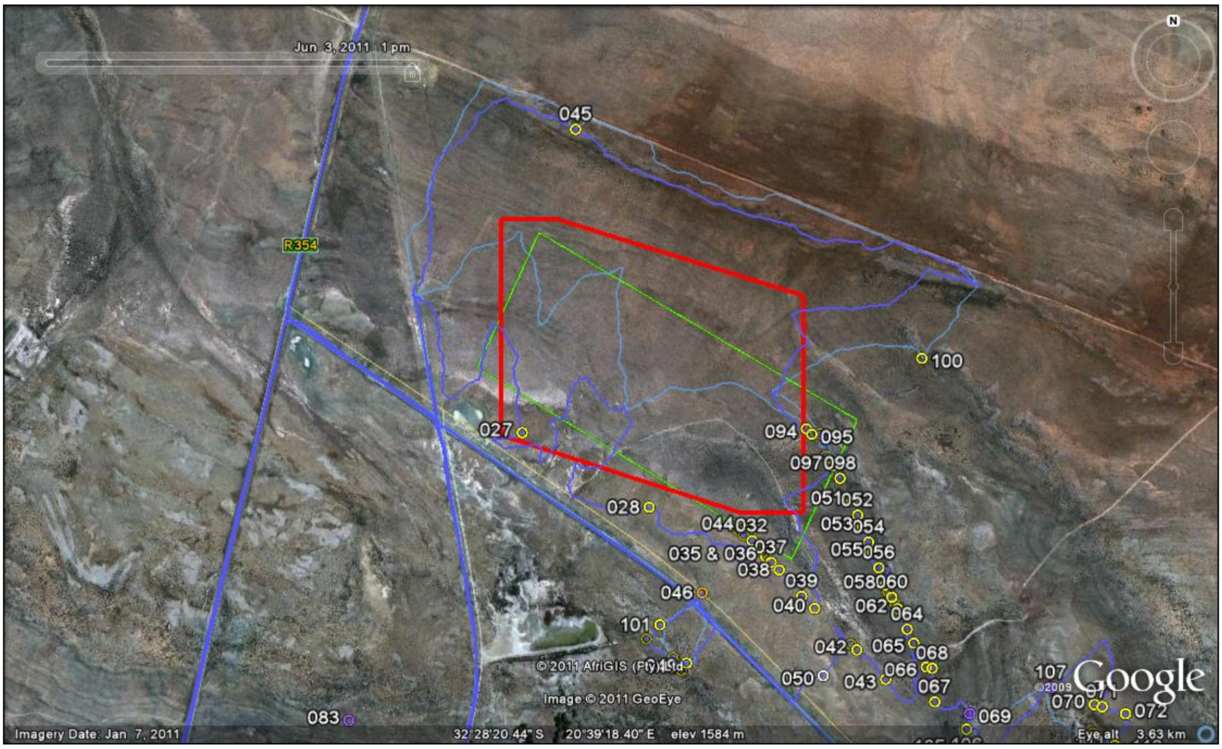
Thank you for sending the new layouts for the two options for the Solar Facility on Jakhals Valley 99, near Sutherland. I note that these changes have been in mitigation of impacts determined during the EIA process. This letter serves to provide preliminary feedback on the new layouts from a heritage perspective.

<u>New layouts</u>

Option 1 has now changed in shape to be more of a square and has been shifted some distance to the east such that it now lies between 1.0 km and 1.5 km from the R354 road. The old (green) and new (red) layouts are shown below along with heritage resources and walk paths recorded during the original survey in June 2011.



Although no fixed shape for Option 2 was provided at the time of assessment, the area later considered is shown below (green) along with the now modified area as has been guided by the findings of the EIA. Its shape seeks to avoid heritage resources.



<u>Discussion of changes</u>

Option 1 remains the preferred alternative from the project point of view and also from a heritage point of view. This is because the Anglo-Boer War material is confined to the northern part of the farm and many features recorded in that area cannot yet be definitively tied to the War. As such the northern part of the farm is deemed a far more sensitive cultural heritage landscape. Option 2 would definitely negatively impact on this landscape.

Option 1 lies in a far more open area with low rocky outcrops in proximity but no high ridges. The far more varied topography is likely the primary reason for the War material to be in the north. While important heritage sites were recorded in the southern part of the farm, the installation of the proposed solar facility there will not have the same kind of landscape-scale impact that it would for Option 2. For this reason Option 1 is strongly favoured.

Although our survey did not cover the eastern parts of the area now covered by Option 1, it is believed that heritage resources of high significance are not very likely to occur there. Any artefact scatters are likely to be of low significance.

Implications for EMP

The planned development should be allowed to proceed on Option 1 but subject to the reporting of **any** stone-built structures discovered on site during construction, no matter how ephemeral these may appear. The ECO should be briefed as to what these look like (the original HIA report can be used to illustrate) and should then report back to an archaeologist who will need to inspect and evaluate the finds, either through provision of suitable photographs or perhaps a site visit if necessary. Should it become necessary to destroy the structure then a permit may be required from the relevant heritage resources authority and mitigation measures may need to be implemented.

As an alternative, an archaeologist could be contracted to visit the site again and examine the eastern half of Option 1 should that prove to be the final development site. This would remove responsibility from the ECO and ensure that no ephemeral heritage resources are lost without suitable recording.

Development of Option 2 remains strongly discouraged.

Kind regards,

Jayson Orton

PALAEONTOLOGICAL SPECIALIST STUDY: COMBINED DESKTOP AND FIELD ASSESSMENT

Proposed photovoltaic solar energy facility on the farm Jakhals Valley (RE/99) near Sutherland, Karoo Hoogland Municipality, Eastern Cape Province

John E. Almond PhD (Cantab.)
***Natura Viva* cc, PO Box 12410 Mill Street,**
Cape Town 8010, RSA
naturaviva@universe.co.za

June 2011

EXECUTIVE SUMMARY

The proposed 10 MW solar energy facility, to be located on the farm Jakhals Valley RE/99 some 11 km south of Sutherland, Northern Cape province, is underlain by Middle Permian fluvial sediments of the Lower Beaufort Group, *viz*. the Moordenaars Member of the Abrahamskraal Formation. An important continental fossil biota of therapsids ("mammal-like reptiles"), true reptiles, fish, plant remains (including petrified wood) and trace fossils has been recorded from both channel sandstones and overbank mudrocks within this rock unit elsewhere in the western Karoo region. However, fossil records in the literature from the study region itself are very sparse, and the scarcity of fossils here was borne out by a two-day field assessment. Only reworked silicified wood from surface gravels and scattered, fragmentary plant remains associated with channel sandstones were recorded during this study, perhaps in part because of the low levels of bedrock exposure, especially in the flatter-lying southern portion of the study area. Much of the Beaufort Group outcrop here is mantled with silty alluvium, pan sediments and coarse, down-wasted gravels that are all of low palaeontological sensitivity.

Since in addition extensive, deep bedrock excavations are not envisaged for this solar energy development, it is concluded that its significance for palaeontological heritage conservation is low. No further specialist palaeontological studies for this project are required. There are no preferred development sites or no-go areas within the study area. It is recommended that:

- The ECO responsible for the development should be aware of the possibility of important fossils being present or unearthed on site and should monitor all substantial excavations into fresh (*i.e.* unweathered) sedimentary bedrock for fossil remains;

- In the case of any significant fossil finds (*e.g.* vertebrate teeth, bones, burrows, petrified wood) during construction, these should be safeguarded - preferably *in situ* - and reported by the ECO as soon as possible to the relevant heritage management authority (SAHRA) so that any appropriate mitigation by a palaeontological specialist can be considered and implemented, at the developer's expense;

- These recommendations should be incorporated into the EMP for the proposed solar energy facility.

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 as far as possible the study (*e.g.* data recording fossil collection and curation, final report) should adhere to the minimum standards for Phase 2 palaeontological studies currently being developed by SAHRA.

TABLE OF CONTENTS

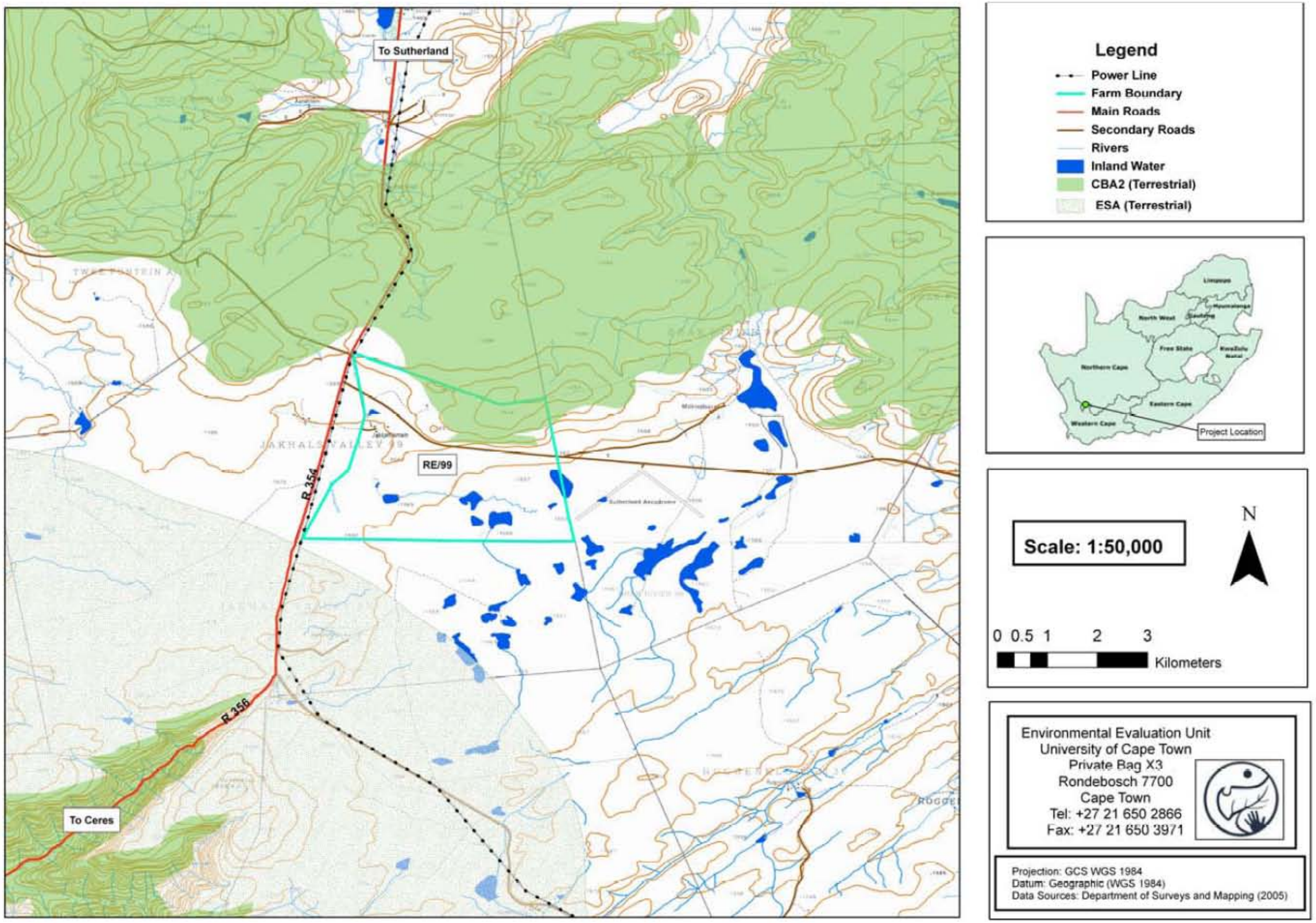
1. INTRODUCTION

The company Inca Sutherland Solar (Pty) Ltd is proposing to develop a 10 MW solar energy facility, known as the Photovoltaic Solar Energy Facility, on the farm Jakhals Valley (RE/99). The project area is situated on the eastern side of the R354 Sutherland to Matjiesfontein tar road approximately 11 km south of the town of Sutherland, Karoo Hoogland Municipality, Northern Cape province (Fig. 1). An area of less than 20 ha is required for the solar energy facility, while the farm has a total area of 1 300 ha and is currently zoned for agricultural use.

According to the Background Information Document prepared by the Environmental Evaluation Unit (EEU) based at the University of Cape Town the solar energy facility will consist of the following major components:

- 44 000 PV solar modules (0.99 m x 1.66 m) that are grouped into panels approximately 4 m wide and 3.5 m high. The panels are mounted onto steel frames;
- A 66 kV transmission line to connect to the existing Eskom line to the west of the site;
- A 66 kV transformer;
- Underground cabling between panels;
- An approximately 4 m wide unsurfaced access road to the site from the R354;
- Approximately 4 m wide unsurfaced internal access roads;
- An operational and maintenance building (32 m^2);
- Security fencing.

Fig. 1 (Following page). Location of the proposed Inca Sutherland solar energy facility *c*. 11 km south of Sutherland, Northern Cape province (Image kindly provided by the Environmental Evaluation Unit, University of Cape Town).



To Sutherland
RE/99
R 354
R 356
To Ceres
Legend
Power Line
Farm Boundary
Main Roads
Secondary Roads
Rivers
Inland Water
CBA2 (Terrestrial)
ESA (Terrestrial)
Project Location
Scale: 1:50,000
N
0 0.5 1 2 3
Kilometers
Environmental Evaluation Unit
University of Cape Town
Private Bag X3
Rondebosch 7700
Cape Town
Tel: +27 21 650 2866
Fax: +27 21 650 3971
Projection: GCS WGS 1984
Datum: Geographic (WGS 1984)
Data Sources: Department of Surveys and Mapping (2005)

Fig. 2. Google Earth™ satellite image of the iNca Sutherland study area (Jakhals Valley RE/99) *c*. 11km south of Sutherland, Northern Cape. The area lies on the eastern side of the R354 tar road (north-south yellow line) and both north and south of the Sutherland – Merweville dust road (E-W yellow line). Note rusty-brown Karoo dolerite intrusions along the northern margin of the study area, the terraced escarpment built of alternating sandstones and mudrocks of the Moordenaars Member (Abrahamskraal Formation), and the flatter terrain in the south with scattered pans, sandstone ridges and low mudrock slopes.

2. APPROACH TO THE STUDY AND LEGISLATIVE FRAMEWORK

The present report forms part of the Basic Assessment Process and EIA for both phases of the proposed iNca Sutherland Solar (Pty) Ltd solar energy facility and it will also inform the Environmental Management Plan for the project. This development falls under Section 38 (Heritage Resources Management) of the South African Heritage Resources Act (Act No. 25 of 1999). The various categories of heritage resources recognised as part of the National Estate in Section 3 of the Heritage Resources Act include, among others:

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

A combined desktop and two-day palaeontological field assessment of this project was commissioned by the Environmental Evaluation Unit at the University of Cape Town. Contact details are:

Ms Sandra Rippon / Ms Kirsten Scott
Environmental Management Unit

University of Cape Town
Cape Town, South Africa

Tel: +27 21 6502871
Email: Sandra.Rippon@uct.ac.za

Minimum standards for the palaeontological component of heritage impact assessment reports are currently being developed by SAHRA. The latest version of the SAHRA guidelines is dated May 2007.

3. SCOPE OF STUDY & METHODOLOGY

This palaeontological specialist report provides an assessment of the observed or inferred palaeontological heritage within the study area in particular, with recommendations for specialist palaeontological mitigation where this is considered necessary. The report is based on (1) a review of the relevant scientific literature, (2) published geological maps and accompanying sheet explanations, (3) a two-day field scoping study (24-25 May 2011) as well as (4) the author's extensive field experience with the formations concerned and their palaeontological heritage, including several palaeontological heritage studies in the Sutherland region (*e.g.* Almond 2005, 2010b) .

3.1. Terms of reference

Key elements of the Terms of Reference for the present palaeontological study, as specified by the Environmental Evaluation Unit, University of Cape Town, are:

- Document the baseline conditions including the findings of the field survey;
- Identify and assess the impacts and issues of the proposed project and alternatives;
- Identify and assess any cumulative impacts potentially arising from the project;
- Apply the generic significance criteria to establish the significance of the impacts;
- Propose mitigation measures to reduce the significance of negative impacts;
- Recommend suitable auditing and monitoring measures;
- Identify opportunities to enhance the Project benefits;
- Record the assumptions, and identify the limitations and uncertainties;
- Record and detail the specific approach and methodology;
- Document the above in a stand alone Impact Report.

3.2. Methodology

In preparing a palaeontological desktop study the potentially fossiliferous rock units (groups, formations *etc*) represented within the study area are determined from geological maps. 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 scoping during the compilation of the final report). This data is then used to assess the palaeontological sensitivity of each rock unit to development (Provisional tabulations of palaeontological sensitivity of all formations in the Western, Eastern and Northern Cape have already been compiled by J. Almond and colleagues; *e.g.* Almond & Pether 2008). 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 notably the extent of fresh bedrock excavation envisaged. When rock units of moderate to high palaeontological sensitivity are present within the development footprint, a field scoping study by a professional palaeontologist is usually warranted.

The focus of palaeontological field assessment work is *not* simply to survey the development footprint or even the development area as a whole (*e.g.* farms or other parcels of land concerned in the development). Rather, the palaeontologist seeks to assess or predict the diversity, density and distribution of fossils within and beneath the study area, as well as their heritage or scientific interest. This is primarily achieved through a careful field examination of one or more representative exposures of all the sedimentary rock units present (*N.B.* Metamorphic and igneous rocks rarely contain fossils). The best rock exposures are generally those that are easily accessible, extensive, fresh (*i.e.* unweathered) and include a large fraction of the stratigraphic unit concerned (*e.g.* formation). These exposures may be natural or artificial and include, for example, rocky outcrops in stream or river banks, cliffs, quarries, dams, dongas, open building excavations or road and railway cuttings. Uncemented superficial deposits, such as alluvium, scree or wind-blown sands, may occasionally contain fossils and should also be included in the scoping study where they are well-represented in the study area. It is normal practice for impact palaeontologists to collect representative, well-localized (*e.g.* GPS and stratigraphic data) samples of fossil material during scoping studies. All fossil material collected must be properly curated within an approved repository (usually a museum or university collection).

Note that while fossil localities recorded during fieldwork within the study area itself are obviously highly relevant, most fossil heritage here is embedded within rocks beneath the land surface or obscured by surface deposits (soil, alluvium *etc*) and by vegetation cover. In many cases where levels of fresh (*i.e.* unweathered) bedrock exposure are low, the hidden fossil resources have to be *inferred* from palaeontological observations made from better exposures of the same formations elsewhere in the region but outside the immediate study area. Therefore a palaeontologist might reasonably spend far *more* time examining road cuts and borrow pits close to, but outside, the study area than within the study area itself. Field data from localities even further afield (*e.g.* an adjacent province) may also be adduced to build up a realistic picture of the likely fossil heritage within the study area.

On the basis of the desktop and field 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. Mitigation by a professional palaeontologist – normally involving the recording and sampling of fossil material and associated geological information (*e.g.* sedimentological data) – is usually most effective 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 Northern Cape). It should be emphasized that, *providing appropriate mitigation is carried out*, the majority of developments involving bedrock excavation can make a *positive* contribution to our understanding of local palaeontological heritage.

3.3. 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, however.

In the case of palaeontological desktop studies without supporting 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 present case the restricted bedrock exposure over most of the study area (due to superficial sediment and vegetation cover), especially of the potentially more fossiliferous mudrock units, seriously limited the assessment of potential or buried fossil heritage here. This limitation was partially compensated by inspection of other localities near Sutherland where exposure of the same bedrock units is very good.

4. GEOLOGY AND PALAEONTOLOGY OF THE STUDY AREA

The study area on the northeastern part of farm Jakhals Valley 99 is situated on a narrow west-east extending plateau between the top of the Verlatekloof Pass and a low, rocky escarpment of sandstone and dolerite some 10km south of Sutherland (Figs. 1,2). Elevations here are between 1550m amsl in the southern *vlaktes* and 1650 m amsl on top of the low escarpment that forms the northern margin of the farm. This latter rocky area has a distinctive terraced topography that is characteristic of the Moordenaars Member bedrocks of the Beaufort Group (See below). Rocky outcrops in the southern, lower portion of study region are few, consisting of low sandstone ridges and ledges *plus* occasional gentle slopes underlain by dark mudrocks. Drainage here is poor, so there are numerous small pans floored by silty sediment, patches of downwasted surface gravels, and only a few small, shallow streams. Overall, exposure of the potentially fossiliferous Beaufort Group mudrocks within the study area is very poor, and largely restricted to occasional stream gullies, low hill slopes, the margins of a large dam to the south of the main homestead as well as several shallow borrow pits. Supplementary data on the geology and palaeontology of the Beaufort Group bedrocks was therefore obtained from several excellent road cuttings along the R354 in the Rooikloof area a few kilometres to the north of Jakhals Valley 99.

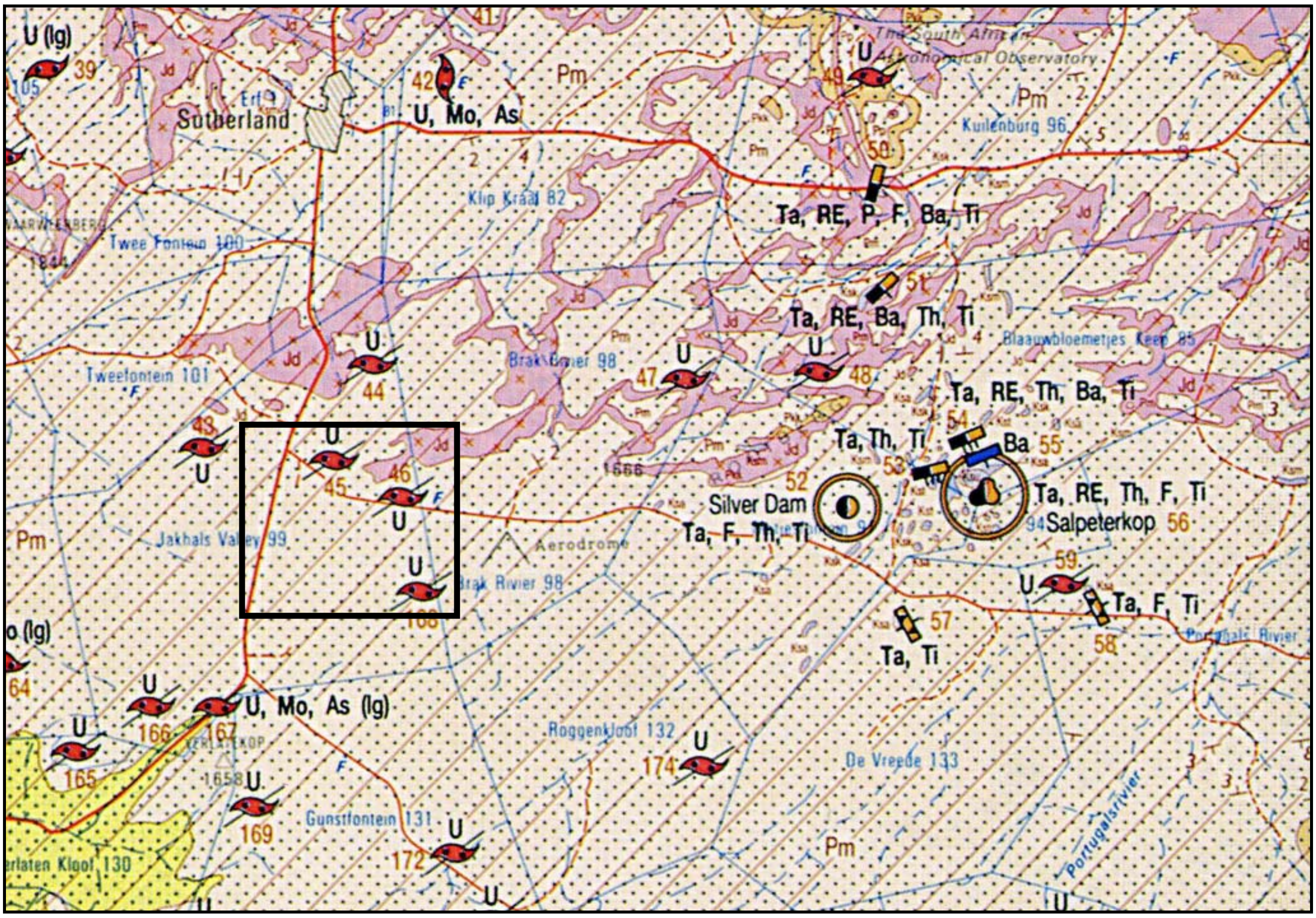


Fig. 3. Extract from the 1: 250 000 scale Sutherland Metallogenic Sheet 3220 Sutherland (Council for Geoscience, Pretoria, 1999) showing approximate location of the proposed solar energy facility study area *c*. 11 km south of Sutherland, Northern Cape province (black rectangle). The study area on farm Jakhals Valley 99 is largely underlain by Middle Permian sediments of the Moordenaars Member of the Abrahamskraal Formation, Lower Beaufort Group (Pm, pink with dots). Several uranium anomalies (U, red symbol) are located on this farm. Note the Late Cretaceous volcanic centre of Salpeterkop lies only some 20 km to the east of the study area (large yellow circle) while extensive intrusions of Early Jurassic dolerites are mapped in the northern part of Jakhals Valley 99 as well as to the north and northeast.

GPS data for all numbered localities mentioned in the text are provided in Appendix 1.

3.1. Geological setting

The geology of the Sutherland region is outlined on the 1: 250 000 scale geology sheet 3220 Sutherland (Theron 1983) as well as the updated 1: 250 000 Sutherland metallogenic map that includes important new stratigraphic detail for the Beaufort Group succession (Cole & Vorster 1999; Fig. 3). The study area is almost entirely underlain by Middle Permian continental sediments of the **Lower Beaufort Group** (Adelaide Subgroup, Karoo Supergroup), and in particular the **Abrahamskraal Formation** (Pa) at the base of the Beaufort Succession (Johnson *et al.* 2006 and references cited below). In the Sutherland region, situated just north of the Great Escarpment, the Lower Beaufort Group sediments have been extensively intruded and thermally metamorphosed (baked) by dolerite sills and dykes of the **Karoo Dolerite Suite** of Early Jurassic age (*c*. 182 Ma = million years ago; Duncan & Marsh 2006). These igneous rocks were intruded during an interval of crustal uplift and stretching that preceded the break-up of the supercontinent Gondwana. They show up on satellite images as rusty-brown areas (Fig. 2). Narrow breccia dykes of the Latest Cretaceous (c. 75-66 Ma) **Sutherland Suite** (Ks) also extend into the northern part of the study area; the major Cretaceous volcanic centre of Salpeterkop is situated only some 20 km to the east (De Wet 1975, Verwoerd 1990, Verwoerd *et al.* 1990). The Karoo dolerites and Sutherland Suite rocks in the study area are entirely unfossiliferous and will therefore only be very briefly treated in this report. The Palaeozoic and Mesozoic bedrocks in the study area are extensively overlain by Late Caenozoic **superficial deposits** or "drift" such as scree and other slope deposits (colluvium), stream alluvium, down-wasted surface gravels, pan sediments and soils. These geologically youthful sediments are generally of low palaeontological sensitivity,

3.1.1. Lower Beaufort Group (Adelaide Subgroup)

A useful recent overview of the Beaufort Group continental succession has been given by Johnson *et al.* (2006). Geological and palaeoenvironmental analyses of the Lower Beaufort Group sediments in the western Great Karoo region have been conducted by a number of workers. Key references within an extensive scientific literature include various papers by Roger Smith (*e.g.* Smith 1979, 1980, 1986, 1987a, 1987b, 1988, 1989, 1990, 1993a, 1993b) and Stear (1978, 1980a, 1980b), as well as several informative field guides (*e.g.* Cole *et al.* 1990, Cole & Smith 2008) and two geological sheet explanations for the Sutherland area (Theron 1983, Cole & Vorster 1999). In brief, the thick Beaufort Group successions of clastic sediments were laid down by a series of large, meandering rivers within a subsiding basin over a period of some ten or more million years, largely within the Middle to Late Permian Period (*c*. 266-251 Ma). Sinuous sandstone bodies of lenticular cross-section represent ancient channel infills, while thin (<1.5m), laterally-extensive sandstone beds were deposited by crevasse splays during occasional overbank floods. The bulk of the Beaufort sediments are greyish-green to reddish-brown or purplish mudrocks ("mudstones" = fine-grained claystones and slightly coarser siltstones) that were deposited over the floodplains during major floods. Thin-bedded, fine-grained playa lake deposits also accumulated locally where water ponded-up in floodplain depressions and are associated with distinctive fossil assemblages (*e.g.* fish, amphibians, coprolites or fossil droppings, arthropod, vertebrate and other trace fossils, plant fossils).

Frequent development of fine-grained pedogenic (soil) limestone or calcrete as nodules and more continuous banks indicates that semi-arid, highly seasonal climates prevailed in the Late Permian Karoo. This is also indicated by the common occurrence of sand-infilled mudcracks and silicified gypsum "desert roses" (Smith 1980, 1990, 1993a, 1993b). Highly continental climates can be expected from the palaeogeographic setting of the Karoo Basin at the time – embedded deep within the interior of the Supercontinent Pangaea and in the rainshadow of the developing Gondwanide Mountain Belt. Fluctuating water tables and redox processes in the alluvial plain soil and subsoil are indicated by interbedded mudrock horizons of contrasting colours. Reddish-brown to purplish mudrocks probably developed during drier, more oxidising conditions associated with lowered water tables, while greenish-grey mudrocks reflect reducing conditions in waterlogged soils during periods of raised water tables. However, diagenetic (post-burial) processes also greatly influence predominant mudrock colour (Smith 1990).

3.1.1,2. Abrahamskraal Formation

The Abrahamskraal Formation is a very thick (*c*. 2.5km) succession of fluvial deposits laid down in the Main Karoo Basin by meandering rivers on an extensive, low-relief floodplain during the Mid Permian Period, some 266-260 million years ago (Rossouw & De Villiers 1952, Johnson & Keyser 1979, Turner 1981, Theron 1983, Smith 1979, 1980, 1990, 1993a, 1993b, Smith & Keyser 1995a, Loock *et al*., 1994, McCarthy & Rubidge 2005, Johnson *et al*., 2006). These sediments include (a) lenticular to sheet-like channel sandstones, often associated with thin, impersistent intraformational breccio-conglomerates (larger clasts mainly of reworked mudflakes, calcrete nodules, *plus* sparse rolled bones, teeth, petrified wood), (b) well-bedded to laminated, grey-green to purple-brown floodplain mudrocks with common pedocrete horizons (calcrete nodules formed in ancient soils), (c) thin, sheet-like crevasse-splay sandstones, as well as more (d) localized playa lake deposits (*e.g.* wave-rippled sandstones, laminated mudrocks, limestones, evaporites). A number of greenish to reddish weathering, silica-rich "chert" horizons are also found. Many of these appear to be secondarily silicified mudrocks or limestones but at least some contain reworked volcanic ash (tuffs). A wide range of sedimentological and palaeontological observations point to deposition under seasonally arid climates. These include, for example, the abundance of calcretes and evaporites (silicified gypsum pseudomorphs or “desert roses”), reddened mudrocks, sun-cracked muds, “flashy” river systems, sun-baked fossil bones, well-developed seasonal growth rings in fossil wood, rarity of fauna, and little evidence for substantial bioturbation or vegetation cover (*e.g.* root casts) on floodplains away from the river banks.

The 1: 250 000 Sutherland geological sheet 3220 (Theron 1983) shows a large area of undifferentiated Abrahamskraal Formation beds in the Sutherland area. There have since been a number of attempts, only partially successful, to subdivide the very thick Abrahamskraal Formation succession in both lithostratigraphic (rock layering) and biostratigraphic (fossil) terms. Among the most recent and relevant of these was the study by Loock *et al.* (1994) in the Moordenaarskaroo area north of Laingsburg. Detailed geological mapping here led to the identification of six lithologically-defined members within the Abrahamskraal Formation. These members have since been mapped in the Sutherland area by Cole and Vorster (1999; Fig. 3) whose metallogenic map identifies the Abrahamskraal Formation beds in the Inca Sutherland study area as belonging to the **Moordenaars Member** (Pm) towards the top of the Abrahamskraal succession (Fig. 4). These rocks were previously included with the Verlatenkloof Member of Wadley and Hoffmann (1986), named after the Verlatenkloof gorge just to the southwest of the present study area.

The Moordenaars Member is a 350 m – thick, sandstone-rich succession of continental fluvial rocks characterized by stacked sheet sandstones with intervening, more recessive-weathering mudrocks (Stear 1980, Le Roux 1985, Loock *et al.* 1994, Cole & Vorster 1999) (Figs. 5 to 10). The prominent, laterally-persistent sandstone ledges generate a distinctive terraced topography on hill slopes in the Sutherland area. The sheet sandstones are generally pale-weathering (enhanced by epilithic lichens), fine-grained, and structured by horizontal lamination (flaggy, with primary current lineation) or tabular to trough cross-bedding (Figs. 5 to 7). The tabular-laminated units often contain numerous dark, very thin, laterally persistent laminae composed of heavy minerals that suggest density sorting during high energy sheet-flow conditions. The lower contacts of the channel sandstones are erosive, with lenticular basal breccias that may infill small-scale erosive gullies (Fig. 6). The breccias, which may also occur within the body of the channel sandstone unit (Fig. 7), are composed of reworked mudflake intraclasts, small calcrete nodules as well as occasional rolled vertebrate bones, teeth and plant debris. Some of the originally more organic-rich breccias are associated with secondary ferruginous (‘*koffieklip*”) and uranium ore mineralization (Cole & Vorster 1999). Several uranium anomalies have been mapped to the east of the R354 road on farm Jakhals Valley 99 (red symbols in map Fig. 3) on both sides of the dust road to Merweville.

According to the 1: 250 000 Sutherland sheet the Lower Beaufort Group rocks have been gently folded along east-west or WNW-ESE fold axes. In the study area the beds are fairly flat-lying and levels of tectonic deformation are generally low.

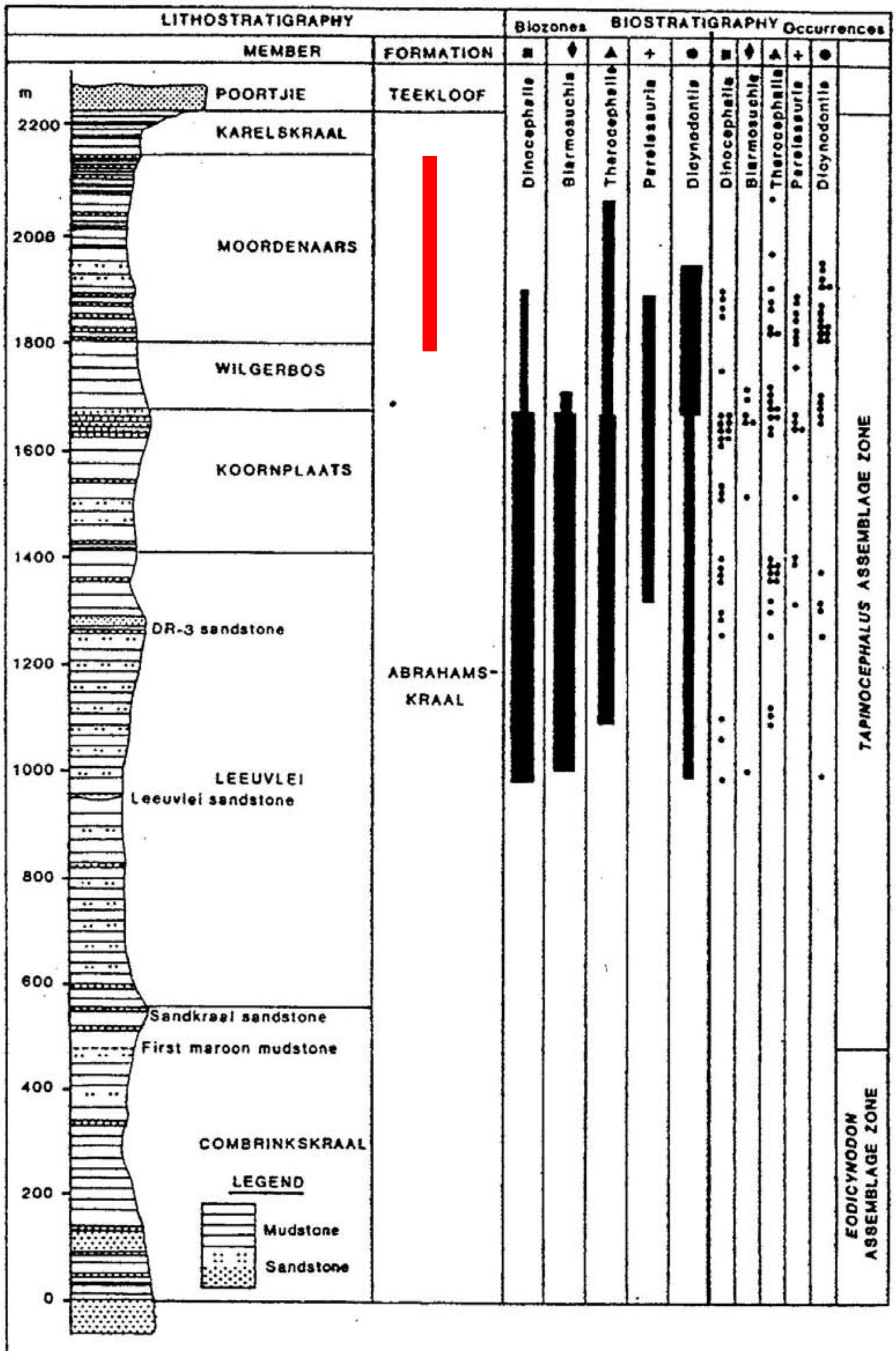


Fig. 4. Chart showing subdivision of the Abrahamskraal Formation in the western Karoo region with stratigraphic distribution of the major fossil vertebrate groups (Loock *et al*. 1994). The iNca Sutherland study area is underlain by sediments of the Mordenaars Member (red bar). Note the inferred faunal turnover episode at the top of the Koornplaats Member lower down in the succession.

Fig. 5. Typical sheet sandstone of the Moordenaars Member showing sharp erosive contact between tabular cross-bedded lower subunit and horizontally laminated upper subunit (Loc. 974).

Fig. 6. Roadcut through a thick channel sandstone of the Moordenaars Member near Rooikloof showing irregular erosive lower contact (Loc. 991). The small basal gullies are infilled with intraformational breccias (Hammer = 30 cm).

Fig. 7. Lenticular intraformational breccia of reworked mudflakes within a horizontally laminated sheet sandstone, Moordenaars Member, Rooikloof (Loc. 990). Scale = 15 cm.

Fig. 8. Patchy exposure of dark purple-brown and grey-green mudrocks with cover of down-wasted and stream gravels (Loc. **).

Fig. 9. Steam section close to Jakkalsfontein homestead showing hackly-weathering grey mudrocks overlain by buff channel sandstones (Loc. 986) (Hammer = 30 cm).

Fig. 10. Patch of wave-rippled, thinly laminated sandstones – probably deposited in a floodplain playa lake – overlain by overbank mudrocks (Loc. 989) (Hammer = 30 cm).

3.1.2. Karoo Dolerite Suite

Good sections through weathered and fresh dolerite intrusions can be seen in road cuttings along the R354 in the Rooikloof area just to the north of the study area. Typical features such as corestones, rusty-red lateritic and onion-skin weathering as well as thermal metamorphism of adjacent Beaufort Group country rocks to dark hornfels and pale buff quartzite can be seen here. In the northern part of Jakhals Valley 99 sizeable east-west trending dolerite intrusions occur, the thicker examples showing well-developed polygonal columnar jointing (Loc. 976). Rounded dolerite boulders are locally abundant and represent weathered-out corestones. A thin dolerite dyke is exposed in a borrow pit at Loc. 977 in the northwestern corner of the study area.

3.1.3. Sutherland Suite

Several narrow dykes and other more irregular intrusive bodies of grey-green breccias, locally with a fine-grained to glassy matrix, are exposed in the northwestern corner of the study area and are assigned to the Late Cretaceous Sutherland Suite (Loc. 977). Here they intrude sediments of the Lower Beaufort Group.

3.1.4. Superficial deposits

Various types of superficial deposits ("drift") of Late Caenozoic (Miocene / Pliocene to Recent) age occur widely throughout the Karoo region, including the Sutherland study area (Figs. 11 to 13). They include pedocretes (*e.g*. calcretes or soil limestones), colluvial slope deposits (blocky sandstone scree), downwasted gravels of sandstone, hornfels and dolerite, sheet wash and stream alluvium as well as silty pan sediments in depressions between sandstone ridges (Theron 1983, Cole *et al.* 2004, Partridge *et al*. 2006). Tracts of alluvium overlying the Beaufort Group bedrock are not indicated separately in the study area on the Sutherland geology sheet, presumably because they are too narrow.

Fig. 11. Concentration of coarse, blocky sandstone gravels, probably emplaced by a combination of down-wasting processes and stream action (Loc. 982).

Fig. 12. Silty pan sediments overlying Beaufort Group sandstone bedrock in a shallow depression between sandstone ridges (Loc. 982). Note also scattered blocky, down-wasted sandstone gravels.

Fig. 13. Down-wasted platy blocks of flaggy, horizontally-laminated sandstone and intervening silts overlying Beaufort Group sandstone bedrock (Loc. 982).

3.2. Palaeontological heritage

In this section are outlined the fossil heritage recorded within the main rock units represented within the study area, together with fossils observed here during the present field assessment.

3.2.1. Fossil biotas of the Lower Beaufort Group (Adelaide Subgroup)

The overall palaeontological sensitivity of the Beaufort Group sediments is high to very high (Almond & Pether 2008). These continental sediments have yielded one of the richest fossil records of land-dwelling plants and animals of Permo-Triassic age anywhere in the world (MacRae 1999, Rubidge 2005, McCarthy & Rubidge 2005). Bones and teeth of Late Permian tetrapods have been collected in the western Great Karoo region since at least the 1820s and this area remains a major focus of palaeontological research in the South Africa.

A chronological series of mappable fossil biozones or assemblage zones (AZ), defined mainly on their characteristic tetrapod faunas, has been established for the Main Karoo Basin of South Africa (Rubidge 1995, 2005). Maps showing the distribution of the Beaufort Group assemblage zones within the Main Karoo Basin have been provided by Keyser and Smith (1979, Fig. 14 herein) and Rubidge (1995, 2005); a new updated version is currently in press (Nicolas 2007, Van der Walt *et al.* in press). The only assemblage zone represented within the Inca Sutherland study area is the Middle Permian ***Tapinocephalus*** **Assemblage Zone** (Theron 1983, Rubidge 1995).

The main categories of fossils expected within the *Tapinocephalus* fossil biozone (Keyser & Smith 1977-78, Anderson & Anderson 1985, Smith & Keyser 1995a, MacRae 1999, Rubidge 2005, Nicolas 2007, Almond 2010a, 2010b) include:

- isolated petrified bones as well as rare articulated skeletons of tetrapods (*i.e.* air-breathing terrestrial vertebrates) such as true **reptiles** (notably large herbivorous pareiasaurs like *Bradysaurus* (Fig. 15), small insectivorous millerettids), rare pelycosaurs, and diverse **therapsids** or "mammal-like reptiles" (*e.g.* numerous genera of large-bodied dinocephalians (Figs. 15-16), herbivorous dicynodonts, flesh-eating biarmosuchians, gorgonopsians and therocephalians);

- aquatic vertebrates such as large **temnospondyl amphibians** (*Rhinesuchus*, usually disarticulated), and **palaeoniscoid bony fish** (*Atherstonia*, *Namaichthys*, often represented by scattered scales rather than intact fish);

- freshwater **bivalves** (*Palaeomutela*);

- **trace fossils** such as worm, arthropod and tetrapod burrows and trackways, coprolites (fossil droppings) and plant root casts;

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

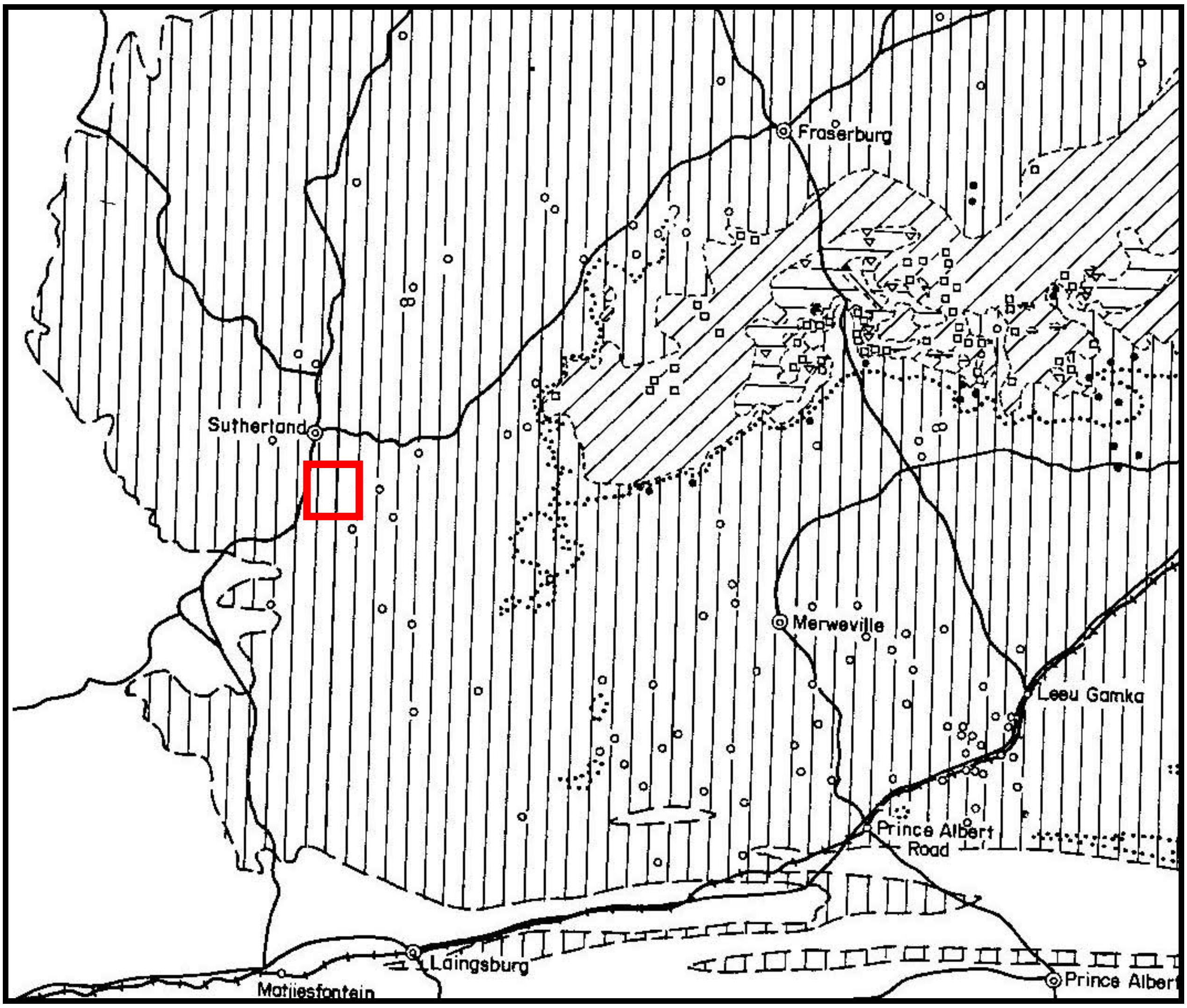


Fig. 14. Vertebrate fossil localities within the Lower Beaufort Group in the southwestern Karoo region (Map abstracted from Keyser & Smith 1977-78). Outcrop areas with a vertical lined ornament are assigned to the Middle Permian *Tapinocephalus* Assemblage Zone. Note the absence of fossil records in the iNca Sutherland study area southeast of Sutherland (red rectangle).

In general, tetrapod fossil assemblages in this zone are dominated by a wide range of dinocephalian genera and small therocephalians *plus* pareiasaurs while relatively few dicynodonts can be expected (Day & Rubidge 2010 Jirah & Rubidge 2010 and refs. therein). Vertebrate fossils in this zone are generally much rarer than seen in younger assemblage zones of the Lower Beaufort Group, with almost no fossils to be found in the lowermost beds (Fig. 4).

Despite their comparative rarity, there has been a long history of productive fossil collection from the *Tapinocephalus* Assemblage Zone in the western and central Great Karoo area, as summarized by Rossouw and De Villiers (1952) and Boonstra (1969). Numerous fossil sites recorded in the region are marked on the published 1: 250 000 Sutherland geology sheet 3220, Beaufort West sheet 3222, and on the map in Keyser and Smith (1977-78; Fig. 14). Vertebrate fossils found in the Sutherland sheet area are also listed by Kitching (1977) as well as Theron (1983). They include forms such as the pareiasaur *Bradysaurus*, tapinocephalid and titanosuchid dinocephalians *plus* rarer dicynodonts, gorgonopsians and therocephalians (*e.g.* pristerognathids, *Lycosuchus*) as well as land plant remains (*e.g.* stems and leaves). Numerous fossil sites were recorded along the eastern edge of the Moordenaarskaroo in the key biostratigraphic study of the Abrahamskraal Formation by Loock *et al.* (1994). A recent palaeontological scoping study was carried out by the author within the Abrahamskraal Formation of the Moordenaarskaroo. This fieldwork yielded locally abundant dinocephalian and other therapsid skeletal remains, large, cylindrical vertical burrows or plant stem casts, *Scoyenia* ichnofacies trace fossil assemblages and sphenophytes (horsetail ferns) associated with probable playa lake deposits, as well as locally abundant petrified wood (Almond, 2010a).

Fossils in the *Tapinocephalus* Assemblage Zone occur in association with both mudrocks and sandstones, most notably in thin intraformational conglomerates (*beenbreksie*) at the base of channel sandstones (Rossouw & De Villiers 1952, Turner 1981, Smith & Keyser 1995a, Almond 2010a).

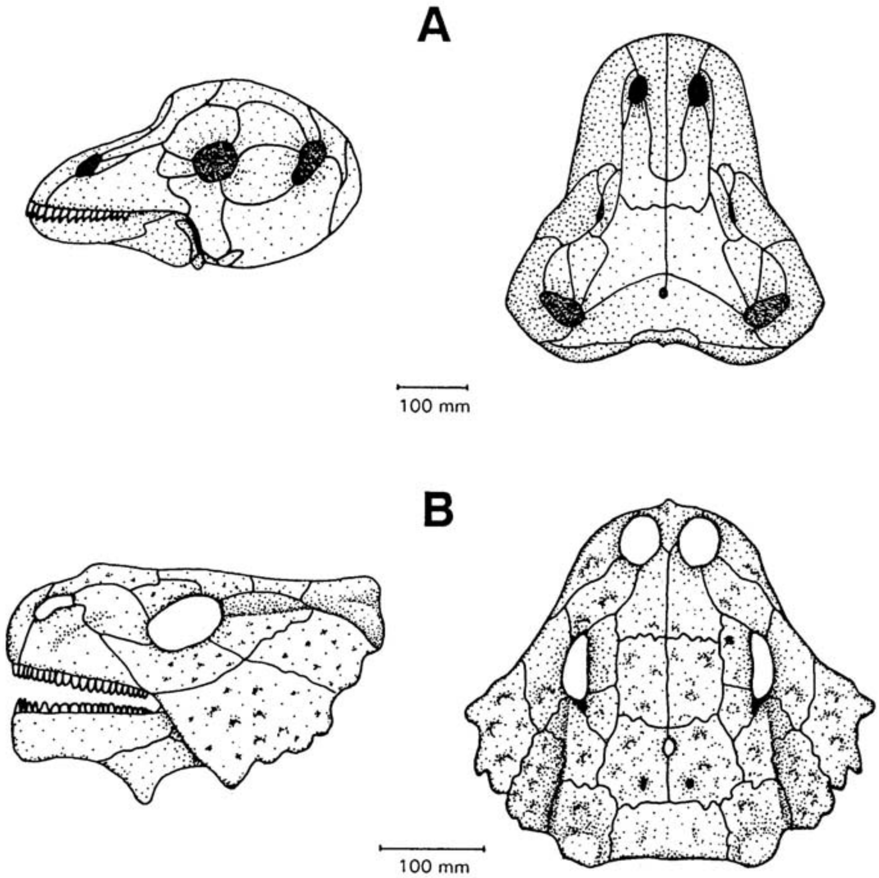


Fig. 15. Skulls of two key tetrapods of the *Tapinocephalus* Assemblage Zone: A – the dinocephalian therapsid *Tapinocephalus*; B – the pareiasaur *Bradysaurus* (From Smith & Keyser 1995b).

Intensive fossil collection within the middle part of the Abrahamskraal Formation succession has suggested that a significant faunal turnover event may have occurred at or towards the top of the sandstone-rich Koornplaats Member, with the replacement of a more archaic, dinocephalian-dominated fauna (with primitive therapsids like the biarmosuchians) by a more advanced, dicynodont-dominated one at this level (Loock *et al.* 1994; Fig. 4 herein). This is the "faunal reversal" previously noted by Boonstra (1969) as well as Rossouw and De Villiers (1953). Other fossil groups such as therocephalians and pareiasaurs do not seem to have been equally affected. Problems have arisen in trying to correlate the lithologically-defined members recognized within the Abrahamskraal Formation by different authors across the whole outcrop area, with evidence for complex lateral interdigitation of the sandstone-dominated packages (D. Cole, pers. com., 2009). A research project is currently underway to subdivide the Abrahamskraal Formation on a biostratigraphic basis, emphasizing the range zones of various genera of small dicynodonts such as *Eodicynodon, Robertia* and *Diictodon* (Day & Rubidge 2010, Jirah & Rubidge 2010). The Moordenaars Member beds in the present study area lie within the later, dinocephalian-poor portion of the Abrahamskraal Formation within which dicynodonts are the dominant herbivorous therapsids (Fig. 4).

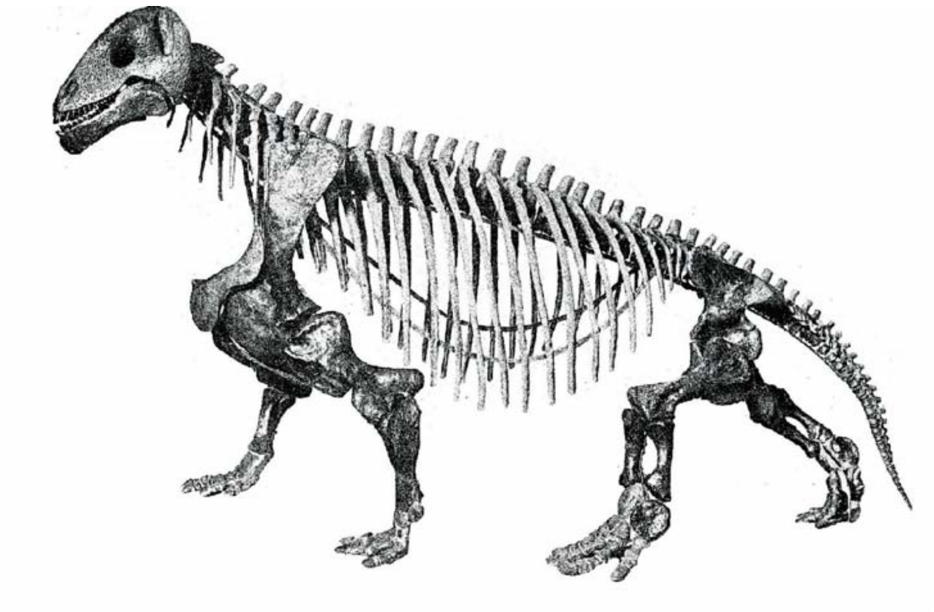


Fig. 16. Skeleton of the tapinocephalid (thick-skulled) dinocephalian *Moschops*, a rhino-sized herbivorous therapsid that reached lengths of 2.5 to 3m and may have lived in small herds.

Selected fossil sites recorded within the *Tapinocephalus* Assemblage Zones in the Sutherland region are indicated on outline maps by Kitching (1977) as well as Keyser and Smith (1977-78) (Fig. 14). Several fossil sites near Sutherland are also shown on the 1: 250 000 geological sheet 3220 Sutherland published by the Council for Geoscience, Pretoria (*e.g.* Farm Matjiesfontein just to the east of the study area). Fossil occurrences on the farms Portugalsrivier (southeast of Salpeterkop) and Palmietfontein are mentioned in local tourism literature. In addition Kitching (1977) provides palaeofaunal lists for specific localities within the Great Karoo region. It is notable that these works suggest a paucity of fossils in the study area to the south of Sutherland, although a few localities are indicated to the east of the study area (Fig. 14). This palaeontological impoverishment seems to apply even to the excellent exposures of Abrahamskraal Formation sediments within the Verlatekloof Pass a few kilometres to the southwest. The reasons for the lack of fossils even here, despite appropriate facies and good exposures, is currently unresolved and may have a palaeoenvironmental component. A previous palaeontological field assessment of Mordenaars Member rocks on the outskirts of Sutherland by Almond (2005) yielded only transported plant remains (arthrophytes including *Phyllotheca*, glossopterid and other, more strap-shaped leaves, possible wood tool marks), sparse trace fossil assemblages of the damp-ground *Scoyenia* ichnofacies, and rare fragments of rolled bone.

Fig. 17. Disarticulated rib of a moderate-sized tetrapod – probably therapsid – associated with a thin crevasse splay sandstone, road cutting near Rooikloof (Loc. 990) (Scale in cm and mm).

Fig. 18. Worn, reworked block of silicified wood showing well-developed seasonal growth rings, collected from gravels between the Jakkalsfontein farmstead and the large farm dam to the south (Mnr C. Visagie, pers. comm., 2011).

Fig. 19. Longitudinally-striated plant stem embedded within Lower Beaufort sandstone, collected close to the Jakkalsfontein homestead (Mnr C. Visagie, pers. comm., 2011).

Sandstone surfaces in the study area are often covered in a patina of lichens which hinders recognition of fossil material. Small to quite extensive mudrock exposures in several borrow pits (Locs. 977, 987, 989), stream sections (Locs. 978, 985), dam margins (Loc. 980) and low hill slopes (Loc. 981, 983, 984) were examined for fossils without success. Pale grey and rusty brown, ferruginous calcrete nodules are locally abundant, both *in situ* as well as concentrated by surface weathering into gullies and depressions, but no associated vertebrate remains were seen. A well-preserved, longitudinally-striated fossil plant stem (cast and internal mould) have been previously collected from sandstones near the Jakkalsfontein farmstead (Fig. 19) while a single, subrounded block of reworked silicified wood from the Beaufort Group (Fig. 18) was previously collected from surface gravels south of the homestead (Mnr. C. Conradie, pers. comm., 2011). Ferruginised breccias (*koffieklip*) associated with channel sandstones in a stream section near the Jakkalsfontein farmstead (Loc. 986, Fig. 9) contain poorly-preserved impressions of transported plant material, as do channel sandstones near Rooikloof homestead (Loc. 992). Uranium anomalies indicated on farm Jakhals Valley 99 on the metallogenic map by Cole & Vorster (1999) may well be associated with similar concentrations of fossilised plant material within channel sandstones (Fig. 3). An isolated rib of a moderate-sized tetrapod (reptile or, more probably, therapsid) was recorded from a Moordenaars Member crevasse splay sandstone in a road cutting near Rooikloof homestead (Fig. 17).

It is concluded that, while sparse palaeontological heritage such as disarticulated tetrapods and transported plant material (*e.g.* petrified wood) do occur within the Lower Beaufort Group sediments in and around the study area, fossil remains are generally sparse here.

3.2.2. Fossils within igneous rocks

The Karoo dolerites and breccias of the Sutherland Suite are igneous rocks, intruded at depth within the crust, and therefore do not contain fossils. Intrusion of hot basic magmas often bakes the adjacent country rocks and may compromise fossils preserved within them, or at least complicate their mechanical extraction.

3.2.3. Fossil biotas within superficial deposits

The geologically young - largely Quaternary to Recent- superficial deposits such as colluvium, gravels, silty alluvium *etc* in the Karoo region as a whole have been comparatively neglected in palaeontological terms for the most part. However, they may occasionally contain important fossil biotas, notably the bones, teeth and horn cores of mammals (*e.g.* Skead 1980, Klein 1984, MacRae 1999, Partridge & Scott 2000, Partridge *et al.,* 2006). Other late Caenozoic fossil biotas from these superficial deposits include non-marine molluscs (bivalves, gastropods, rhizoliths), ostrich egg shells, trace fossils (*e.g.* calcretised termitaria, coprolites), and plant remains such as peats or palynomorphs (pollens) in organic-rich alluvial horizons.

No fossils – apart from stone artefacts (mainly of dark, fine-grained hornfels) of archaeological interest and the reworked block of siicified Beaufort Group wood shown in Fig. 18 – were recorded within the superficial sediments in the Sutherland study area.

5. IMPACT ASSESSMENT

The proposed Inca Sutherland Solar (Pty) Ltd solar energy facility south of Sutherland is located in an area of the Western Karoo that is underlain by potentially fossil-rich sedimentary rocks of the Karoo Supergroup that are of Middle Permian age. The construction phase of the development will entail excavations into the superficial sediment cover (soils *etc*) and *perhaps* also into the underlying bedrock. These notably include excavations for the solar panel support frames, buried cables, new gravel access roads and ancillary buildings. All these developments may adversely affect potential fossil heritage within the study area by destroying, disturbing or permanently sealing-in fossils at or below the surface of the ground within the development footprint that are then no longer available for scientific research or other public good. These impacts are of a direct nature.

The significance of the impacts on palaeontological heritage caused by the proposed development is assessed in the summary table below (Table 5.1). Note that significant impacts are only likely during the construction phase. Once constructed, the operational and decommissioning / closure phases of the solar energy facility will not involve further adverse impacts on palaeontological heritage.

Loss of or damage to fossil heritage is regarded as a *negative* impact whose effect is confined to the immediate development footprint, *i.e. local* in extent. Since fossils are irreplaceable, such impacts are generally *permanent*. In the case of the proposed development the impact intensity is *low* (*negative*) because of the scarcity of fossil remains within the study area, and for the same reason the probability of significance impacts on palaeontological heritage here is *low*. The overall significance of the iNca Sutherland solar energy facility development for palaeontological heritage is consequently LOW.

Note that should fossils be exposed or found during development and the appropriate mitigation protocol is followed (as recommended below), this would constitute a *positive* impact because new, well-documented fossil records in the Sutherland region are of significant scientific value. Depending on the uniqueness and quality of the fossil finds concerned, mitigation could then result in a *low to medium* (*positive*) impact significance for the development.

Confidence levels for this assessment are moderate but *not* high because of the low levels of bedrock exposure in the study area and the known occurrence of rich, but often very localized, concentrations of important fossils within the outcrop area of the Abrahamskraal Formation elsewhere.

5.1. Site preference and no-go areas

The inferred low significance applies to the entire Jakhals Valley 99 study area and there are therefore no no-go areas or preferred sites here as far as palaeontological heritage is concerned.

5.2. Cumulative impacts

There are several other renewable energy facilities (REFs) planned for the Sutherland region, including (1) the Suurplaat REF 50 km south-east of Sutherland (Savannah SA & Moyeng Energy); (2) the Roggeveld REF 45 km south of Sutherland (ERM & G7 Renewables), and (3) the Sutherland REF 25 km south-east of Sutherland (ERM & Mainstream). Some of these projects cover a large area of veld that is largely unstudied from a palaeontological viewpoint and so significant fossil heritage impacts are possible, especially if no professional mitigation is undertaken. However, the small scale iNca Sutherland project will not contribute significantly to cumulative palaeontological impacts in the Sutherland region.

5.3. Mitigation

In view of the inferred low significance of the proposed development for fossil heritage, further professional palaeontological mitigation is unlikely to be necessary here.

The following recommendations are made:

- The ECO responsible for the development should be aware of the possibility of important fossils being present or unearthed on site and should monitor all substantial excavations into fresh (*i.e.* unweathered) sedimentary bedrock for fossil remains;

- In the case of any significant fossil finds (*e.g.* vertebrate teeth, bones, burrows, petrified wood) during construction, these should be safeguarded - preferably *in situ* - and reported by the ECO as soon as possible to the relevant heritage management authority (SAHRA) so that any appropriate mitigation by a palaeontological specialist can be considered and implemented, at the developer's expense;

- These recommendations should be incorporated into the EMP for the iNca Sutherland solar energy facility.

It should be noted that all South African fossil heritage is protected by law (South African Heritage Resources Act, 1999) and fossils cannot be collected, damaged or disturbed without a permit. Any palaeontologist concerned with mitigation work for the project will therefore need a valid fossil 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 currently being developed by SAHRA.

Should fossils be discovered before or during construction and reported by the responsible ECO to the responsible heritage management authority (SAHRA) for professional recording and collection, as recommended here, the overall impact significance of the project would change to low to medium (*positive*). This is a positive outcome because any new, well-recorded and suitably curated fossil material from these Karoo bedrocks would constitute a useful addition to our scientific understanding of the palaeontological heritage of the region.

Table 5.1: Significance of Sutherland Solar Energy Facility Project for Palaeontological Heritage

DESCRIPTION OF THE IMPACT	NATURE / STATUS	EXTENT	DURATION	INTENSITY	PROBABILITY	SIGNIFICANCE (WITHOUT MITIGATION)	MITIGATION	SIGNIFICANCE (WITH MITIGATION)
PLANNING AND DESIGN								
No significant impacts	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
CONSTRUCTION								
Disturbance, damage, destruction or sealing-in of fossils at or below surface of the ground	Negative	Local	Permanent	Low	Improbable	Low (negative)	Recording of new fossil material by ECO and /or palaeontologist during construction	Low to Medium (positive)
OPERATION								
No significant impacts	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
DECOMMISSIONING								
No significant impacts	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

6. CONCLUSION & RECOMMENDATIONS

The proposed iNca Sutherland solar energy facility is underlain by Middle Permian fluvial sediments of the Lower Beaufort Group, *viz*. the Moordenaars Member of the Abrahamskraal Formation. Elsewhere in the western Karoo region these rocks are known to be highly fossiliferous, containing important remains of mammal-like reptiles, true reptiles, trace fossils and plant material. However, published fossil records from the study region are very sparse, and the scarcity of fossils here was borne out by a two-day field assessment (*N.B.* Levels of bedrock exposure here are generally low to very low). For this reason, and also because extensive, deep bedrock excavations are not envisaged for this solar energy development, it is concluded that its significance for palaeontological heritage conservation is *low*. No further specialist palaeontological studies for this project are required.

There are no fatal flaws with the proposed development as far as fossil heritage is concerned. Likewise there are no no-go areas or preferred development sites within the study area.

It is recommended that:

- The ECO responsible for the development should be aware of the possibility of important fossils being present or unearthed on site and should monitor all substantial excavations into fresh (*i.e.* unweathered) sedimentary bedrock for fossil remains;

- In the case of any significant fossil finds (*e.g.* vertebrate teeth, bones, burrows, petrified wood) during construction, these should be safeguarded - preferably *in situ* - and reported by the ECO as soon as possible to the relevant heritage management authority (SAHRA) so that any appropriate mitigation by a palaeontological specialist can be considered and implemented, at the developer's expense;

- These recommendations should be incorporated into the EMP for the proposed solar energy facility.

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 as far as possible the study (*e.g.* data recording fossil collection and curation, final report) should adhere to the minimum standards for Phase 2 palaeontological studies currently being developed by SAHRA.

7. REFERENCES

ALMOND, J.E. 2005. Palaeontological scoping report: Proposed golf estate, Sutherland, Northern Cape, 10 pp. Natura Viva cc, Cape Town.

ALMOND, J.E. 2010a. Eskom Gamma-Omega 765kV transmission line: Phase 2 palaeontological impact assessment. Sector 1, Tanqua Karoo to Omega Substation (Western and Northern Cape Provinces), 95 pp + Appendix. Natura Viva cc, Cape Town.

ALMOND, J.E. 2010b. Palaeontological impact assessment: desktop study – Proposed Suurplaat wind energy facility near Sutherland, Western Cape, 33 pp. Natura Viva cc, Cape Town.

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

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

ATAYMAN, S., RUBIDGE, B.S. & ABDALA, F. 2009. Taxonomic re-evaluation of tapinocephalid dinocephalians. Palaeontologia africana 44, 87-90.

BAMFORD, M. 1999. Permo-Triassic fossil woods from the South African Karoo Basin. Palaeontologia africana 35, 25-40.

BENDER, P.A. 2004. Late Permian actinopterygian (palaeoniscid) fishes from the Beaufort Group, South Africa: biostratigraphic and biogeographic implications. Council for Geoscience Bulletin 135, 84 pp.

BOONSTRA, L.D. 1969. The fauna of the Tapinocephalus Zone (Beaufort Beds of the Karoo). Annals of the South African Museum 56: 1-73.

BOTHA-BRINK, J. & MODESTO, S.P. 2007. A mixed-age classed “pelycosaur” aggregation from South Africa: earliest evidence of parental care in amniotes? Proceedings of the Royal Society of London (B) 274, 2829-2834.

COLE, D.I., SMITH, R.M.H. & WICKENS, H. DE V. 1990. Basin-plain to fluvio-lacustrine deposits in the Permian Ecca and Lower Beaufort Groups of the Karoo Sequence. Guidebook Geocongress ’90, Geological Society of South Africa, PO2, 1-83.

COLE, D.I., NEVELING, J., HATTINGH, J., CHEVALLIER, L.P., REDDERING, J.S.V. & BENDER, P.A. 2004. The geology of the Middelburg area. Explanation to 1: 250 000 geology Sheet 3124 Middelburg, 44 pp. Council for Geoscience, Pretoria.

COLE, D. & SMITH, R. 2008. Fluvial architecture of the Late Permian Beaufort Group deposits, S.W. Karoo Basin: point bars, crevasse splays, palaeosols, vertebrate fossils and uranium. Field Excursion FT02 guidebook, AAPG International Conference, Cape Town October 2008, 110 pp.

COLE, D.I. & VORSTER, C.J. 1999. The metallogeny of the Sutherland area, 41 pp. Council for Geoscience, Pretoria.

DAY, M. & RUBIDGE, B. 2010. Middle Permian continental biodiversity changes as reflected in the Beaufort group of South Africa: An initial review of the Tapinocephalus and Pristerognathus assemblage zones. Proceedings of the 16th conference of the Palaeontological Society of Southern Africa, Howick, August 5-8, 2010, pp. 22-23.

DE WET, J.J. 1975. Carbonatites and related rocks at Salpetre Kop, Sutherland, Cape Province. Annals of the University of Stellenbosch Series A1 (Geology) 1, 193-232.

DUNCAN, A.R. & MARSH, J.S. 2006. The Karoo Igneous Province. Pp. 501-520 in Johnson. M.R., Anhaeusser, C.R. & Thomas, R.J. (eds.) The geology of South Africa. Geological Society of South Africa, Johannesburg & the Council for Geoscience, Pretoria.

ERWIN, D.H. 2006. Extinction. How life on Earth nearly ended 250 million years ago, 296 pp. Princeton University Press, Princeton.

JIRAH, S. & RUBIDGE, B.S. 2010. Sedimentological, palaeontological and stratigraphic analysis of the Abrahamskraal Formation (Beaufort Group) in an area south of Merweville, South Africa. Proceedings of the 16th conference of the Palaeontological Society of Southern Africa, Howick, August 5-8, 2010, pp. 46-47.

JOHNSON, M.R. & KEYSER, A.W. 1979. The geology of the Beaufort West area. Explanation of geological Sheet 3222, 14 pp. Council for Geoscience, Pretoria.

JOHNSON, M.R., VAN VUUREN, C.J., VISSER, J.N.J., COLE, D.I., WICKENS, H. DE V., CHRISTIE, A.D.M., ROBERTS, D.L. & BRANDL, G. 2006. Sedimentary rocks of the Karoo Supergroup. In: Johnson. M.R., Anhaeusser, C.R. & Thomas, R.J. (eds.) The geology of South Africa, pp. 461-499. Geological Society of South Africa, Johannesburg & the Council for Geoscience, Pretoria.

KEYSER, A.W. & SMITH, R.M.H. 1977-78. Vertebrate biozonation of the Beaufort Group with special reference to the Western Karoo Basin. Annals of the Geological Survey of South Africa 12: 1-36.

KITCHING, J.W. 1977. The distribution of the Karroo vertebrate fauna, with special reference to certain genera and the bearing of this distribution on the zoning of the Beaufort beds. Memoirs of the Bernard Price Institute for Palaeontological Research, University of the Witwatersrand, No. 1, 133 pp (incl. 15 pls).

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

LE ROUX, J.P. 1985. Palaeochannels and uranium mineralization in the main Karoo Basin of South Africa. Unpublished PhD thesis, University of Port Elizabeth, 250 pp.

LOOCK, J.C., BRYNARD, H.J., HEARD, R.G., KITCHING, J.W. & RUBIDGE, B.S. 1994. The stratigraphy of the Lower Beaufort Group in an area north of Laingsburg, South Africa. Journal of African Earth Sciences 18: 185-195.

LUCAS, D.G. 2009. Global Middle Permian reptile mass extinction: the dinocephalian extinction event. Geological Society of America Abstracts with Programs 41, No. 7, p. 360.

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

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

NICOLAS, M.V. 2007. Tetrapod diversity through the Permo-Triassic Beaufort Group (Karoo Supergroup) of South Africa. Unpublished PhD thesis, University of Witwatersrand, Johannesburg.

PARTRIDGE, T.C. & MAUD, R.R. 1987. Geomorphic evolution of southern Africa since the Mesozoic. South African Journal of Geology 90: 179-208.

PARTRIDGE, T.C., BOTHA, G.A. & HADDON, I.G. 2006. Cenozoic deposits of the interior. In: Johnson, M.R., Anhaeusser, C.R. & Thomas, R.J. (Eds.) The geology of South Africa, pp. 585-604. Geological Society of South Africa, Marshalltown.

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

RETALLACK, G.J., METZGER, C.A., GREAVER, T., HOPE JAHREN, A., SMITH, R.M.H. & SHELDON, N.D. 2006. Middle – Late Permian mass extinction on land. GSA Bulletin 118, 1398-1411.

ROSSOUW, P.J. & DE VILLIERS, J. 1952. Die geologie van die gebied Merweville, Kaapprovinsie. Explanation to 1: 125 000 geology sheet 198 Merweville, 63 pp. Council for Geoscience, Pretoria.

RUBIDGE, B.S. (Ed.) 1995. Biostratigraphy of the Beaufort Group (Karoo Supergroup). South African Committee for Biostratigraphy, Biostratigraphic Series No. 1., 46 pp. Council for Geoscience, Pretoria.

RUBIDGE, B.S. 2005. Re-uniting lost continents – fossil reptiles from the ancient Karoo and their wanderlust. 27th Du Toit Memorial Lecture. South African Journal of Geology 108, 135-172.

RUBIDGE, B.S., ERWIN, D.H., RAMEZANI, J., BOWRING, S.A. & DE KLERK, W.J. 2010. The first radiometric dates for the Beaufort Group, Karoo Supergroup of South Africa. Proceedings of the 16th conference of the Palaeontological Society of Southern Africa, Howick, August 5-8, 2010, pp. 82-83.

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

SMITH, R.M.H. 1979. The sedimentology and taphonomy of flood-plain deposits of the Lower Beaufort (Adelaide Subgroup) strata near Beaufort West, Cape Province. Annals of the Geological Survey of South Africa 12, 37-68.

SMITH, R.M.H. 1980. The lithology, sedimentology and taphonomy of flood-plain deposits of the Lower Beaufort (Adelaide Subgroup) strata near Beaufort West. Transactions of the Geological Society of South Africa 83, 399-413.

SMITH, R.M.H. 1986. Trace fossils of the ancient Karoo. Sagittarius 1 (3), 4-9.

SMITH, R.M.H. 1987a. Morphological and depositional history of exhumed Permian point bars in the southwestern Karoo, South Africa. Journal of Sedimentary Petrology 57, 19-29.

SMITH, R.M.H. 1987b. Helical burrow casts of therapsid origin from the Beaufort Group (Permian) of South Africa. Palaeogeography, Palaeoclimatology, Palaeoecology 60, 155-170.

SMITH, R.M.H. 1988. Fossils for Africa. An introduction to the fossil wealth of the Nuweveld mountains near Beaufort West. Sagittarius 3, 4-9. SA Museum, Cape Town.

SMITH, R.M.H. 1989. Fossils in the Karoo – some important questions answered. Custos 17, 48-51.

SMITH, R.M.H. 1990. Alluvial paleosols and pedofacies sequences in the Permian Lower Beaufort of the southwestern Karoo Basin, South Africa. Journal of Sedimentary Petrology 60, 258-276.

SMITH, R.M.H. 1993a. Sedimentology and ichnology of floodplain paleosurfaces in the Beaufort Group (Late Permian), Karoo Sequence, South Africa. Palaios 8, 339-357.

SMITH, R.M.H. 1993b. Vertebrate taphonomy of Late Permian floodplain deposits in the southwestern Karoo Basin of South Africa. Palaios 8, 45-67.

SMITH, R.M.H. & KEYSER, A.W. 1995a. Biostratigraphy of the *Tapinocephalus* Assemblage Zone. Pp. 8-12 in Rubidge, B.S. (ed.) Biostratigraphy of the Beaufort Group (Karoo Supergroup). South African Committee for Stratigraphy, Biostratigraphic Series No. 1. Council for Geoscience, Pretoria.

SMITH, R.M.H. & KEYSER, A.W. 1995b. Biostratigraphy of the *Pristerognathus* Assemblage Zone. Pp. 13-17 in Rubidge, B.S. (ed.) Biostratigraphy of the Beaufort Group (Karoo Supergroup). South African Committee for Stratigraphy, Biostratigraphic Series No. 1. Council for Geoscience, Pretoria.

SMITH, R.M.H. & ALMOND, J.E. 1998. Late Permian continental trace assemblages from the Lower Beaufort Group (Karoo Supergroup), South Africa. Abstracts, Tercera Reunión Argentina de Icnologia, Mar del Plata, 1998, p. 29.

STEAR, W.M. 1978. Sedimentary structures related to fluctuating hydrodynamic conditions in flood plain deposits of the Beaufort Group near Beaufort West, Cape. Transactions of the Geological Society of South Africa 81, 393-399.

STEAR, W.M. 1980a. The sedimentary environment of the Beaufort Group uranium province in the vicinity of Beaufort West, South Africa. Unpublished PhD thesis, University of Port Elizabeth, 188 pp.

STEAR, W.M. 1980b. Channel sandstone and bar morphology of the Beaufort Group uranium district near Beaufort West. Transactions of the Geological Society of South Africa 83: 391-398.

THERON, J.N. 1983. Die geologie van die gebied Sutherland. Explanation of 1: 250 000 geological Sheet 3220, 29 pp. Council for Geoscience, Pretoria.

TURNER, B.R. 1981. The occurrence, origin and stratigraphic significance of bone-bearing mudstone pellet conglomerates from the Beaufort Group in the Jansenville District, Cape Province, South Africa. Palaeontologia africana 24, 63-73.

VAN DER WALT, M., DAY, M., RUBIDGE, B., COOPER, A.K. & NETTERBERG, I. In press, 2010. Utilising GIS technology to create a biozone map for the Beaufort Group (Karoo Supergroup) of South Africa. Palaeontologia Africana.

VERWOERD, W.J. 1990. The Salpeterkop ring structure, Cape Province, South Africa. Tectonophysics 171, 275-285.

VERWOERD, W.J., VILJOEN, J.H.A. & VILJOEN, K.S. 1990. Olivine melilitites and associated intrusives of the southwestern Cape Province. Guidebook Geocongress ’90, Geological Society of South Africa, PR3, 1-60.

8. ACKNOWLEDGEMENTS

Ms Sandra Rippon and Ms Kirsten Scott of the Environmental Evaluation Unit, University of Cape Town, are both thanked for commissioning this study, for discussing the project on site, and for kindly providing all the necessary background information. I am also very grateful to the landowner at Jakkalsfontein, Mnr Cronjé Visagie, for sharing his knowledge of local fossils with us and for hospitality during our study. As always, Madelon Tusenius provided invaluable assistance in the field.

APPENDIX: GPS LOCALITY INFORMATION

All GPS readings were taken in the field using a hand-held Garmin GPSmap 60CSx instrument. The datum used is WGS 84.

Only those localities mentioned in the text are listed here.

LOCALITY NUMBER	SOUTH	EAST
974	32° 28’ 43.1”	20° 41’ 08.1”
976	32° 28’ 05.6”	20° 39’ 16.1”
977	32° 28’ 01.4”	20° 39’ 04.6”
978	32° 28’ 30.0”	20° 39’ 51.5”
980	32° 29’ 33.2”	20° 39’ 22.1”
981	32° 29’ 16.7”	20° 39’ 19.4”
982	32° 29’ 44.1”	20° 38’ 58.3”
983	32° 29’ 12.3”	20° 39’ 14.6”
984	32° 28’ 45.9”	20° 39’ 06.1”
985	32° 28’ 42.5”	20° 39’ 09.0”
986	32° 28’ 40.4”	20° 39’ 09.6”
987	32° 28’ 18.5”	20° 38’ 55.6”
989	32° 28’ 23.3”	20° 39’ 06.4”
990	32° 26’ 04.0”	20° 39’ 19.9”
991	32° 26’ 11.6”	20° 39’ 19.7”
992	32° 26’ 24.1”	20° 39’ 19.8”

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 APHAP (Association of Professional Heritage Assessment Practitioners – Western Cape).

Declaration of Independence

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

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