HERITAGE IMPACT ASSESSMENT FOR THE PROPOSED KOMSBERG EAST AND WEST WIND ENERGY FACILITIES AND GRID CONNECTIONS TO BE SITUATED IN THE WESTERN CAPE PROVINCE, ESCARPMENT AREA, MOORDENAARS KAROO

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

Prepared for
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November 2015

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Summary

ACO Associates CC has been appointed by Arcus Consulting Pty Ltd to contribute a specialist heritage report to an EIA process for the proposed Komsberg Wind Energy Facility. The project area lies in the Great Karoo close to the Moordenaars Karoo escarpment between Sutherland and Laingsburg in the Western Cape Province. This is an arid area characterised by the escarpment and its foothills of long windswept ridges. It is isolated and sparsely populated. It has been deemed a Renewable Energy Development Zone (REDZ) by the CSIR, earmarked through Strategic Environmental Assessments (SEAs) by the DEA.

This report identifies potential impacts with respect to the broad discipline of heritage which includes palaeontology, archaeology, historic structures, places, and landscape quality. Previous work in the region has revealed a long history of human occupation, several periods of conflict and numbers of archaeological sites. The palaeontology of the Karoo is internationally significant.

Findings

- Archaeology. The physical remnants of human activity were identified and assessed through physical site inspection, mapped and assigned field grades. As predicted in the scoping report the main sensitivities of both Komsberg East and Komsberg West lie within the valley bottoms where there is much evidence of 19th century historic *Trekboer* farming includes numerous stone kraals, stock posts and occasional historic farmsteads, two of which in the study area have been assigned field grades of IIIA. The precolonial archaeology of the study area is almost non-existent. Despite travelling several hundreds of kilometres (with 4 team members with archaeological knowledge) within the study area none were found. This is attributable to the complete lack of raw material (rock) in the project areas that can be used for making stone artefacts. Since most of the infrastructure development will take place on high windswept ridges that impact of the proposals will be of very low significance.
- Palaeontology. An examination of the shales and mudrocks of the Abrahamskraal formation which characterises the project area has produced minimal evidence of surface palaeontological material. Indications are that the impact of the proposed activities will be of medium significance based on the general sensitivity of the region but of low significance with mitigation.
- Landscape and setting. Both Komsberg East and Komsberg West are very isolated localities. On many land parcels farming activities have been scaled down and some of the landlords of properties are absentee. The landscape is empty and desolate with nature prevailing. The ridge tops where the proposed activities will take are windswept and bleak, some areas are completely devoid of farm tracks making access to the higher mountain areas a tortuous task. The sense of isolation, nature and desertification do impart a certain beauty and distinct sense of place. Overall a grade IIIb is recommended (medium local significance), however there are enclaves of high aesthetic value and views from the higher ridges are very good. Due to the size of the turbines, and landscape scarring that will result from road construction, the impact of the proposed activity will be of high significance.

Details of the specialist

This study has been lead by Tim Hart BA Hons, MA (ASAPA, APHP) of ACO Associates CC, archaeologists and heritage consultants.

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CURRICULUM VITAE

Name: Timothy James Graham Hart

Profession: Archaeologist

Date of Birth: 20/07/60

Parent Firm: ACO Associates

Position in Firm: Director

Years with Firm: 8

Years experience: 29 years

Nationality: South African

HDI Status: n/a

Education: Matriculated Rondebosch Boys High, awarded degrees BA (UCT) BA Hons (UCT) MA (UCT).

Professional Qualifications: Principal Investigator ASAPA, member of Association of Heritage Professionals (APHP)

Languages: Fully literate in English, good writing skills. Conversation in Afrikaans, mediocre writing skills, good reading skills. Some knowledge of Latin.

PROPOSED POSITION ON TEAM: Overall project co-director, task leader on field projects.

KEY QUALIFICATIONS

- Bachelor of Arts in Archaeology and Psychology
- BA Honours in archaeology
- MA in Archaeology
- Recipient of Frank Schwietzer Memorial Prize (UCT) for student excellence

- Professional member (no 50) Association of Southern African Professional Archaeologists (ASAPA)
- Principal Investigator, cultural resources management section (ASAPA)
- Professional member in specialist and generalist categories Association of Heritage Professionals (APHP)
- Committee Member Heritage Western Cape, Committee Member SAHRA
- Awarded Department of Arts and Culture and Sport award for best heritage impact study in 2014,

Relevant recent Project Experience with respect to large projects:

- Specialist Specialist consultant – Eskom's Kudu Integration project (identifying transmission line routes across Namaqualand)
- Specialist consultant – Eskom's Atantis Open Cycle Gas Turbine project, upgrade and power lines
- Specilaist consultant – Eskom's Mossel Bay Open Cycle Gas Turbine project, substations and power lines
- Specialist consultant – Eskoms proposed Omega sub-station
- Specialist consultant – Eskoms Nuclear 1 programme
- Specialist consultant – Eskoms PBMR programme
- Specialist consultant – Department of Water Affairs raising of Clanwilliam Dam project
- Specialist consultant to De Beers Namaqualand Mines (multiple projects since 1995)
- Specialist consultant – Saldanha Ore Handling Facility phase 2 upgrade
- Three years of involvement in Late Stone Age projects in the Central Great Karoo
- Wind Energy systems: Koekenaap, Hopefield, Darling, Vredendal, Bedford, Sutherland, Caledon
- Specialist consultant – Eskom nuclear 1
- Bantamsklip Nuclear 1 TX lines
- Koeberg Nuclear 1 TX lines
- Karoo uranium prospecting various sites
- HIA Houses of Parliament
- Proposed Ibhubesi gas project, West Coast of South Africa.

Experience

After graduating from UCT with my honours degree I joined the Southern Methodist University (SMU Dallas Texas) team undertaking Stone Age research in the Great Karoo. After working in the field for a year I registered for a Masters degree in pre-colonial archaeology at UCT with support from SMU. On completion of this degree in 1987 I commenced working for the ACO when it was based at UCT. This was the first unit of its kind in RSA.

In 1991 I took over management of the unit with David Halkett. We nursed the office through new legislation and were involved in setting up the professional association and assisting SAHRA with compiling regulations. The office developed a reputation for excellence in field skills with the result that ACO was contracted to provide field services for a number of research organisations, both local and international. Since 1987 in professional practise I have has been involved in a wide range of heritage related projects ranging from excavation of fossil and Stone Age sites to the conservation of historic buildings, places and industrial structures. To date the ACO Associates CC (of which I am co-director) has completed more than 1500 projects throughout the country ranging from minor assessments to participating as a specialist in a number of substantial EIA's as well as international research projects. Some of these projects are of more than 4 years duration

Together with my colleague Dave Halkett I have been involved in heritage policy development, development of the CRM profession, the establishment of 2 professional bodies and development of professional practice standards. Notable projects I have been involved with are the development of a heritage management plan and ongoing annual mitigation for the De Beers Namaqualand Mines Division, heritage management for Namakwa Sands and other west coast and Northern Cape mining firms. Locally, I was responsible for the discovery of the "Battery Chavonnes" at the V&A Waterfront (now a conserved as a museum – venue for Da Vinci exhibition), the discovery of a massive paupers burial ground in Green Point (now with museum and memorial), the fossil deposit which is now the subject of a public display at the West Coast Fossil Park National Heritage Site as well as participating in the development of the Robben Island Museum World Heritage Site. I have teaching experience within a university setting and have given many public lectures on archaeology and general heritage related matters. I am presently running a NLF funded project to research the historic burial grounds of Green Point.

Academic Publications

Hart, T.J.G. 1987. Porterville survey. In Parkington, J & Hall, M.J. eds. Papers in the Prehistory of the Western Cape, South Africa. Oxford: BAR International Series 332.

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Smith, A., Halkett, D., Hart, T. & Mütti, B. 2001. Spatial patterning, cultural identity and site integrity on open sites: evidence from Bloeddrift 23, a pre-colonial herder camp in the Richtersveld, Northern Cape Province, South Africa. South African Archaeological Bulletin 56 (173&174): 23-33.

Smith, A., Halkett, D., Hart, T. & Mütti, B. 2001. Spatial patterning, cultural identity and site integrity on open sites: evidence from Bloeddrift 23, a pre-colonial herder camp in the Richtersveld, Northern Cape Province, South Africa. South African Archaeological Bulletin 56 (173&174): 23-33.

Halkett, D., Hart, T., Yates, R., Volman, T.P., Parkington, J.E., Klein, R.J., Cruz-Uribe, K. & Avery, G. 2003. First excavation of intact Middle Stone Age layers at Ysterfontein, western Cape province, South Africa: implications for Middle Stone Age ecology. Journal of Archaeological Science

Cruz-Uribe, K., Klein, R.G., Avery, G., Avery, D.M., Halkett, D., Hart, T., Milo, R.G., Sampson, C.G. & Volman, T.P. 2003. Excavation of buried late Acheulean (mid-quaternary) land surfaces at Duinefontein 2, western Cape province, South Africa. Journal of Archaeological Science 30.

Parkington, JE. Poggenpoel, C. Halkett, D. & Hart, T.2004 Initial observations from the Middle Stone Age coastal settlement in the Western Cape In Conard, N. Eds. Settlement dynamics of the Middle Paleolithic and Middle Stone Age. Tubingen: Kerns Verlag.

Orton, J. Hart, T. Halkett, D. 2005. Shell middens in Namaqualand: two later Stone Age sites at Rooiwalbaai, Northern Cape Province, South Africa. South African Archaeological Bulletin. Volume 60 No 181

G Dewar, D Halkett, T Hart, J Orton, J Sealy, 2006. Implications of a mass kill site of springbok (Antidorcas marsupialis) in South Africa: hunting practices, gender relations, and sharing in the Later Stone Age .Journal of Archaeological Science 33 (9), 1266-127

Finnegan, E. Hart, T and Halkett, D. 2011. The informal burial ground at Prestwich Street, Cape Town: Cultural and chronological indicators for the informal Cape underclass. The South African Archaeological Bulletin Vol. 66, No. 194 (DECEMBER 2011), pp. 136-148


<<archaeologists
THE ASSOCIATION OF SOUTHERN AFRICAN PROFESSIONAL ARCHAEOLOGISTS
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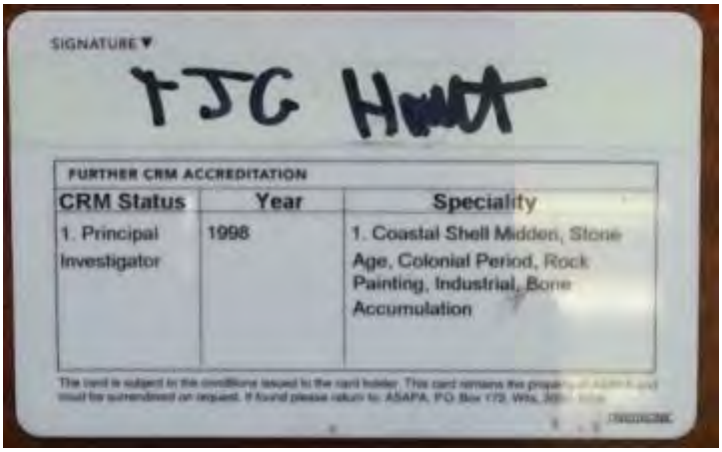
Professional Member
EXP. 31/07/2016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FURTHER CRM ACCREDITATION
CRM Status
Year
Speciality
1. Principal Investigator
1998
1. Coastal Shell Midden, Stone Age, Colonial Period, Rock Painting, Industrial, Bone Accumulation

Declaration of independence

environmental affairs

Department:
Environmental Affairs
REPUBLIC OF SOUTH AFRICA

DETAILS OF SPECIALIST AND DECLARATION OF INTEREST

	(For official use only)
File Reference Number:	12/12/20/ or 12/9/11/L
NEAS Reference Number:	DEA/EIA
Date Received:	

Application for integrated environmental authorisation and waste management licence in terms of the-

(1) National Environmental Management Act, 1998 (Act No. 107 of 1998), as amended and the Environmental Impact Assessment Regulations, 2014; and

(2) National Environmental Management Act: Waste Act, 2008 (Act No. 59 of 2008) and Government Notice 921, 2013

PROJECT TITLE

Proposed Komsberg Wind Energy facility

Specialist:	Tim Hart		
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Professional affiliation(s) (if any)	Member ASAPA (no 50) Member APHP		

Project Consultant:			
Contact person:			
Postal address:			
Postal code:		Cell:	
Telephone:		Fax:	
E-mail:			

THE INDEPENDENT PERSON WHO COMPILED A SPECIALIST REPORT OR UNDERTOOK A SPECIALIST PROCESS

I Timothy Hart, as the appointed independent specialist hereby declare that I:

- act/ed as the independent specialist in this application;
- regard the information contained in this report as it relates to my specialist input/study to be true and correct, and
- do not have and will not have any financial interest in the undertaking of the activity, other than remuneration for work performed in terms of the NEMA, the Environmental Impact Assessment Regulations, 2010 and any specific environmental management Act;
- have and will not have no vested interest in the proposed activity proceeding;
- have disclosed, to the applicant, EAP and competent authority, any material information that have or may have the potential to influence the decision of the competent authority or the objectivity of any report, plan or document required in terms of the NEMA, the Environmental Impact Assessment Regulations, 2010 and any specific environmental management Act;
- am fully aware of and meet the responsibilities in terms of NEMA, the Environmental Impact Assessment Regulations, 2010 (specifically in terms of regulation 17 of GN No. R. 543) and any specific environmental management Act, and that failure to comply with these requirements may constitute and result in disqualification;
- have ensured that information containing all relevant facts in respect of the specialist input/study was distributed or made available to interested and affected parties and the public and that participation by interested and affected parties was facilitated in such a manner that all interested and affected parties were provided with a reasonable opportunity to participate and to provide comments on the specialist input/study;
- have ensured that the comments of all interested and affected parties on the specialist input/study were considered, recorded and submitted to the competent authority in respect of the application;
- have ensured that the names of all interested and affected parties that participated in terms of the specialist input/study were recorded in the register of interested and affected parties who participated in the public participation process;
- have provided the competent authority with access to all information at my disposal regarding the application, whether such information is favourable to the applicant or not; and
- am aware that a false declaration is an offence in terms of regulation 71 of GN No. R. 543.

Note: The terms of reference must be attached.

TJG Hart

Signature of the specialist:

ACO Associates CC

Name of company:

26 November 2015

Date:

GLOSSARY

Archaeology: *Remains resulting from human activity which are in a state of disuse and are in or on land and which are older than 100 years, including artefacts, human and hominid remains and artificial features and structures.*

Calcrete: *A soft sandy calcium carbonate rock related to limestone which often forms in arid areas*.

Cultural landscape: *The combined works of people and natural processes as manifested in the form of a landscape*

Early Stone Age: *The archaeology of the Stone Age between 700 000 and 2500 000 years ago***.**

Fossil: *Mineralised bones of animals, shellfish, plants and marine animals. A trace fossil is the track or footprint of a fossil animal that is preserved in stone or consolidated sediment.*

Heritage: *That which is inherited and forms part of the National Estate (Historical places, objects, fossils as defined by the National Heritage Resources Act 25 of 1999.*

Holocene: *The most recent geological time period which commenced 10 000 years ago.*

Late Stone Age: *The archaeology of the last 20 000 years associated with fully modern people.*

Middle Stone Age: *The archaeology of the Stone Age between 20-300 000 years ago associated with early modern humans.*

Midden: *A pile of debris, normally shellfish and bone that have accumulated as a result of human activity.*

National Estate: *The collective heritage assets of the Nation*

Palaeontology: *Any fossilised remains or fossil trace of animals or plants which lived in the geological past, other than fossil fuels or fossiliferous rock intended for industrial use, and any site which contains such fossilised remains or trace.*

Pan: *A shallow depression in the landscape that accumulates water from time to time.*

Palaeosole: *An ancient land surface.*

Pleistocene: *A geological time period (of 3 million – 20 000 years ago).*

Pliocene: *A geological time period (of 5 million – 3 million years ago).*

Miocene: *A geological time period (of 23 million - 5 million years ago).*

SAHRA: *South African Heritage Resources Agency – the compliance authority which protects national heritage.*

Structure (historic:) *Any building, works, device or other facility made by people and which is fixed to land, and includes any fixtures, fittings and equipment associated therewith. Protected structures are those which are over 60 years old.*

Acronyms

DEAT	Department of Environmental Affairs and Tourism
ESA	Early Stone Age
GPS	Global Positioning System
HIA	Heritage Impact Assessment
HWC	Heritage Western Cape
LSA	Late Stone Age
MSA	Middle Stone Age
NHRA	National Heritage Resources Act
SAHRA	South African Heritage Resources Agency
WEF	Wind Energy Facility
PV	Photo-voltaic (solar) array

Contents

1 Introduction

The Komsberg project area is located 60km NE of Laingsburg and 40km SE of Sutherland in the foothills of the Komsberg mountain range or escarpment (Figure 1 & 2). The main access route to the study area is via the R354 and then the Komsberg and Moordenaars Karoo District Roads, approaching the project area from the west. Spread along the foothills of the escarpment the project consists of two zones – Komsberg East and Komsberg West. The population density of the area is very low with only two active homesteads occupying the Komsberg East project area and one occupying Komsberg West. The area is isolated and arid but has been deemed a Renewable Energy Development Zone (REDZ) by the CSIR, earmarked through Strategic Environmental Assessments (SEA) by the DEA. Wind quality is in this part of South Africa is considered optimal for renewable energy projects of this kind.

Each envisaged facility will consist of

- 55 Wind turbines between 2MW and 5MW in capacity with a rotor diameter of up to 140m and a hub height of up to 120m with a Maximum generation capacity of 275MW.
- There will be foundations and hardstands associated with the wind turbines.
- Up to 8m wide internal access roads to each turbine, the substation complex and the ancillary infrastructure, including underground cabling adjacent the roads. Road length will be up to 40km in total.
- Medium voltage cabling between turbines and the substation, to be laid underground where practical.
- Overhead medium voltage cables between turbine strings or rows.
- A 100 x150m on-site substation complex to facilitate stepping up the voltage from medium to high voltage (up to 400kV) to enable the connection of the wind farm to the national grid.
- An on-site switching station is to be located adjacent to the proposed WEF substations with a maximum footprint of 100m x 150m. The switch gear within this station enables energy to be transferred to the existing national grid.
- An approximately 35km (Komsberg West) and approximately 55km (Komsberg East) high voltage power line from the onsite substation to the National Grid at the Eskom Komsberg Main Transmission Substation.
- A 30x50m operations and services workshop area / office building for control, maintenance and storage; and
- Temporary infrastructure including a site camp, laydown areas and a batching plant totalling 150 x100m in extent.
- Upgrades to the public road where required

1.1 Time and season

In the arid Karoo areas the season in which the work is done does not influence the outcome of the study as visibility is good all year round.

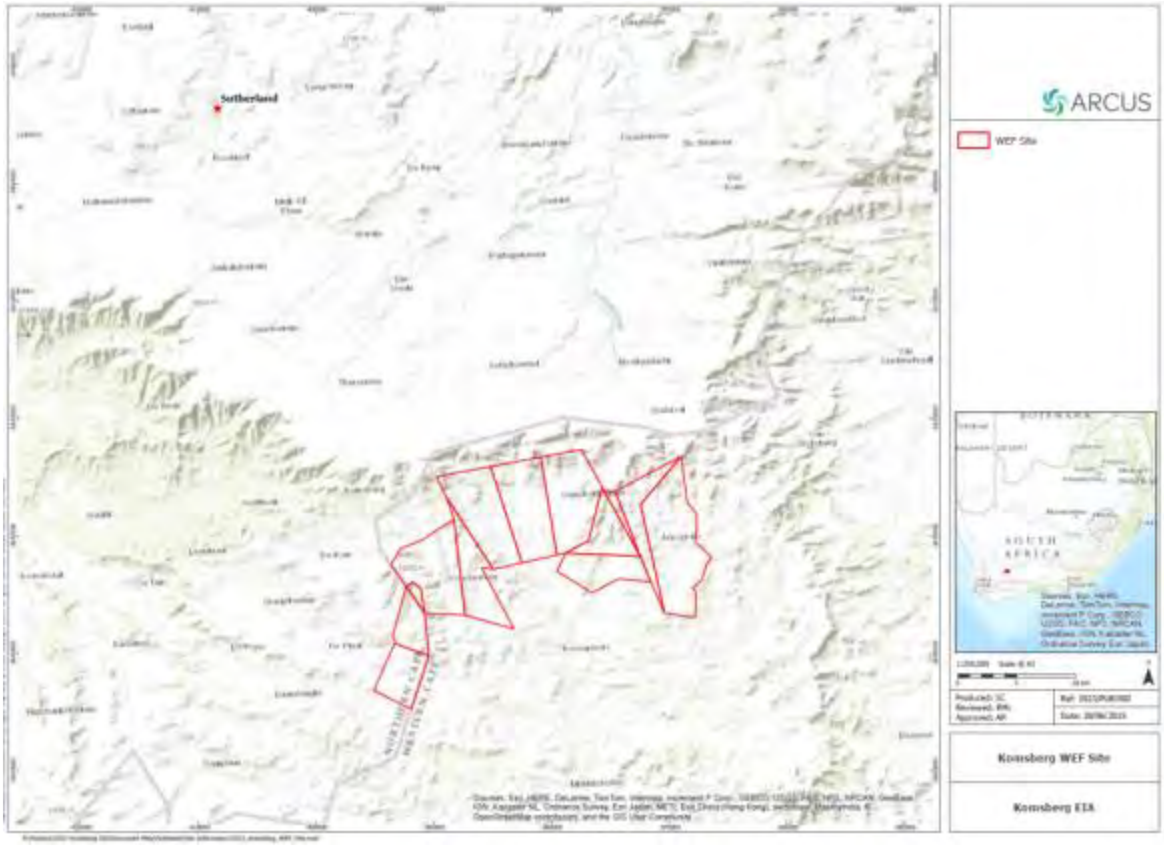

Figure 1. Location of the proposed Komsberg WEF, supplied by Arcus.

Figure 2. A Google Earth image of the farm portions of the proposed Komsberg WEF.

2 Methodology

The study area is known to the author of this report as he has completed a number of other similar studies nearby. The findings of this study are derived from a desktop based background study, prior knowledge of the area and a site inspection during which time both phases of the proposed project were visited and samples of the different land forms in the project area walked, driven and searched. Prior to commencing the field component heritage sites visible on Google Earth were identified and plotted. All visible farm tracks were identified, traced and converted into GPX files for upload into GPS receivers for use in the field. For reasons of health and safety the work was carried out in conjunction with the project palaeontologists (Natura Viva cc) and two-way radio communication maintained. Any heritage sites found during the site inspection were photographed and plotted. Natura Viva covered different areas of the landscape to ACO which increased the diversity of areas surveyed.

Please note: Site co-ordinates are not included in this report for security reasons but will be provided on request to *bona-fide* researchers and heritage authorities.

2.1 Assessing heritage in the context of wind energy developments

Wind energy facilities have increased exponentially throughout the world in response to the national energy crisis and climate change due to wind power being clean energy, as well as due to wind energy facilities being a cost effective form of electricity generation. Initially communities enthusiastically accepted the presence of wind energy facilities, however web-based research of international experience has indicated that they are not without controversy. The impacts of clusters of massive wind turbines on certain cultural landscapes can be seen as severe by certain groups, both in physical terms and with respect to the intangible and aesthetic qualities of a given locality.

In terms of landscapes and heritage in South Africa, the grading of landscapes is in its infancy with the result that there a few well-conceived studies that can be referred to for guidance, however the heritage authorities generally recognise the desirability of clean energy and the need to build clean energy facilities in landscape that can tolerate them. Heritage sites are contextually sensitive to any form of development – this is particularly the case with a heritage site or place that is well known, well used and publically celebrated.

Wind energy facilities are often big developments. Turbines can be more than 100m high with blades greater than 50m in radius. The structure has to be counterweighted by a concrete block sunk deep into the ground. Each turbine site needs road access that can be negotiated by a heavy lift crane which means that in undulating topography deep cuttings and numerous roads may be made into a landscape to create workable gradients. Due to their size the visual impacts are immitigable (they are generally visible from 10 km or further depending on conditions) in virtually all landscapes.

The point at which a wind turbine may be perceived as being "intrusive" in terms of the aesthetics of an area is a subjective judgment which is value laden depending on individual backgrounds, perceptions and values. However it can be anticipated that the presence of such facilities close to wilderness and heritage areas may impact many of the intangible and aesthetic qualities for which an area is valued, or could be potentially valued in the future. Yet the circumstances are variable as in certain landscape forms, the graceful shapes of the turbines and the sculptured twist of the rotors are perceived to be aesthetically pleasing. In essence, the perception of whether a wind turbine is an acceptable presence in a landscape depends greatly on context, setting, landscape character and an individual's aesthetic values.

The degree of physical landscape disturbance caused during the construction of turbines is such that the destruction of archaeological and palaeontological heritage can be a high likelihood. Hence, in the assessment of impacts of wind energy proposals it is necessary to assess both physical damage to heritage caused by the establishment of infrastructure, as well as focus on the way that such a facility can change the aesthetic and intangible values of the cultural landscapes in which the physical heritage resources exist.

2.2 Landscape and setting

Landscapes are heritage resources of national or regional or local importance in terms of rarity and representivity.

The UNESCO Operational Guidelines for the World Heritage Convention (1995) identified three main types of cultural landscapes derived from the following characteristics:

a. The **clearly defined landscape** designed and created intentionally. This embraces garden and parkland landscapes constructed for aesthetic reasons
b. The **organically evolved landscape.** This results from an initial social, economic, administrative, and/or religious imperative and has developed its present form by association with and in response to its natural environment. Such landscapes reflect that process of evolution in their form and component features. They fall into two sub-categories:
c. A **relict (or fossil) landscape** is one in which an evolutionary process came to an end at some time in the past, either abruptly or over a period. Its significant distinguishing features are, however, still visible in material form.
d. A **continuing landscape** is one which retains an active social role in contemporary society closely associated with the traditional way of life, and in which the evolutionary process is still in progress. At the same time it exhibits significant material evidence of its evolution over time.
e. The **associative cultural landscape** included by virtue of the powerful religious, artistic or cultural associations of the natural element rather than material cultural evidence which may be insignificant or even absent (Extract from paragraph 39 of the Landscape *Operational Guidelines for the Implementation of the World Heritage Convention)*

Also, criteria that have been considered (Baumann, Winter, Aikman 2005) locally are:

- Design quality: The landscape should represent a particular artistic or creative achievement or represent a particular approach to landscape design

- Scenic quality: The landscape should be of high scenic quality, with pleasing, dramatic or vivid patterns and combinations of landscape features, and important aesthetic or intangible qualities (vividness, intactness, unity)

- Unspoilt character/authenticity/integrity:The landscape should be unspoilt, without visually intrusive urban, agricultural or industrial development or infrastructure. It should thus reveal a degree of integrity and intactness

- Sense of place: The landscape should have a distinctive and representative character, including topographic and visual unity and harmony

- Harmony with nature: The landscape should demonstrate a good example of the harmonious interaction between people and nature, based on sustainable land use practices

- Cultural tradition: The landscape should bear testimony to a cultural tradition which might have disappeared or which illustrates a significant stage in history or which is a good example of traditional human settlement or land use which is representative of a culture/s

- Living traditions: The landscape should be directly and tangibly associated with events or living traditions with ideas or with beliefs, with artistic and literary works of high significance

The study area lies within a rural context. In terms of the UNESCO guidelines it is a natural evolving landscape. In terms of the assessment checklist published by Baumann, Winter, Aikman (2005) the landscape is largely intact as a natural landscape, intrusions within the last 60 years are very few, it is therefore highly authentic and unspoiled.

2.3 Restrictions

Restrictions to the study were encountered. These were mostly to do with the size of the project area and difficulties in accessing areas. Many farm tracks had not been used for years and their condition was poor. In some instances erosion gullies had to be filled in by the team to get the vehicles over which absorbed much time. Tracks that ascended the ridges were tortuous while a number of areas could not be reached at all due to the lack of paths, farm roads and the long hikes that would be required to reach ridgetops where activities were proposed. Notwithstanding this the team managed to check several ridgetops and covered a large amount of ground in the project area. See Figure 3 which depicts the track logs.

Figure 3. The study area. Proposed project infrastructures are indicated by blue and red as roads, pink and purple as power lines and the red and yellow dots as the proposed turbine positions. Farms are green 'houses' and pre-recorded kraals and ruins are green dots. ACO associates track log is indicated in black.

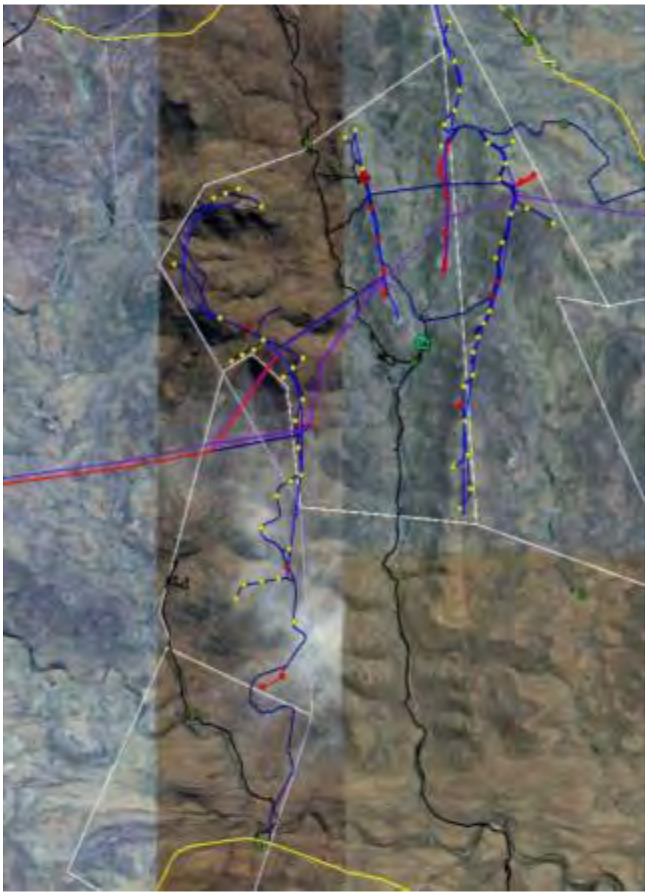

Figure 4. A close up of Komsberg West (excerpt from the above Google Earth Image

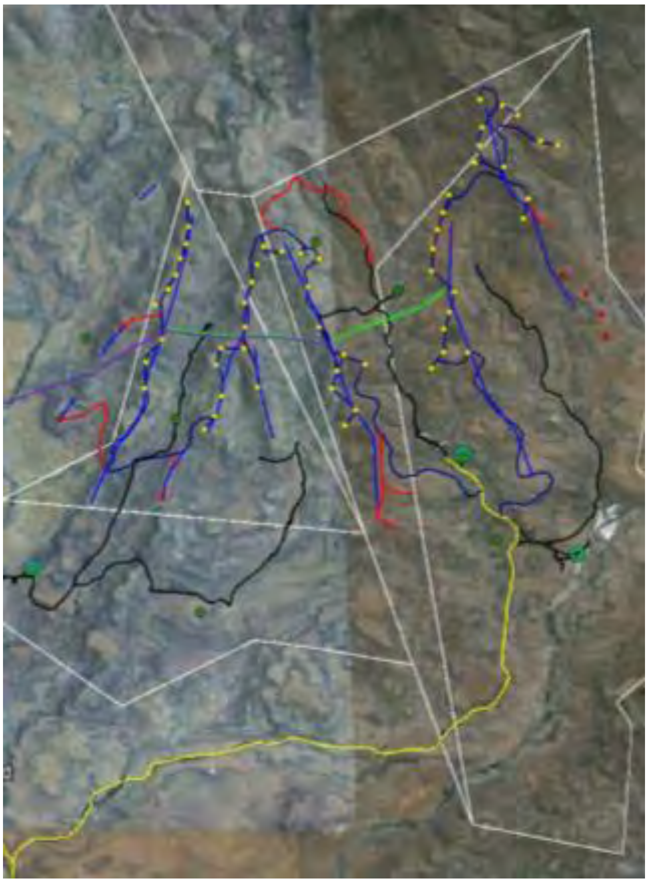

Figure 5. A close up of Komsberg East (excerpt from the above Google Earth Image

3 Baseline Conditions

The Study Area is located in the foothills of the Great Escarpment below the high Roggeveld Karoo. It is a semi-arid region (sometimes known as the Moordenaars Karoo) with rainfall of some 150 mm per annum mainly in the form of summer thunderstorms. There is some snow-melt and precipitation in winter. The vegetation is characteristic of the Succulent Karoo biome. The northern parts of the "site" straddles the slopes below the great escarpment. This area is characterised by a series of very high and long ridges with deep valleys. These contain acacia thickets in places and numerous dry river beds. The high ridges are windswept, dry, inhospitable and un-developed. There are a few farm tracks which cross the study area. Despite much of the site being zoned agricultural the area remains predominantly untransformed and extremely isolated although sheep and goats are grazed here (note that stock-keeping by KhoeKhoen commenced here over 1000 years ago). Even farm tracks are sparse and permanent settlement is almost non-existent except for three active homesteads. The physical location of the study area lends itself to interesting scenery. A sense of isolation and wilderness qualities prevail.

Figure 6. Taken in the Komsberg East and shows typical landscape quality. Ridge tops will be the foci of the proposed activity.

The Komsberg Pass runs to the west of the study area. The pass which is very steep and provides views over the landscape is one of the few areas that may draw tourists. It is not a major works of engineering as passes go in the Western Cape and its landscape qualities are of moderate significance. A suggested field grading is IIIB.

Geologically the project area is set within the Abrahamskraal formation of the Karoo geological sequence. It is known to be fossiliferous in places. A unique feature of the study area is that it is entirely devoid of any dolerite dykes or sills for a radius of many kilometres, the closest dolerites occurring near Sutherland some 40 km away. This has implications for archaeology as there no sources of *hornfels* (indurated shale) in the area. Prehistoric relied on making artefacts from this for their daily survival.

3.1 Palaeontology (by John Almond)

The thick Abrahamskraal succession is well known for its diverse fossil assemblages of the Middle Permian *Tapinocephalus* Assemblage Zone. These include a wide range of fossil vertebrates - notably various small- to large-bodied therapsids ("mammal-like reptiles") and reptiles - as well as fossil plants of the *Glossopteris* Flora and low diversity trace fossil assemblages. Numerous important fossil sites have been documented in the Moordenaarskaroo region just to the southeast of the Komsberg WEF study area but very few sites are known from the study area itself. There are local verbal reports of large fossil bones and petrified wood having been found here, but most of the material appears to have been misplaced, and precise locality details are currently unavailable. Bedrock exposure levels in the broader Komsberg – Moordenaarskaroo study region are generally poor due to the pervasive cover by superficial sediments (colluvium, alluvium, soils, calcrete) and vegetation. Nevertheless, a sufficiently large outcrop area of Abrahamskraal Formation sediments, exposed in stream and riverbanks as well as steep hillslopes and erosion gullies, has been examined during the present field study to infer that macroscopic fossil remains are rare here. Exceptions include low-diversity trace fossil assemblages (small-scale invertebrate burrows, possible plant stem or root casts) and fragmentary plant remains. The latter include horsetail ferns (arthrophytes), moulds of woody plant material and locally abundant blocks of ferruginised and silicified wood that have weathered out from the base of channel sandstones.

3.2 Pre-colonial Heritage of the area

Little was known of the archaeology of the study area until recently and in fact no commercial heritage impact assessments are listed on the SAHRA database for this area (at least up to 2009). Despite the official record, there has been some limited impact assessment and research work around Sutherland (for example: Lloyd Evans et al. 1985; Hart 2005). Lloyd 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 a relatively high proportion of small convex scrapers and thin-walled potsherds of indigenous manufacture, ostrich eggshell and some *Nassarius kraussianus* (a type of marine shell) beads. They comment (1985: 108) that the presence of the shell beads points to cultural ties with people along the Cape coast while the small scrapers can be assigned to the Wilton industry, distinct from the large elongated scrapers typically associated with the interior sites along the Orange River as described by Sampson (et al. 1989).

Hart (2005) undertook a survey for a golf course to the south of the Sutherland urban edge. The most significant find was a complex of 13 stone enclosures which are typical of the *Khoekhoen kraals* that were mapped and described by the author in the eastern Karoo (Hart 1989, Sampson 2008). A single highly dispersed artefact scatter consisting of mainly waste material (flakes made from *hornfels* or indurated shale) was also found. Hart (2005) reported finding a dense artefact scatter associated with a shallow rock shelter outside the study area indicating that archaeological sites may found in areas that were sheltered from the wind (an important consideration given Sutherland's extreme temperature ranges).

Recent work on another wind farm to the in the area the so-called Zuurplaats WEF (Hart et al 2010), the various phases of the proposed Roggeveld wind energy facility (Hart 2014) as well as archaeological specialist studies of the Gamma-Omega 765 kV power line passing to the south of the escarpment (Patrick 2009) has overcome the information vacuum to a degree. The Zuurplaats project is of particular relevance given that it occupies a similar geographical position to the proposed Komsberg wind energy facility. Hart et al (2010:22-23) Hart (2014) observations, included below, are of relevance to the Komsberg site, although such findings were not made there.

Pre-colonial archaeological material*: As expected includes Early Stone Age (ESA), Middle Stone Age (MSA) and Later Stone Age (LSA) artefact scatters. Open sites are extremely sparse on the upper plateau with only one MSA site being recorded – a scatter associated with a dry pan. The most common raw materials used by precolonial people are hornfels, quartzite, chert, and also quartz and Karoo shale. Occasional flakes were noted randomly on the landscape lie scattered on the land surface which represents the "litter" of the Stone Age. On the upper plateau even incidental artefacts were scarce. In the southern portion of the study area, but not within the project site, a significant and well preserved Early Stone Age site containing complete and highly refined bifaces (hand axes) attributable to the Fauresmith industry was found on the farm Klipfontein.*

Stone kraals: *The most common form of pre-colonial site on the upper plateau were stone kraals or kraal clusters, which according to Sampson's (2008) figures from the Eastern Karoo, could be between 300 and just over 1000 years of age. The kraal complexes (which are distinctly different from colonial period stock kraals) tend to be found along the leeward slopes of low ridges (or where minimal wind affects the area). These typically consist of dry stone piled wall enclosures in a roughly circular configuration, sometimes interlocking but not more than half a meter high, and ranging from 3 - 4 meters to 9 m in diameter. In the past they are likely to have been associated with reed mat huts or brush shelter/s), probably erected a few meters away from the main 'kraal' where small stock such as fat tailed sheep and goats were kept. Often found in proximity to the larger 'kraals' are lammerkraals (lambs' kraals), which are much smaller (about 1m in diameter) and a bit higher (usually a few more layers of stones added to the wall) than the adjoining larger 'kraal'. These small kraals are known to have been used to keep new born lambs or goats separate from their mothers so that the milk could be used rather by the people (Webley 1986). It was noted that kraals are arranged in complexes of up to 13 interlocking enclosures with adjoining lammerkraals. Notable complexes were recorded in the area of Hartebeestfontein and at Vinkekuil on the escarpment. Also associated with these 'kraals' is artefactual material, fine thin red burnished pottery, and ostrich egg shell. At a site alongside the access road to Waterval there is a remarkable complex of 'kraals' below and on top of a ridge.*

Below the escarpment another form of archaeological site was identified. These are what we interpret 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 (60 – 80m in diameter), artefactually rich with very fine thin walled and burnished Cape Coastal pottery noted. 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. On two of the sites there is evidence of European goods (19th century glass and ceramics) which may indicate some form of continuous use of the sites by Khoekhoen herders into the colonial period.*

Archaeological sites of this kind are very rare in the Western Cape, having been only previously recorded in the Richtersveld.

3.3 Colonial Heritage

Schoeman (1986) has described the early settlement of the Roggeveld and Sutherland area which commenced around 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. In addition, the escarpment seems to have been where most of the springs were found, and from where they were able to exploit the vegetation of both the *Onder Karoo* as well as the Sak River region in Bushmanland. Each *Trekboer* usually had in addition to a loan farm on the plateaux, a farm in the Karoo known as a *legplaats* (outpost). Initially, the population of the area remained small, because many of the early loan farms were merely “stock posts” and the owners lived elsewhere. Drought, poor grazing and attacks by the San caused many farms to be abandoned. Disputes over farm boundaries were intense. According to Penn (2005), in the 18th century there were numerous independent Khoekhoen kraals located amongst the Trekboer farms in the Roggeveld.

The first recorded loan farms in the Roggeveld date to 1743, and by 1750 there were 31 registrations (Penn 2005). 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) as well as a farm on the edge of the “Comsberg” (sic) that belonged to a Cloete (in Schoeman 1986). Many farmers seem to have had more than one loan farm.

Resistance to the Trekboers in the Roggeveld came initially from the San who resisted fiercely throughout the Great Karoo, at times beating back the vanguard of *Trekboer* farmers. In 1754, attacks from the San are reported to have increased and 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 by Schoeman as a type of guerrilla warfare. Livestock was stolen, Khoikhoi herders and slaves killed, and Trekboer farms attacked. The colonists fought back by establishing the *Kommando* system – and leading to the officially sanctioned “hunting” of San was in 1777 (Adhikari 2011, Dooling 2007) In some instances, bounties were obtainable from the local *landdrost*. There was apparently a massacre of 186 San in the Roggeveld in 1765. The only confirmation of this is from the farm Oorlogskloof near Sutherland. There are a great many graves, some 30, laid out in three groups, with piles of rocks above them. There is also a separate gravestone with the date 1768. Both Penn and Schoeman refer to another mass grave on the farm Gunsfontein (to the west of Schietfontein (Scholtzenhof) - and now part of a private nature reserve), possibly dating to the rebellion of the 1770's. According to Penn (pers comm.), somewhere in the valleys of the escarpment is a large cave or shelter where some of the few surviving San made their last stand against the *kommando's* before being massacred and buried close to where they fell. To date the site of this event has not been identified.

The San were gradually driven from the Roggeveld northward to the extent that by 1809 there is reported to have been only one settled "Bushmen" kraal left in the area. Europoean settlement became more permanent from the beginning of the 19th century. The farmers' main source of income was small stock, since wheat could only be grown with great difficulty in isolated and protected valleys when conditions permitted. 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 lived in grass huts or *Matjieshuise (*mat covered houses), and in tents and some travellers found farmers living in *Matjieshuise* as late as 1839. Attempts at constructing more permanent structures were inhibited by the lack of suitable wood for roofs. The generic house 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 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*. Associated farm buildings also included the houses of the workers. The ruins of these humble frontier farmsteads are not uncommon in the Roggeveld, as is evidence of wheat farming which was never sustainable (certainly by today's standards).

Associated with these early farms were stone kraals, with seven to eight not being uncommon. A number of farm workers were slaves, brought by their owners from the Cape, but also included local indigenous people (Bushmen and Khoekhoen) who for one reason or another were no longer pursuing their traditional lifestyles. Professor Simon Hall, Department of Archaeology, University of Cape Town is currently running a project in the Roggeveld that integrates the spatial distribution and architecture of these early farmsteads and kraals, however the final results have not yet been released. Indications are that before the advent of wire fencing and formal partition of farms, the behaviour of *trekboer* farmers on the landscape was strongly influenced by cultural borrowing from indigenous Karoo herding communities – in particular the location of kraals, seasonal use of the land and even use of reed huts, traditional cooking shelters and certain customs (Simon Hall in discussion).

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. One of the followers was Jan Fourie of Welgemoed

(Schoeman 1986:98). There appears to have been some skirmishes in the vicinity of Skietfontein (Komsberg) in 1901. One of the stone structures located on Beerenvallei during the survey may relate to the Anglo Boer war.

3.4 History of the farms

Indications are that most of the farms in the study area would have started as loan farms.
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 use 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. Weak springs are at the centres of most of loan farms indicates the importance of even the most meagre water resources on this landscape. The formal granting of title deeds only took place in the early 19th century, however judging by the kinds of artefacts and structures found on the landscape, many of the farms were established informally long before land was formally granted or loaned.

4 Legislation and policies

The basis for all Heritage Impact Assessments (HIA) is the National Heritage Resources Act, No 25 of 1999 (NHRA), which in turn prescribes the manner in which heritage is assessed and managed. The NHRA has defined certain kinds of heritage as being worthy of protection, by either specific or general protection mechanisms. In South Africa the law is directed towards the protection of human made heritage, although places and objects of scientific importance are covered. The National Heritage Resources Act also protects intangible heritage such as traditional activities, oral histories and places where significant events happened. Generally protected heritage, which must be considered in any heritage assessment, includes:

- Any place of cultural significance (described below)
- Buildings and structures (greater than 60 years of age)
- Archaeological sites (greater than 100 years of age)
- Palaeontological sites and specimens
- Shipwrecks and aircraft wrecks
- Graves and grave yards.

Section 38 of the NHRA stipulates that HIAs are required for certain kinds of development such as rezoning of land greater than 10 000 m2 in extent or exceeding 3 or more sub-divisions, linear developments in excess of 300 m or for any activity that will alter the character or landscape of a site greater than 5000 m2. Subject to the provisions of subsections (7), (8) and (9), any person who intends to undertake a development categorised as:

a) the construction of a road, wall, powerline, pipeline, canal or other similar form of linear development or barrier exceeding 300 m in length;

b) the construction of a bridge or similar structure exceeding 50 m in length;

c) any development or other activity which will change the character of a site--

i) exceeding 5 000 m2 in extent; or

ii) involving three or more existing erven or subdivisions thereof; or

iii) involving three or more erven or divisions thereof which have been consolidated within the past five years; or

iv) the costs of which will exceed a sum set in terms of regulations by SAHRA or a provincial heritage resources authority;

d) the re-zoning of a site exceeding 10 000 m2 in extent; or

e) any other category of development provided for in regulations by SAHRA or a provincial heritage resources authority, must at the very earliest stages of initiating such a development, notify the responsible heritage resources authority and furnish it with details regarding the location, nature and extent of the proposed development.

Section 3(3) of the National Heritage Resources Act (NHRA), No 25 of 1999 defines the cultural significance of a place or objects with regard to the following criteria:

(a) its importance in the community or pattern of South Africa's history;
(b) its possession of uncommon, rare or endangered aspects of South Africa's natural or cultural heritage;
(c) its potential to yield information that will contribute to an understanding of South Africa's natural or cultural heritage;
(d) its importance in demonstrating the principal characteristics of a particular class of South Africa's natural or cultural places or objects;
(e) its importance in exhibiting particular aesthetic characteristics valued by a community or cultural group;
(f) its importance in demonstrating a high degree of creative or technical achievement at a particular period;
(g) its strong or special association with a particular community or cultural group for social cultural or spiritual reasons;
(h) its strong or special association with the life or work of a person, group or organisation of importance in the history of South Africa; and
(i) sites of significance relating to the history of slavery in South Africa.

4.1 Scenic Routes

While not specifically mentioned in the NHRA, No 25 of 1999, Scenic Routes are recognised as a category of heritage resources which requires grading as the Act protects area of aesthetic significance (see clause "e" above). Baumann & Winter (2005) comment that the visual intrusion of development on a scenic route should be considered a heritage issue. HWC has taken this opinion further by acknowledging that the aesthetics of a landscape/place/area are protected by the National Heritage Resources Act and like any other form of heritage, should be considered a grade-able entity. (The definition of cultural significance in terms of the NHRA includes the aesthetic value of a place or area).

4.2 Heritage Grading

A key tool in the assessment of heritage resources is the heritage grading system which uses standard criteria. In the context of an EIA process, heritage resources are graded following the system established by Winter & Baumann (2005) in the guidelines for involving heritage practitioners in EIA's (Table 1). The system is also used internally within Heritage Authorities around the country for making decisions about the future of heritage places, buildings and artefacts.[1] Presently Heritage Western Cape has a good guide to grading which is nationally applicable, on their website (http://www.westerncape.gov.za/public-entity/heritage-western-cape). The grading system was designed with structures in mind but has been applied to archaeological sites, streetscapes, objects. The call has been made by the heritage authority to apply the system to landscapes. The decision making process that we have used in this report is based on a simple 3-phase process.

1) Decide what kind of landscape is involved (rural, natural wilderness, historical townscape or historical agricultural area) – establish its dominant characteristics taking cognisance of UNESCO guidelines and previous work.
2) Establish the value of the landscape in terms of its history, its aesthetic value and its heritage value to a given community.
3) Consider the intactness of the landscape – has it been recently intruded on by new development (we have taken 60 years as a marker as this is generally used as a historic cut-off), and using the grading system as a guide suggest a field grading.

The system is in its early days of development and still needs to be refined further.

Table 1: Grading of heritage resources (Source: Winter & Baumann 2005).

Grade	Level of significance	Description
1	National	Of high intrinsic, associational and contextual heritage value within a national context, i.e. formally declared or potential Grade 1 heritage resources.

[1] http://www.westerncape.gov.za/other/2012/9/grading_guide_&_policy_version_5_app_30_may_2012.pdf

2	Provincial	Of high intrinsic, associational and contextual heritage value within a provincial context, i.e. formally declared or potential Grade 2 heritage resources.
3A	Local	Of high intrinsic, associational and contextual heritage value within a local context, i.e. formally declared or potential Grade 3A heritage resources.
3B	Local	Of moderate to high intrinsic, associational and contextual value within a local context, i.e. potential Grade 3B heritage resources.
3C	Local	Of medium to low intrinsic, associational or contextual heritage value within a national, provincial and local context, i.e. potential Grade 3C heritage resources.

Heritage specialists use this grading system to express the relative significance of a heritage resource. This is known as a field grading or a recommended grading. Official grading is done by a special committee of the relevant heritage authority; however heritage authorities rely extensively on field grading in terms of decision making.

5 Need and desirability of the project

The need for renewable energy is essentially four-fold. Firstly the planet is facing an unprecedented environmental crisis brought on historical dependence on fossil fuels which have contributed to global warming and climate change. Wind turbines represent renewable energy that is not dependent on the use of fossil fuels (apart from during construction). During operation they produce no emissions. Secondly, South Africa which is heavily reliant on fossil fuels is having its own energy crisis as there is not enough generating capacity to sustain base-load supply. A diversity of supplementary sources is needed to contribute to the national grid. Thirdly, it is the cheapest form of power in South Africa, important given the country's developing economy and levels of poverty. Fourthly, it creates jobs and leads to skills development not only generally but in rural areas where this is lacking.

6 Alternatives

The terms of reference for the project is the assessment of Komsberg East and Komsberg West and associated grid connections. Alternative hardstands also on ridge tops have been proposed for both Komsberg East and West as well as alternative grid connections for both Komsberg East and West that follow moderately different but almost parallel routes.

7 Identified sensitivities

7.1 Palaeontology

Any form of bedrock excavation has the potential to affect continental sediments of the Middle Permian Beaufort Group. These sediments underlie the great majority of the study area and are renowned for their rich fossil heritage of terrestrial vertebrates (most notably mammal-like reptiles or therapsids), as well as fish, amphibians, molluscs, trace fossils (e.g. trackways) and plants (e.g. petrified wood). The upper Abrahamskraal stratigraphic interval represented in the study area is of special palaeontological significance in that it contains a record of extinctions among continental biotas preceding the disastrous End-Guadalupian Mass Extinction Event in the marine realm some 260.4 million years ago. The palaeontological sensitivity of these Beaufort Group rocks is therefore considered to be very high. Caenozoic surface sediments in the study area (e.g. alluvium, colluvium) are generally of low palaeontological sensitivity, but local concentrations of scientifically valuable fossils (e.g. mammalian bones, teeth) may also occur here.

Very few vertebrate fossil occurrences were recorded within the Komsberg West WEF study area during the present field assessment, despite the presence here of several excellent exposures of Lower Beaufort Group mudrocks (with well-developed pedocrete horizons) as well as a range of sandstone facies. Isolated fragments of fossil bone were observed within down-wasted surface gravels but no *in situ* material or well-preserved, articulated specimens were seen, with the exception of a few small fragments of rolled bone in channel lag breccias. Although several scientifically important specimens are recorded from equivalent geological horizons and facies just outside the study area. There are verbal accounts of sizeable fossil bones seen by local farm workers, and occasional collected specimens can be seen at farmsteads in the region (*e.g.* Gemsbokfontein in the Komsberg East WEF study area). This material has mostly been lost or locality data is unavailable. Vertebrate fossils clearly occur here, but are apparently rare.

From a scientific viewpoint, the most interesting fossil site recorded during the present field study is a moderately extensive palaeosurface on the upper surface of a channel sandstone bed. The palaeosurface – the bed of an ancient river or pond - preserves numerous tetrapod tracks as well as a few recognisable trackways and other trace fossils (*N.B.* This site occurs just *outside* the Komsberg West study area and, given its sensitivity, precise localities details are not provided here). The palaeosurface features subdued, slightly-asymmetrical current ripples as well as delicate rill marks indicating very shallow, falling water levels. The associated tetrapod trackways were apparently generated by meter-sized animals with a sprawling posture – as suggested by occasional belly marks, cuspate tail impressions and arcuate digit impressions. The most likely candidates are predatory rhinesuchid temnospondyls (“labyrinthodont” amphibians) that are represented by rare body fossils in the Abrahamskraal Formation and are the only temnospondyls recorded from the *Tapinocephalus* Assemblage

Zone. A curious feature of the trace fossil assemblage is the paired sets of straight, bipartite or tripartite “tram lines” that may have been generated by trailing temnospondyl digits as they floated above the pond or riverbed, or were swept along by a current while the river was still actively flowing. Flaggy, thin-bedded sandstones exposed near Ventersrivier homestead feature trace fossils on their soles, including sinuous paired hypichnial ridges and paired deep prod marks associated with polygonal sandy desiccation crack infills. Invertebrate traces recorded in the region include bioturbation by *Scoyenia* arthropod burrows and indistinct epichnial horizontal “worm burrows” on wave-rippled sandstone surfaces.

Fossil plants in the Lower Beaufort Group rocks of the study area are represented by locally abundant, comminuted plant stems (notably sphenophyte ferns) and unidentifiable plant debris. These fossils are preserved as ferruginised moulds within breccio-congomerate lenses at or close to the base of channel sandstones of the Kooornplaats Member. Several blocks of dense, heavily-ferruginised and -silicified fossil wood have been found but not *in situ*. However, there is little doubt that this material has also weathered out of nearby channel sandstone bodies. The presence of sizeable petrified logs is indicated by the local concentration and size of some fossil wood blocks as well as by drag marks incised into channel sandstone surfaces that are most plausibly attributed to floating logs. Occasional pebbles and cobbles of weathered, exotic granite overlying Lower Beaufort Group mudrocks in the Komsberg East study area might have been introduced among the roots of floating logs (See Almond 2010a and refs. therein) (*N.B.* Whitish quartz mineral lineation along fracture zones might be mistaken for fossil wood but is abiogenic in origin). Assemblages of closely-spaced, vertical, sand-infilled or empty tubes within thin-bedded sandstones and siltstones at several sites probably represent stem casts of dense reedy vegetation (*e.g.* equisetaleans) on the margins of water bodies.

No fossils were observed within the various Late Caenozoic superficial deposits represented within the Komsberg WEF study area during the present field study.

7.2 Archaeological heritage

Experience throughout the Karoo has shown that high ridges seldom attracted any form of prehistoric occupation. Ridge tops tend to be dry, windswept and very cold in winter, and those of the Komsberg are no exception. The ridge tops at Komsberg are extremely harsh, covered with loose shale and almost devoid of soil and vegetation. Unless there was a large rock shelter, source of water or a raw material, it is not expected that the system of ridges with the study area are likely to be sensitive in terms of archaeology. There are few rock shelters in the project area, and those which do exist have steeply sloping floors not suitable for habitation. The turbine sites which are normally situated on high ground are likely to be relatively insensitive.

Very few archaeological sites were recorded during the survey. Only one questionable artefactual find was recorded on any of the ridges, while several ephemeral scatters of ESA and MSA material were recorded in river gravels and valley bottoms. No late Stone Age archaeological sites were recorded.

Figure 7. Ridge top at Komsberg East. These areas are windswept and very dry. Shelter is minimal.

Valley bottoms were rather more favoured by both pre-colonial and historical occupation. Here there are normally sources of water, shelter from the prevailing winds as well as the potential for grazing small stock on or close to the sandy river beds. Also important were low ridges on or adjacent to flat plains. Khoikhoi kraals were almost always built adjacent to or against low ridges and cliffs; however none were identified in the project areas in the areas that were accessed. Within the valley bottoms evidence of colonial period settlement is quite prolific. There are numerous stone walled kraals, simple dwellings and single room abodes made of dry stone. In the project area and outside at several threshing floor have been found indicating that early European settlers in the area were growing wheat which is considered non-viable in the area today. While not yet scientifically verified it would appear that this part of the Karoo was able to carry a greater population in terms of people and livestock in the 18th and 19th centuries than today.

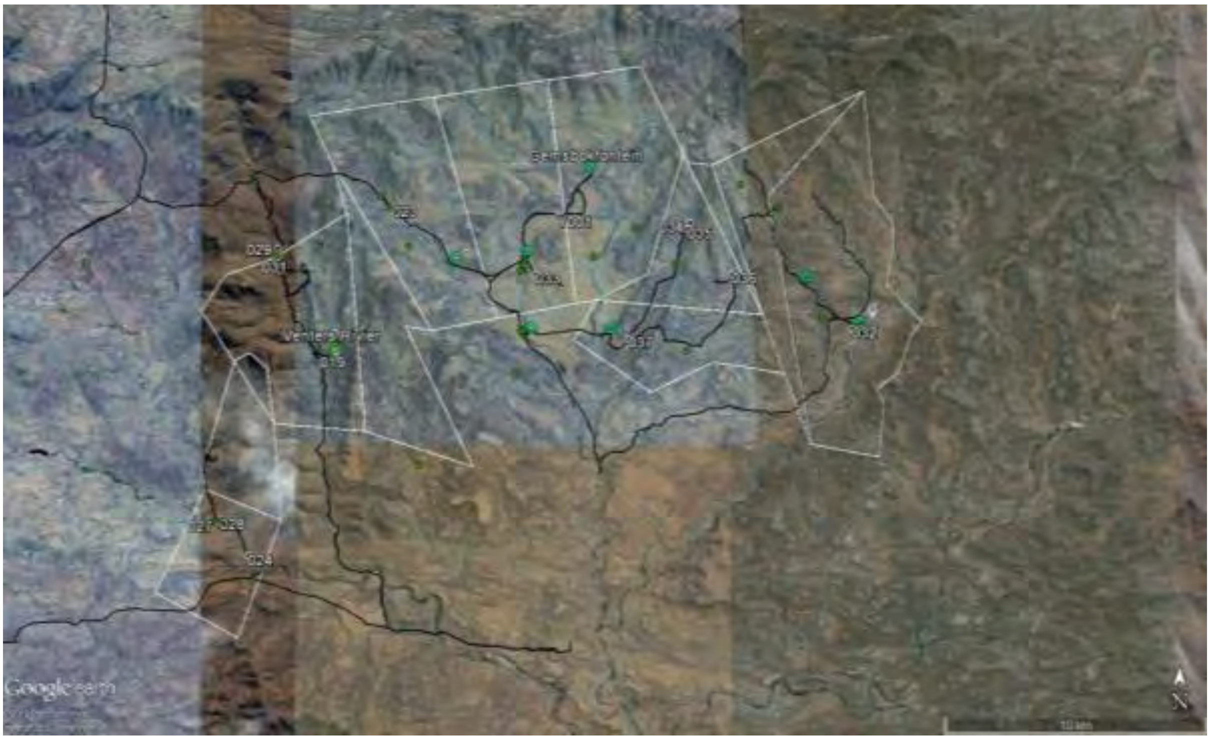

Figure 8. Farms (green 'houses), with pre-recorded kraals and ruins in green and survey recorded way-points in white (Also numbered).

Table 2. Description of the various archaeological occurrences recorded by the ACO and Natura Viva

019	Venters River farm house. A small stone 19th century structure with pitched corrugated iron roof, Victorian sash windows and door. A large barn has been added to the eastern gable-end. There is a very nicely built stone kraal behind the house, and further ruins close to the bank of the river.
020	Venters River: historic stone kraal in the vicinity
021	Venters River: a small fenced cemetery with a single grave and headstone in memory of Huibrect Bothma – born 1880 and died 1950 (possibly the last resident of the farm).
022	022 Venters River: A threshing floor (*trapvloer*) of some 10 m in diameter indicates that wheat was grown in the valley in the past.
023	A stone ruin, stone hut ruin and a kraal indicating a 19th century – early 20th century stock post. Up against a small ridge, close to the road. Also in the immediate area are five historic period stone kraals of rounded, square and rectangular form. One of these abuts a small ridge/cliff.
024	At this point there is a tumbled stone ruin over the river.
025-028	Historic kraal against a ridge, stock post with outdoor oven and ruins of a hut built against the cliff under a large bush

029	An animal trap (*wolvehok*) small stone ruin approx. 1.2m wide. Close to the road on top of a rise
030	Stone ruins on other side of river.
031	031 Two historic stone kraals built against a ridge facing a river. A previous one marked across the river. No artefacts
032	032 A small round stone ruin – single space, possibly shepherds hut
033	033 A small rock shelter/overhang that has been walled off – no deposit or artefacts noted, To the left of the track high up on the ridge
034	Two small stone ruins next to river, on other side of an historic stone kraal (oval-rectangle)
035	Recent picnic/camping place. Stone seats, fire pit and ?memorial
036	Gemsbokfontein farm house. A vernacular 18-19th century vernacular house with stope and end benches, loft and traditional fireplace, cooking shelter made of bush behind the house. Casement windows, very old glass panes (grade 3B)
037	Gemsbokfontein cemetery some 50 m south of south of the farm house, single grave. Also abandoned stone kraals situated close to the river.
Y001	Small stone hut next to large rectangular kraal (over 20m long) built in small slope otherwise very flat area between the ridges. Some ceramics not much else. Small stone oven (1-2m) behind hut
037	Possible grave/stone cairn
JA 069.	Fresh-looking flaked material among surface rubble of weathered sandstone to N of wind mast. This may not be of archaeological origin (figure 11)
JA 071-072	Fresh to patinated, water-worn artefacts on upper surface of calcretised fluvial gravels (figure 11)
JA 073	Isolated flakes of Matjiesfontein chert among surface gravels (figure 11).
A 078	.Isolated flakes of Matjiesfontein chert among surface gravels (figure 11).

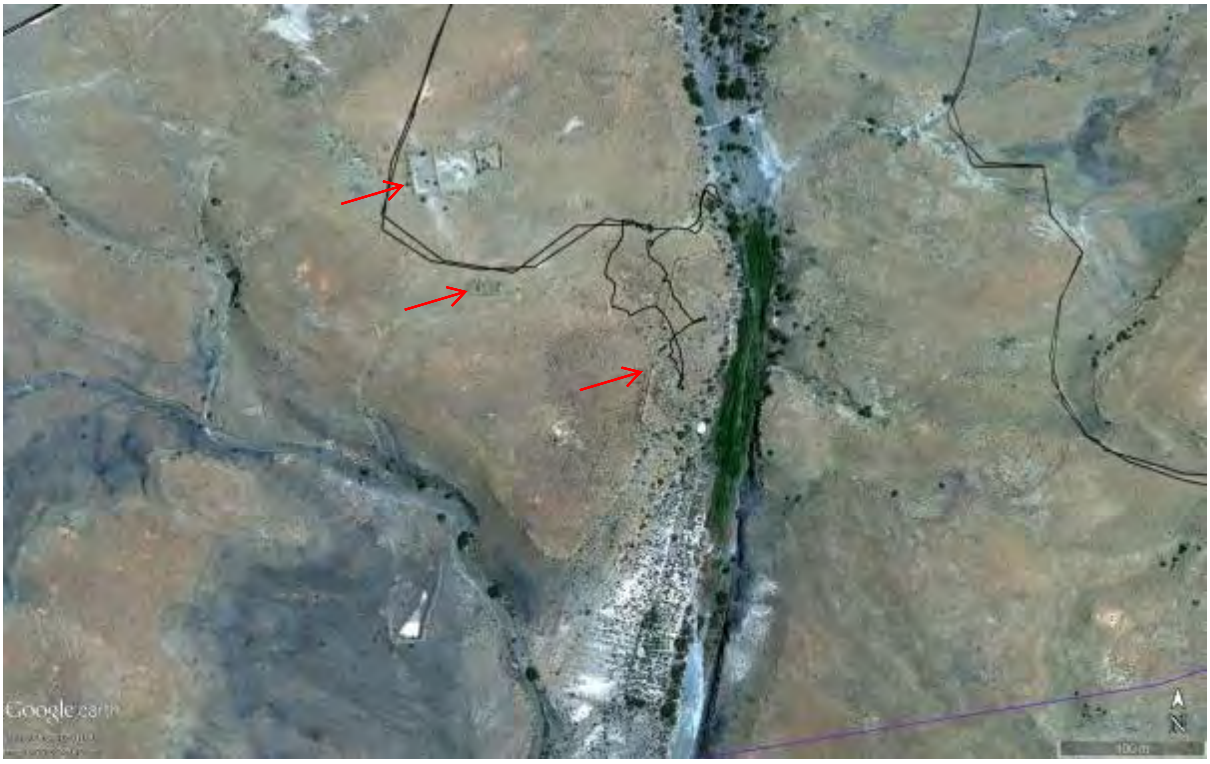

Figure 9. An example of the kraals and ruins as seen in satellite pictures.

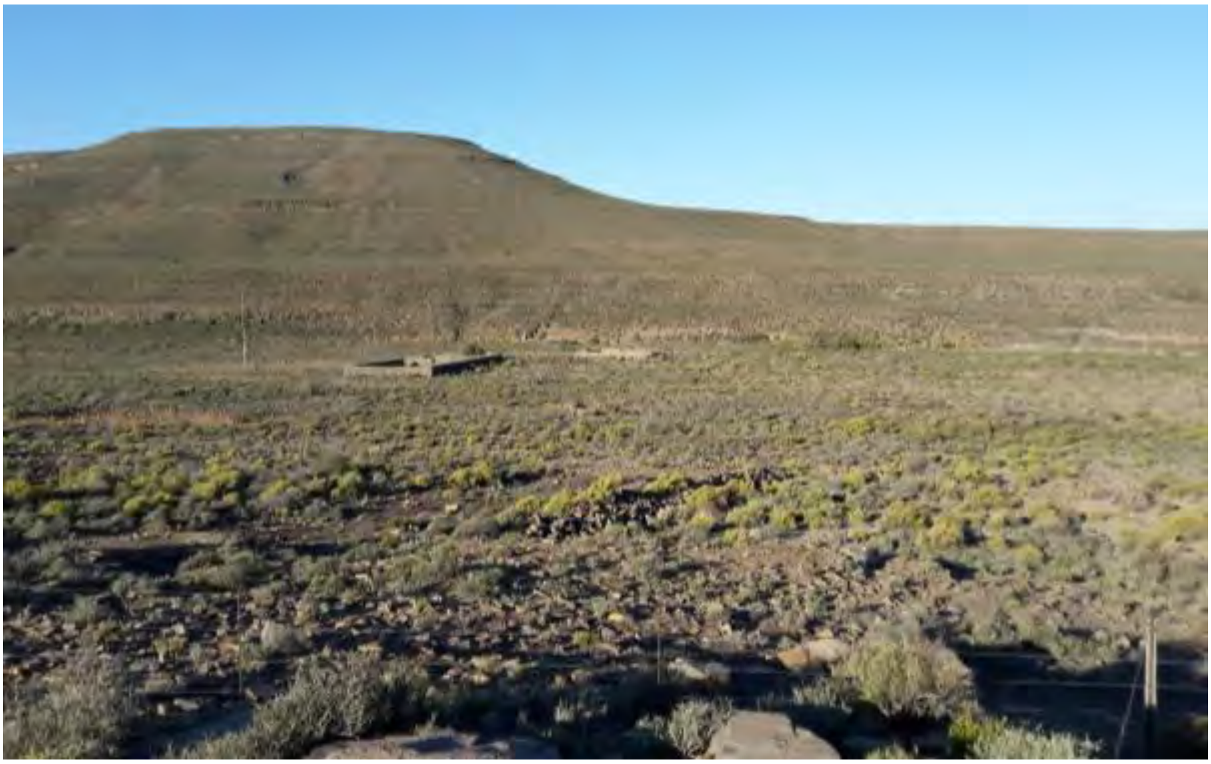

Figure 10. Though difficult to make out against the landscape there are a number of kraals in this photo, all differing in age.

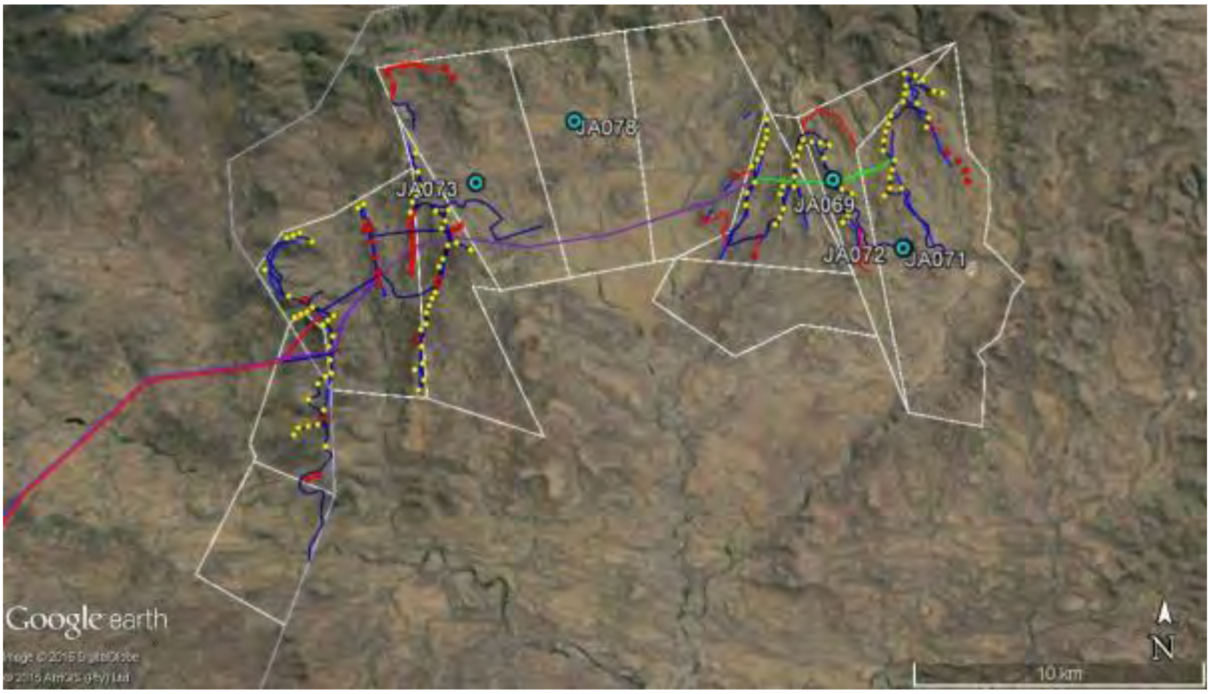

Figure 11. Map of possible archaeological points recorded by John Almond during his palaeontological survey.

7.2.1 *Historic farmhouses*

Two historic farms worthy of heritage grading were identified in the project area (See Figures 12-14).

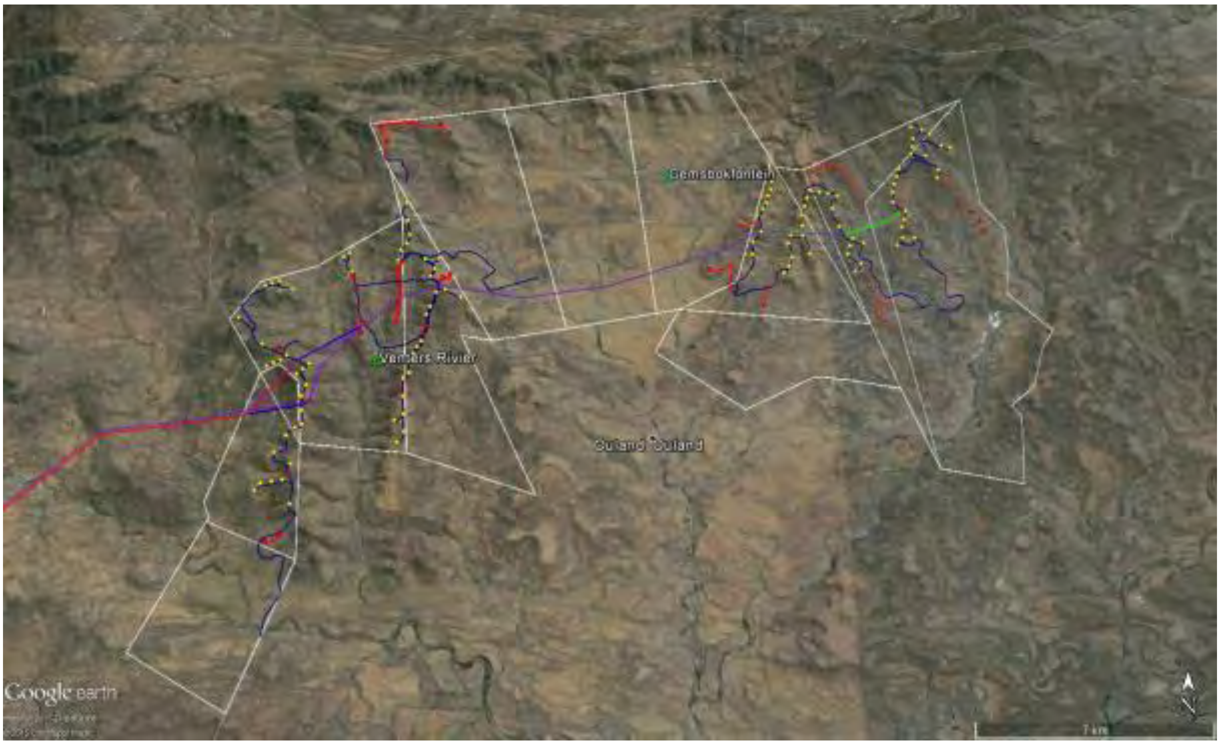

Figure 12. The two farms in relation to the proposed wind farm structures and infrastrucure

At Komsberg West an abandoned farm complex at Venters Rivier is relatively complete. There is a small stone fame house with complete fenestration and joinery that is characteristic of the mid-late 19th century. The house has a pitched corrugated iron roof and a stone barn appended to the end of the gable, also fairly complete. There is a rather beautifully built stone kraal, a small cemetery containing a single formal grave as well as the remains of a threshing floor indicating the wheat was grown in the valley in the past. There are also ruins of a number of out buildings in the area. The wind pump on the site attests to a possible spring, and possibly others in the nearby river bed.

Figure 13. Farm buildings at Venters Rivier. Small 19th century dwelling house, joinery is intact. Note the large vernacular style hearth and barn (*waenhuis*) appended onto the gable end.

Grading: Given the completeness of the site suggested grading is IIIb. At Komberg East the farm house at Gemsbokfontein is a well preserved vernacular structure of white washed stone with a pitched corrugated iron roof, large externally protruding hearth and chimney, and a *solder* (attic) accessed through the end gable. There is a traditional *stoep (veranda)* with benches at the end that extends the length of the property. The fenestration consists of smallish Dutch style casement windows, even the glass window panes are intact showing the distinct signs of flowing and warpage that is characteristic of very old glass. The property is used from time to time. Clearly the owners have taken some care to conserve its heritage qualities. There are outbuilding ruins and stone kraals in the area, as well as a traditional brushwood outdoor *kookskerm (cooking shelter).* To the south lies a small cemetery.

Figure 14. Well preserved vernacular cottage at Gemsbokfontein.

Grading: Given the completeness of the site suggested grading is IIIb.

Other farms in the area have been extensively modernised, however the presence of old kraals associated with most of them indicates a long history.

The buildings at Fontein (outside the study area) are worthy of mention as in passing the presence of a well conserved and cared for brakdak (flatroof) type vernacular farm house was noted. This is of potential grade IIIb status.

7.3 Landscape and setting

Aesthetic impacts along the Great Escarpment and Roggeveld/Moordenaars Karoo Mountains are a concern. The combined effect of wind energy facilities will impact the aesthetic qualities of the region which may diminish the value of the landscape as an aesthetic resource and potentially impact the potential for conservation and hunting related enterprises which in recent years have become popular throughout the central Karoo, although remain very limited in this immediate region. Within the project area the turbines are confined to ridge tops as is most of the proposed road infrastructure. This will protect the valley bottoms which are quite scenic with river beds, cliffs and ruins. The turbines are fairly generously spaced, but not withstanding this, visual impacts will occur and these are very difficult to mitigate. The VIA for this project (Lawson and Oberholzer 2015) has indicated general visual impacts of medium significance. Considering the intactness of the landscape, its strong natural qualities combined with the strong overlay of historical sites and ruins a landscape grading of generally IIIB significance is recommended, however there are enclaves and valleys within the site that could be worthy of a higher grade.

The area has been deemed a Renewable Energy Development Zone (REDZ) by the CSIR, earmarked through Strategic Environmental Assessments (SEAs) by the DEA.

7.3.1 Komsberg Pass

The descent of the escarpment via the Komsberg Pass is the closest scenic route on a secondary road just to the west of the study area. The Komsberg West turbines will be visible from the pass over a distance of 7 km (Oberholzer and Lawson 2015), which means that while they won't be particularly intrusive, the turbines will be visible under most weather conditions apart from heavy haze or fog. The movement of the blades will be discernible. The Komsberg Pass is used by farmers and some of the more adventurous tourists and motorcycle groups. By South African standards the pass, although very steep in places, is of moderate significance being worthy of grade IIIb significance. There are no spectacular cliffs or cuttings, while good views are to be had.

Figure 15. A large dry stone ruin at Anysriver (just outside of project area). The presence of numerous 19th century ceramics indicate this structure was occupied from the 19th - early 20th century. Ruins such as this are part of the history of the landscape and therefore should be conserved and left intact.

Figure 16. View looking westwards from Komsberg Pass.

8 Impact Assessment

8.1 Potential Impacts associated with wind energy facilities.

Wind energy facilities are big developments that can produce a wide range of impacts that will affect the heritage qualities of an area. Each turbine site needs road access that can be negotiated by a heavy lift crane(s) which means that in heavily undulating topography deep cuttings and contoured roads will have to be cut into the landscape to create workable gradients. During the construction phase each of the turbine sites will have to be leveled off to create a solid platform for cranes as well as a lay-down area for materials. This will involve earthmoving and road construction, followed by the bringing in of materials and plant. The actual construction of the turbines will involve excavation into the land surface to a depth of up to 3 m and over an area of some 400 m^2 for the concrete base. The pre-fabricated steel or concrete tower is bolted on to the base and erected in segments. The nacelle containing the generator is finally attached followed by the rotors. The turbines are connected to underground (and over ground where necessary) cables to a sub-station(s) (positioned to be determined) where after the generated current will be fed to the national grid via transmission lines. Less than 2% of the entire site is sued by the development footprint.

8.2 Impacts expected during the construction phase of the wind energy facility

During the construction phase the below physical impacts to the landscape can be expected. Physical heritage resources will have to be adequately avoided to in order to mitigate impacts upon them

- Bulldozing of roads to turbines sites with a possibility of cut and fill operations in places:
- Upgrading of existing farm tracks;

- Creation of working and lay-down areas close to each turbine site;
- Excavation of foundations for each tower;
- Excavation of many kilometres of linear trenches for cables;
- Erection of a power line/s;
- Construction of electrical infra-structure in the form of one or more sub-stations.

In terms of impacts to heritage, archaeological sites which are highly context sensitive are most vulnerable to the alteration of the land surface. The best way to manage impacts to archaeological material is to avoid impacting them. This means micro-adjusting turbine positions where feasible, or routing access roads around sensitive areas. If primary avoidance of the heritage resource is not possible, then some degree of mitigation can be achieved by systematically removing the archaeological material form the landscape. This is generally considered a second best approach as the process that has to be used is exacting and time-consuming, and therefore expensive. Furthermore the NHRA requires that archaeological material is stored indefinitely which has cost implications and places an undue burden on the limited museum storage space available in the province.

It is also during the construction phase that impacts to palaeontological heritage may be expected. Blasting and cutting of roads, digging of the turbine foundations are the areas where fossil bearing rock may be impacted and fossil material physically destroyed.

It is suggested that the following mitigation measures could be implemented.

- Existing farm tracks be re-used or upgraded to minimise the amount of change to un-transformed landscape;
- During the detailed planning phase, drawings of proposed road alignments, infrastructure and near-final turbine positions should be submitted to an archaeologist for review and field-proofing (if need be). Micro-adjustment of alignments and turbine positions is likely to be sufficient to achieve adequate mitigation, although in this instance material is so sparse that no adjustment may be necessary at all.

8.3 Impacts expected during operation of the wind energy facility

In terms of Oberholzer's (2005) classification of development activities, construction of wind turbines is a major industrial activity and therefore a category 5 development. Category 5 developments (major industrial developments) in natural landscapes tend to have a very high visual impact. This implies that there would be a significant change to the sense of place and character of the site.

During the operational life of the wind farm (20 years), it is expected that physical impacts to heritage will diminish or cease. Impacts to intangible heritage are expected to occur. Such impacts relate to changes to the feel, atmosphere and identity of a place or landscape. Such changes are evoked by visual intrusion, noise, changes in land use and population density. In the case of this project, impacts to remote and rural landscape and natural qualities are possibly of greatest concern. The point at which a wind turbine may be perceived as being “intrusive” from a given visual reference point is a subjective judgment, however it can be anticipated that the presence of such facilities in areas such as these may impact some of the intangible and aesthetic qualities for which an area is valued. The fact that turbines are continuously revolving results in a visual impact that is unlike that of a static object.

Impacts during operations are considered below:

- Due to the size of the turbines the visual impacts are largely not easily mitigated (they are easily visible from 10 km) in virtually all landscapes.
- The fact that the turbines are in continuous motion can create a visual impact more noticeable than that caused by static objects and buildings;
- Shadow flicker – an impact particular to wind turbines, comprises very large moving shadows created by the giant blades when the sun is low on the horizon. Such shadows can extend considerable distances from the turbine. Continuous shadow flicker may have an impact on the sense of place of a heritage site but physical sites are rare, at great distances from the turbines and shadow flicker is very temporary;
- Visual impact of road cuttings into the sides of slopes will affect the cultural, natural and wilderness qualities of the area;
- Residual impacts can occur after the cessation of operations which will be about 20 years after commencement. The large concrete turbine bases have to be broken up and removed which will cause some scarring until rehabilitation is complete. Bankruptcy or neglect by a wind energy company can result in turbines standing derelict for years creating a long term eyesore.

While it is not expected that physical impacts will result, changes to the way in which the area is used by people can result in impacts. If the intangible qualities of a place are affected in such a way that it becomes an undesirable place to visit or reside, the sustainable use of local tourism amenities may diminish. There is merit in making sure that no structures are affected by shadow flicker or noise which may result in them being uninhabitable.

9 Impacts: Komsberg West

9.1 Impacts to palaeontological heritage: Komsberg West

Nature of impacts: The main cause of impacts to palaeontological sites is physical disturbance/destruction of fossil material and its context which in the study area, which *may* result in an un-redeemable loss to science and knowledge.

Extent of impacts: It is expected that impacts will be limited (local). There is a chance that the deep excavations for bases could potentially impact buried fossil material, similarly excavation of cable trenches and clearing of access roads could impact material that lies buried in the surface mudstones. Potential impacts caused by power line and proposed access roads are similarly likely to be limited and local. The physical survey of the study area has shown that palaeontological material is not common on the surface or on potentially fossiliferous rock exposures in the study area therefore the extent of impacts is likely to be low and local.

Significance of impacts: In terms of the information that has been collected, indications are that impacts to palaeontology will be low provided that mitigation is in place.

Status of impacts: The destruction of palaeontological material is usually considered to be negative; however opportunities for the advancement of science and knowledge can result provided that professional assessments and mitigation is carried out. Without mitigation the impact will be medium negative, but potentially positive with successful mitigation.

Table 3. Impacts to Palaeontology

Impact Phase: Construction							
<u>Possibility of encountering unique fossils during excavation for turbine foundations</u>							
	Extent	Duration	Intensity	Status	Significance	Probability	Confidence
Without Mitigation	L	H	L	Negative	Medium -	Possible	High
With Mitigation	L	H	L	Neutral – Pos.	Medium	Possible	High
Can the impact be reversed?	NO – palaeontological heritage resources are non-renewable and key contextual data for fossils (sedimentology, taphonomy) is difficult to reconstruct following disturbance						
Will impact cause irreplaceable loss or resources?	Possible but UNLIKELY – well-preserved, scientifically valuable fossils are scarce within the project area. Many of the fossils concerned are probably of widespread occurrence (Exceptions: well-preserved, articulated vertebrate skeletons, vertebrate trackways).						
Can impact be avoided, managed or mitigated?	YES – effective mitigation of chance fossil finds by the ECO and a professional palaeontologist is possible.						
Mitigation measures: 1) Safeguarding of chance fossil finds (preferably *in situ*) during the construction phase by the responsible ECO, followed by reporting of finds to Heritage Western Cape / SAHRA. 2) Recording and judicious sampling of significant chance fossil finds by a qualified palaeontologist, together with pertinent contextual data (stratigraphy, sedimentology, taphonomy) within the final footprint. 3) Curation of fossil material within an approved repository (museum / university fossil collection) by a qualified							

palaeontologist.	
Can any residual risk be monitored/managed?	YES, through ongoing application of the fossil chance finds procedure by ECO.
Will this impact contribute to any cumulative impacts?	YES. Cumulative impacts, albeit low-level, on local fossil heritage resources are anticipated as a result of construction of the considerable number of wind energy facilities that have been proposed for the Sutherland area.

9.1.1 Palaeontological mitigation

- During the construction phase a chance-finds procedure should be applied should substantial fossil remains such as vertebrate bones, teeth or trackways, plant-rich fossil lenses or dense fossil burrow assemblages be exposed by excavation or discovered within the development footprint. The responsible Environmental Control Officer should safeguard the fossils, preferably *in situ*, and alert the responsible heritage management authority (Heritage Western Cape for the Western Cape, SAHRA for the Northern Cape) so that appropriate action can be taken by a professional palaeontologist, at the project owner's expense. Mitigation would normally involve the scientific recording and judicious sampling or collection of fossil material as well as associated geological data (*e.g.* stratigraphy, sedimentology, taphonomy) by a professional palaeontologist.

- Palaeontological mitigation recommendations should be incorporated into the Construction Environmental Management Plan (EMP) for Komsberg West Wind Energy Facility and associated transmission line. *Provided that* the recommended mitigation measures are carried through, it is likely that any potentially negative impacts of the proposed developments on local fossil resources will be substantially reduced. Furthermore, they will be partially offset by the *positive* impact represented by our increased understanding of the palaeontological heritage of the Great Karoo region.

9.2 Impacts to archaeological material: Komsberg West

Nature of impacts: The main cause of impacts to archaeological sites is physical disturbance of the material itself and its context. The heritage and scientific potential of an archaeological site is highly dependent on its geological and spatial context. This means that even though, for example a deep excavation may expose archaeological artefacts, the artefacts are relatively meaningless once removed from the area in which they were found. In the case of the proposed activity the main source of impact (if any) is likely to be the construction of access roads, lay-down areas and excavation of the footings of the turbines.

Extent of impacts: It is expected that impacts will be very limited, if any (local). Most of the areas that will be affected by the proposed activity are archaeologically sterile due to their unfavourable habitation conditions. Potential impacts caused by power line and proposed access roads are similarly likely to be limited and local.

Significance of impacts: In terms of the information that has been collected, indications are that impacts to pre-colonial archaeological material will be extremely limited if at all. In terms of buried archaeological material, one can never be sure of what lies below the ground surface, however indications are that this is extremely sparse and that impacts caused by the construction of footings and other ground disturbance is likely to be negligible.

Status of impacts: The destruction of archaeological material is usually considered to be negative; however opportunities for the advancement of science and knowledge about a place can result provided that professional assessments and mitigation is carried out in the event of an unexpected find. In this case there is so little material on site that there will be no opportunity to benefit therefore the impact will be neutral.

Table 4. Impacts to archaeology

Impact Phase: Construction only							
Possible Impact or Risk: Displacement or destruction of archaeological material.							
	Extent	Duration	Intensity	Status	Significance	Probability	Confidence
Without Mitigation	L	H	L	Negative-neutral	M	Improbable/L	High
With Mitigation	n/a/L	H	L	Negative /neutral	M	L	H
Can the impact be reversed?	Mitigation is not required, low or no impact expected. Significance of impact does not change even though precautionary mitigation suggested.						
Will impact cause irreplaceable loss or resources?	No, the very few occurrences noted are well represented in other area.						
Can impact be avoided, managed or mitigated?	Yes, impacts can be managed at level of ECO.						
Mitigation measures: Precautions only. 1) Do not disturb and old stone kraals or ruins, do not remove stone from walls, or artefacts from the earth or earth surface. 2) Report any chance discoveries of human remains to an archaeologist or a heritage authority.							
Can any residual risk be monitored/managed?	YES, mainly through avoidance or seeking advice from and archaeologist or heritage authority if necessary.						
Will this impact contribute to any cumulative impacts?	No. The site is not considered archaeologically sensitive and has few unique qualities.						

9.3 Impacts to colonial period heritage: Komsberg West

Colonial period heritage – that is buildings and historical sites of significance have been identified within the boundaries of the study area.

Nature of impacts: Historic structures are sensitive to physical damage such as demolition as well as neglect. They are also context sensitive in that changes to the surrounding landscape will affect their significance.

Extent of Impacts: Direct impacts are not expected. Some visual impacts in terms of Karoo context are possible; however most heritage structures and ruins are situated well clear of the proposed activity.

Significance of impacts: Given that there are no structures or historical sites that will be affected by Komsberg West, impacts will be low.

Status of impacts: Within the boundaries of the proposed wind energy facility, impacts are considered to be low negative.

Table 5. Impacts to colonial period heritage

Impact Phase: Construction mainly but appropriate at all times as well.							
Possible Impact or Risk: Displacement or destruction structures.							
	Extent	Duration	Intensity	Status	Significance	Probability	Confidence
Without Mitigation	L	H	L	Negative-neutral	+ or –M	L/improbable	High
With Mitigation	n/aL	H	L	Negative - neutral	+ or -M	L	H
Can the impact be reversed?	In the unlikely event of impacts occurring, they cannot be reversed without compromising authenticity. Even though precautionary mitigation provided, significance of impact does not change.						
Will impact cause irreplaceable loss or resources?	No, this kind of heritage is well represented in the region.						
Can impact be avoided, managed or mitigated?	Yes, impacts can be managed at level of ECO.						
Mitigation measures: precautionary only 1) Do not disturb and old stone kraals or ruins, do not remove stone from walls, or artefacts from the earth or earth surface. 2) Do not demolish without HWC authorisation, ideally reuse old structures and cottages, care for the fabric but change it as little as possible.							
Can any residual risk be monitored/managed?	YES, mainly through avoidance or seeking advice from an archaeologist or heritage authority if necessary.						
Will this impact contribute to any cumulative impacts?	No. The site is not considered archaeologically sensitive and has few unique qualities. Most of t heritage sites are in valley bottoms which will not be affected by the proposal.						

9.4 Cultural landscape and setting: Komsberg West

Nature of impacts: Cultural landscapes are highly sensitive to accumulative impacts and large scale development activities that change the character and public memory of a place. In terms of the National Heritage Resources Act, a cultural landscape may also include a natural landscape of high rarity value, aesthetic and scientific significance. The construction of a large facility can result in profound changes to the overall sense of place of a locality, if not the Roggeveld-Komsberg region.

Extent of impacts: Wind Turbines are without doubt conspicuous structures which will affect the atmosphere of the “place”. While this impact may be considered local in terms of physical extent, there may be wider implications in terms of the change in “identity” of the area and the accumulative effect this could have on future tourism potential. The impact of the proposed activity will be local but with a likely contribution to accumulative impacts.

Significance of impacts: The impact of the proposed activity is medium.

Status of impacts: The status of the impact is negative.

Table 6. Impacts to cultural landscape and setting

Impact Phase: Construction and operation							
Possible Impact or Risk: Alteration of sense of place, destruction of landscape quality.							
	Extent	Duration	Intensity	Status	Significance	Probability	Confidence
Without Mitigation	L	M	H	Negative-	M	Likely	High
With Mitigation	L	M	H	Negative	M	Likely	High
Can the impact be reversed?	Impact can be reversed after the life of the facility, however it is not expected that complete rehabilitation will be possible.						
Will impact cause irreplaceable loss or resources?	No, not if rehabilitation can be achieved after life of the facility.						
Can impact be avoided, managed or mitigated?	No. Some moderate reduction in impacts may be possible with adherence to findings of the VIA						
Mitigation measures: 1) Mitigation not possible due to size of turbines, hence significance of impact remains the same. 2) Adhere to findings and recommendations of the VIA							
Can any residual risk be monitored/managed?	Not possible. .						
Will this impact contribute to any cumulative impacts?	Yes, this will contribute to a general aesthetic degeneration of the Great Escarpment area, a remote scenic region of the Western Cape Karoo. It has been deemed an ideal locality in terms of it wind resources, however the high volume of proposals for the area will result in industrialis of a natural place of good aesthetic value. Depending on how many are built the impact on cultural/heritage sense of place could be high.						

10 Summary of Impacts: Komsberg East

10.1 Impacts to palaeontological heritage: Komsberg East

Nature of impacts: The main cause of impacts to palaeontological sites is physical disturbance/destruction of fossil material and its context which in the study area, may result in an un-redeemable loss to science and knowledge.

Extent of impacts: It is expected that impacts will be limited (local). There is a chance that the deep excavations for bases could potentially impact buried fossil material, similarly excavation of cable trenches and clearing of access roads could impact material that lies buried in the surface mudstones. Potential impacts caused by power line and proposed access roads are similarly likely to be limited and local. The physical survey of the study area has shown that palaeontological material is not common in the study area therefore the significance of impacts is likely to be low.

Significance of impacts: In terms of the information that has been collected, indications are that impacts to palaeontology will be low.

Status of impacts: The destruction of palaeontological material is usually considered to be negative; however opportunities for the advancement of science and knowledge can result provided that professional assessments and mitigation is carried out. Without mitigation the impact will be medium negative, but potentially positive with successful mitigation.

Table 7. Impacts to Palaeontology

Impact Phase: Construction							
<u>Possibility of of encountering unique fossils during excavation for turbine foundations.</u>							
	Extent	Duration	Intensity	Status	Significance	Probability	Confidence
Without Mitigation	L	H	L	Negative	Medium -	Possible	High
With Mitigation	L	H	L	Neutral – Pos.	Low +	Possible	High
Can the impact be reversed?	NO – palaeontological heritage resources are non-renewable and key contextual data for fossils (sedimentology, taphonomy) is difficult to reconstruct following disturbance						
Will impact cause irreplaceable loss or resources?	Possible but UNLIKELY – well-preserved, scientifically valuable fossils are scarce within the project area. Many of the fossils concerned are probably of widespread occurrence (Exceptions: well-preserved, articulated vertebrate skeletons, vertebrate trackways).						
Can impact be avoided, managed or mitigated?	YES – effective mitigation of chance fossil finds by the ECO and a professional palaeontologist is possible.						
Mitigation measures: 1) Safeguarding of chance fossil finds (preferably *in situ*) during the construction phase by the responsible ECO, followed by reporting of finds to Heritage Western Cape / SAHRA. 2) Recording and judicious sampling of significant chance fossil finds by a qualified palaeontologist, together with pertinent contextual data (stratigraphy, sedimentology, taphonomy) within the final footprint. 3) Curation of fossil material within an approved repository (museum / university fossil collection) by a qualified palaeontologist.							

Can any residual risk be monitored/managed?	YES, through ongoing application of the fossil chance finds procedure by ECO.
Will this impact contribute to any cumulative impacts?	YES. Cumulative impacts, albeit low-level, on local fossil heritage resources are anticipated as a result of construction of the considerable number of wind energy facilities that have been proposed for the Sutherland area.

10.1.1 Palaeontological mitigation

- During the construction phase a chance-finds procedure should be applied should substantial fossil remains such as vertebrate bones, teeth or trackways, plant-rich fossil lenses or dense fossil burrow assemblages be exposed by excavation or discovered within the development footprint. The responsible Environmental Control Officer should safeguard the fossils, preferably *in situ*, and alert the responsible heritage management authority (Heritage Western Cape for the Western Cape, SAHRA for the Northern Cape) so that appropriate action can be taken by a professional palaeontologist, at the developer's expense. Mitigation would normally involve the scientific recording and judicious sampling or collection of fossil material as well as associated geological data (*e.g.* stratigraphy, sedimentology, taphonomy) by a professional palaeontologist.

- Palaeontological mitigation recommendations should be incorporated into the Construction Environmental Management Plan (EMP) for Komsberg East Wind Energy Facility and associated transmission line. *Provided that* the recommended mitigation measures are carried through, it is likely that any potentially negative impacts of the proposed developments on local fossil resources will be substantially reduced. Furthermore, they will be partially offset by the *positive* impact represented by our increased understanding of the palaeontological heritage of the Great Karoo region.

10.2 Impacts to archaeological material: Komsberg East

Nature of impacts: The main cause of impacts to archaeological sites is physical disturbance of the material itself and its context. The heritage and scientific potential of an archaeological site is highly dependent on its geological and spatial context. This means that even though, for example a deep excavation may expose archaeological artefacts, the artefacts are relatively meaningless once removed from the area in which they were found. In the case of the proposed activity the main source of impact (if any) is likely to be the construction of access roads, lay-down areas and excavation of the footings of the turbines.

Extent of impacts: It is expected that impacts will be very limited, if any (local). Most of the areas that will be affected by the proposed activity are archaeologically sterile due to their unfavourable habitation conditions. Potential impacts caused by power line and proposed access roads are similarly likely to be limited and local.

Significance of impacts: In terms of the information that has been collected, indications are that impacts to pre-colonial archaeological material will be extremely limited if at all. In terms of buried archaeological material, one can never be sure of what lies below the ground surface, however indications are that this is extremely sparse and that impacts caused by the construction of footings and other ground disturbance is likely to be negligible. Note that in real terms, the impact is very low but because the duration is always permanent (archaeological material cannot be replaced if lost), the significance results in a medium.

Status of impacts: The destruction of archaeological material is usually considered to be negative; however opportunities for the advancement of science and knowledge about a place can result provided that professional assessments and mitigation is carried out in the event of an unexpected find. In this case there is so little material on site that there will be no opportunity to benefit therefore the impact will be neutral.

Table 8. Impacts to archaeology

Impact Phase: Construction only							
Possible Impact or Risk: Displacement or destruction of archaeological material.							
	Extent	Duration	Intensity	Status	Significance	Probability	Confidence
Without Mitigation	L	H	L	Negative-neutral	Medium - neutral	improbable	High
With Mitigation	L	H	L	Negative - neutral	Medium-neutral	L	H
Can the impact be reversed?	Mitigation is not required, low or no impact expected. Significance of impact will not change with mitigation.						
Will impact cause irreplaceable loss or resources?	No, the very few occurrences noted are well represented in other area.						
Can impact be avoided, managed or mitigated?	Yes, impacts can be managed at level of ECO.						
Mitigation measures: Precautions only. 1) Do not disturb and old stone kraals or ruins, do not remove stone from walls, or artefacts from the earth or earth surface. 2) Report any chance discoveries of human remains to an archaeologist or a heritage authority.							
Can any residual risk be monitored/managed?	YES, mainly through avoidance or seeking advice from and archaeologist or heritage authority if necessary.						
Will this impact contribute to any cumulative impacts?	No. The site is not considered archaeologically sensitive and has few unique qualities.						

10.3 Impacts to colonial period heritage: Komsberg East

Colonial period heritage – that is buildings and historical sites of significance have been identified within the boundaries of the study area.

Nature of impacts: Historic structures are sensitive to physical damage such as demolition as well as neglect. They are also context sensitive in that changes to the surrounding landscape will affect their significance.

Extent of Impacts: Direct impacts are not expected. Some visual impacts in terms of Karoo context are expected; however most heritage structures and ruins are situated well clear of the proposed activity.

Significance of impacts: Given that there are no structures or historical sites that will be affected by Komsberg East, impacts will be low.

Status of impacts: Within the boundaries of the proposed wind energy facility, impacts are considered to be low negative.

Table 9. Impacts to colonial period heritage

<table>
<tr><td colspan="8">Impact Phase: Construction mainly but appropriate at all times as well.</td></tr>
<tr><td colspan="8"><u>Possible</u> Impact or Risk: Displacement or destruction of archaeological material.</td></tr>
<tr><td></td><td>Extent</td><td>Duration</td><td>Intensity</td><td>Status</td><td>Significance</td><td>Probability</td><td>Confidence</td></tr>
<tr><td>Without Mitigation</td><td>L</td><td>H</td><td>L</td><td>Negative-neutral</td><td>M</td><td>improbable</td><td>High</td></tr>
<tr><td>With Mitigation</td><td>L</td><td>H</td><td>L</td><td>Neutral - positive</td><td>M</td><td>Improbable</td><td>High</td></tr>
<tr><td colspan="3">Can the impact be reversed?</td><td colspan="5">In the unlikely event of impacts occurring, they can be reversed without compromising authenticity. Significance of impact does not change with mitigation.</td></tr>
<tr><td colspan="3">Will impact cause irreplaceable loss or resources?</td><td colspan="5">No, this kind of heritage is well represented in the region.</td></tr>
<tr><td colspan="3">Can impact be avoided, managed or mitigated?</td><td colspan="5">Yes, impacts can be managed at level of ECO.</td></tr>
<tr><td colspan="8">Mitigation measures: Precautions only.
1) Do not disturb and old stone kraals or ruins, do not remove stone from walls, or artefacts from the earth or earth surface.
2) Do not demolish without HWC authorisation, ideally reuse old structures and cottages, care for the fabric but change it as little as possible.</td></tr>
<tr><td colspan="2">Can any residual risk be monitored/managed?</td><td colspan="6">YES, mainly through avoidance or seeking advice from an archaeologist or heritage authority if necessary.</td></tr>
<tr><td colspan="2">Will this impact contribute to any cumulative impacts?</td><td colspan="6">No. The site is not considered archaeologically sensitive and has few unique qualities. Most the heritage sites are in valley bottoms which will not be affected by the proposal. Low cumu impact.</td></tr>
</table>

10.4 Cultural landscape and setting: Komsberg East

Nature of impacts: Cultural landscapes are highly sensitive to accumulative impacts and large scale development activities that change the character and public memory of a place. In terms of the National Heritage Resources Act, a cultural landscape may also include a natural landscape of high rarity value, aesthetic and scientific significance. The construction of a large facility can result in profound changes to the overall sense of place of a locality, if not a region.

Extent of impacts: Wind Turbines are without doubt conspicuous structures which will affect the atmosphere of the "place". While this impact may be considered local in terms of physical extent, there may be wider implications in terms of the change in "identity" of the area and the accumulative effect this could have on future tourism potential. The impact of the proposed activity will be local but with a likely contribution to accumulative impacts.

Significance of impacts: The impact of the proposed activity is medium.

Status of impacts: The status of the impact is negative.

Table 10. Impacts to cultural landscape and setting

Impact Phase: Construction and operation							
Possible Impact or Risk: Alteration of sense of place, destruction of landscape quality.							
	Extent	Duration	Intensity	Status	Significance	Probability	Confidence
Without Mitigation	L	M	M	Negative-	Medium -	Likely	High
With Mitigation	L	M	M	Negative	Medium -	Likely	High
Can the impact be reversed?	Impact can be reversed after the life of the facility, however it is not expected that complete rehabilitation will be possible due to the size of road cuttings and the difficulty of bringing back a natural appearance on a stony landscape. Significance of impact will not change with mitigation.						
Will impact cause irreplaceable loss or resources?	No, not if rehabilitation can be achieved after life of the facility.						
Can impact be avoided, managed or mitigated?	No. Some moderate reduction in impacts may be possible with adherence to findings of the VIA						
Mitigation measures: 1) Mitigation not possible due to size of turbines. 2) Adhere to findings and recommendations of the VIA							
Can any residual risk be monitored/managed?	N/a						
Will this impact contribute to any cumulative impacts?	Yes, this will contribute to a general aesthetic degeneration of the Great Escarpment area, a remote scenic region of the Western Cape Karoo. It has been deemed an ideal locality in terms of it wind resources, however the high volume of proposal for the area will result in industrialisat a natural place of good aesthetic value resulting in a high impact						

11 Impacts of grid connection for Komsberg West

11.1 Impacts to palaeontological heritage

Given that the grid connection will involve fairly light weight structures not requiring the deep foundation conditions of turbines, the impacts to heritage will be surface only, and in all likelihood very few.

Nature of impacts: The main cause of impacts to palaeontological sites is physical disturbance/destruction of fossil material and its context which in the study area, could result in an un-redeemable loss to science and knowledge.

Extent of impacts: It is expected that impacts will be limited (local) There is a chance that the deep excavations for bases could potentially impact buried fossil material, similarly excavation of cable trenches and clearing of access roads could impact material that lies buried in the surface mudstones. Potential impacts caused by power line and proposed access roads are similarly likely to be limited and local. The physical survey of the study area has shown that palaeontological material is common in areas where there is mudstone geology, and often visible on the surface.

Significance of impacts: In terms of the information that has been collected, indications are that impacts to palaeontology may occur in mudstone areas. Impacts are not expected in the high dolerite areas where many of the turbines are to be situated. The impacts have the potential to be of high to medium negative significance, however proper mitigation may result in a positive impact which will derive knowledge.

Status of impacts: The destruction of palaeontological material is usually considered to be negative; however opportunities for the advancement of science and knowledge can result provided that professional assessments and mitigation is carried out. Without mitigation the impact will be medium negative, but potentially positive with successful mitigation.

Table 11. Palaeontological impacts – grid connection infrastructure

Impact Phase: Construction							
<u>Possibility of encountering unique fossils during excavation for turbine footings</u>							
	Extent	Duration	Intensity	Status	Significance	Probability	Confidence
Without Mitigation	Local	Permanent	Low	Negative	Medium -	Possible	High
With Mitigation	Local	Permanent	Low	Neutral – Positive.	Medium	Possible	High
Can the impact be reversed?	NO – palaeontological heritage resources are non-renewable and key contextual data for fossils (sedimentology, taphonomy) is difficult to reconstruct following disturbance						
Will impact cause irreplaceable loss or resources?	Possible but UNLIKELY – well-preserved, scientifically valuable fossils are scarce within the project area. Many of the fossils concerned are probably of widespread occurrence (Exceptions: well-preserved, articulated vertebrate skeletons, vertebrate trackways).						
Can impact be avoided, managed or mitigated?	YES – effective mitigation of chance fossil finds by the ECO and a professional palaeontologist is possible.						

Mitigation measures: 1) Safeguarding of chance fossil finds (preferably *in situ*) during the construction phase by the responsible ECO, followed by reporting of finds to Heritage Western Cape / SAHRA. 2) Recording and judicious sampling of significant chance fossil finds by a qualified palaeontologist, together with pertinent contextual data (stratigraphy, sedimentology, taphonomy) within the final footprint. 3) Curation of fossil material within an approved repository (museum / university fossil collection) by a qualified palaeontologist.

Can any residual risk be monitored/managed?	YES, through ongoing application of the fossil chance finds procedure by ECO.
Will this impact contribute to any cumulative impacts?	YES. Cumulative impacts, albeit low-level, on local fossil heritage resources are anticipated as a result of construction of the considerable number of wind energy facilities that have been proposed for the Sutherland area.

11.2 Potential impacts to pre-colonial archaeology and colonial period heritage

The Zeekoei Valley Archaeological Project is the only existing saturation survey in the Great Karoo that can used as a device to "predict" the frequency of direct impacts to archaeological sites. Sampson 1985 conducted an audit of impacts his area of work in the Great Karoo and established that within a sample survey area of 37 kilometres impacts of transmission lines on archaeological sites was minimal. Given that the eastern Karoo is carries many more archaeological sites than this project area, it is argued that the impact of the construction of power lines will be very small, if at all. The likelihood of towers directly impacting archaeological sites is low, and in the event of this happening the impact will be over a small area.

Table 12. Archaeological and colonial period impacts – grid connection infrastructure

Impact Phase: Construction only							
<u>Possible</u> Impact or Risk: Displacement or destruction of archaeological material, structures or kraals.							
	Extent	Duration	Intensity	Status	Significance	Probability	Confidence
Without Mitigation	L	M	L	Negative-neutral	Low-neutral	improbable	High
With Mitigation	L	M	L	Neutral	Low-neutral	improbable	High
Can the impact be reversed?	Mitigation is not required, low or no impact expected						
Will impact cause irreplaceable loss or resources?	No, the very few occurrences noted are well represented in other area.						
Can impact be avoided, managed or mitigated?	Yes, impacts can be managed at level of ECO.						
Mitigation measures: 1) Do not disturb and old stone kraals or ruins, do not remove stone from walls, or artefacts from the earth or earth surface. 2) Avoid farm yards and buildings (none in the alignment). 3) Report any chance discoveries of human remains to an archaeologist or a heritage authority.							
Can any residual risk be monitored/managed?	YES, mainly through avoidance or seeking advice from and archaeologist or heritage authority if necessary.						
Will this impact contribute to any cumulative impacts?	No. The site is not considered archaeologically sensitive and has few unique qualities.						

11.3 Impacts to landscape quality

Compared with the turbines the impact of the grid connection will be small in comparison, and not particular aggressive in the context of the recent 765 kV lines that pass close to the site. In many instances there will be backdrop scenery which will help absorb the lines and substation. If lattice towers are used, the impact to the landscape will be very low but monopoles will still be acceptable or low impact.

Table 13. Impacts to landscape quality

<table>
<tr><td colspan="8">Impact Phase: Construction and operation</td></tr>
<tr><td colspan="8">Possible Impact or Risk: Alteration of sense of place, destruction of landscape quality.</td></tr>
<tr><td></td><td>Extent</td><td>Duration</td><td>Intensity</td><td>Status</td><td>Significance</td><td>Probability</td><td>Confidence</td></tr>
<tr><td>Without Mitigation</td><td>L</td><td>M</td><td>L</td><td>Negative-</td><td>Low</td><td>Likely</td><td>High</td></tr>
<tr><td>With Mitigation</td><td>L</td><td>M</td><td>L</td><td>Negative</td><td>Very low -</td><td>Likely</td><td>High</td></tr>
<tr><td colspan="2">Can the impact be reversed?</td><td colspan="6">Impact can be reversed after the life of the facility.</td></tr>
<tr><td colspan="2">Will impact cause irreplaceable loss or resources?</td><td colspan="6">No, not if rehabilitation can be achieved after life of the facility.</td></tr>
<tr><td colspan="2">Can impact be avoided, managed or mitigated?</td><td colspan="6">Yes, this can be achieved through tower choice and alignment adjustment although either tower type will be acceptable</td></tr>
<tr><td colspan="8">Mitigation measures:
1) Avoid farmsteads and structures (at least 400 m buffer).
2) Consider using a lattice tower form as these are visually more permeable, at at a distance are almost invisible against a backdrop.</td></tr>
<tr><td colspan="2">Can any residual risk be monitored/managed?</td><td colspan="6">Yes, through good rehabilitation after life of facility, removal of towers.</td></tr>
<tr><td colspan="2">Will this impact contribute to any cumulative impacts?</td><td colspan="6">Yes, this will make a minor contribution to a general aesthetic degeneration of the Great Escar area, a remote scenic region of the Western Cape Karoo. It has been deemed an ideal locality in terms of it wind resources, however the high volume of proposal for the area will result in industrialisation of a natural place of good aesthetic value. The accumulative impact will be of low significance.</td></tr>
</table>

12 Impacts of grid connection for Komsberg East

12.1 Impacts to palaeontological heritage

Given that the grid connection will involve fairly light weight structures not requiring the deep foundation conditions of turbines, the impacts to heritage will be surface only, and in all likelihood very few.

Nature of impacts: The main cause of impacts to palaeontological sites is physical disturbance/destruction of fossil material and its context which in the study area, could result in an un-redeemable loss to science and knowledge.

Extent of impacts: It is expected that impacts will be limited (local) There is a chance that the deep excavations for bases could potentially impact buried fossil material, similarly excavation of cable trenches and clearing of access roads could impact material that lies buried in the surface mudstones. Potential impacts caused by power line and proposed access roads are similarly likely to be limited and local. The physical survey of the study area has shown that palaeontological material is common in areas where there is mudstone geology, and often visible on the surface.

Significance of impacts: In terms of the information that has been collected, indications are that impacts to palaeontology may occur in mudstone areas. Impacts are not expected in the high dolerite areas where many of the turbines are to be situated. The impacts have the potential to be of high to medium negative significance, however proper mitigation may result in a positive impact which will derive knowledge.

Status of impacts: The destruction of palaeontological material is usually considered to be negative; however opportunities for the advancement of science and knowledge can result provided that professional assessments and mitigation is carried out. Without mitigation the impact will be medium negative, but potentially positive with successful mitigation.

Table 14. Palaeontological impacts – grid connection infrastructure

<table>
<tr><td colspan="8">Impact Phase: Construction</td></tr>
<tr><td colspan="8">possibility of encountering unique fossils during excavation for turbine footings</td></tr>
<tr><td></td><td>Extent</td><td>Duration</td><td>Intensity</td><td>Status</td><td>Significance</td><td>Probability</td><td>Confidence</td></tr>
<tr><td>Without Mitigation</td><td>L</td><td>M</td><td>L</td><td>Negative</td><td>L0w</td><td>Possible</td><td>High</td></tr>
<tr><td>With Mitigation</td><td>L</td><td>M</td><td>L</td><td>Neutral – Pos.</td><td>Low</td><td>Possible</td><td>High</td></tr>
<tr><td colspan="3">Can the impact be reversed?</td><td colspan="5">NO – palaeontological heritage resources are non-renewable and key contextual data for fossils (sedimentology, taphonomy) is difficult to reconstruct following disturbance</td></tr>
<tr><td colspan="3">Will impact cause irreplaceable loss or resources?</td><td colspan="5">Possible but UNLIKELY – well-preserved, scientifically valuable fossils are scarce within the project area. Many of the fossils concerned are probably of widespread occurrence (Exceptions: well-preserved, articulated vertebrate skeletons, vertebrate trackways).</td></tr>
</table>

Can impact be avoided, managed or mitigated?	YES – effective mitigation of chance fossil finds by the ECO and a professional palaeontologist is possible.
Mitigation measures: 1) Safeguarding of chance fossil finds (preferably *in situ*) during the construction phase by the responsible ECO, followed by reporting of finds to Heritage Western Cape / SAHRA. 2) Recording and judicious sampling of significant chance fossil finds by a qualified palaeontologist, together with pertinent contextual data (stratigraphy, sedimentology, taphonomy) within the final footprint. 3) Curation of fossil material within an approved repository (museum / university fossil collection) by a qualified palaeontologist.	
Can any residual risk be monitored/managed?	YES, through ongoing application of the fossil chance finds procedure by ECO.
Will this impact contribute to any cumulative impacts?	YES. Cumulative impacts, albeit low-level, on local fossil heritage resources are anticipated as a result of construction of the considerable number of wind energy facilities that have been proposed for the Sutherland area.

12.2 Potential impacts to pre-colonial archaeology and colonial period heritage

The Zeekoei Valley Archaeological Project is the only existing saturation survey in the Great Karoo that can used as a device to "predict" the frequency of direct impacts to archaeological sites. Sampson 1985 conducted an audit of impacts his area of work in the Great Karoo and established that within a sample survey area of 37 kilometres impacts of transmission lines on archaeological sites was minimal. Given that the eastern Karoo is carries many more archaeological sites that this project area, it is argued that the impact of the construction of power lines will be very small, if at all. The likelihood of towers directly impacting archaeological sites is low, and in the event of this happening the impact will be over a small area.

Table 15. Archaeological and colonial period impacts – grid connection infrastructure

Impact Phase: Construction only							
<u>Possible</u> Impact or Risk: Displacement or destruction of archaeological material, structures or kraals.							
	Extent	Duration	Intensity	Status	Significance	Probability	Confidence
Without Mitigation	L	H	L	Negative-neutral	Medium - neutral	improbable	High
With Mitigation	L	H	L	Neutral	Medium Low-neutral	improbable	High
Can the impact be reversed?	Mitigation is not required, low or no impact expected, Significance of impact does not change with mitigation.						
Will impact cause irreplaceable loss or resources?	No, the very few occurrences noted are well represented in other area.						
Can impact be avoided, managed or mitigated?	Yes, impacts can be managed at level of ECO.						
Mitigation measures: 1. Do not disturb and old stone kraals or ruins, do not remove stone from walls, or artefacts from the earth or earth surface. 2. Avoid farm yards and buildings (none in the alignment). 3. Report any chance discoveries of human remains to an archaeologist or a heritage authority.							
Can any residual risk be monitored/managed?	YES, mainly through avoidance or seeking advice from and archaeologist or heritage authority if necessary.						

Will this impact contribute to any cumulative impacts?	No. The site is not considered archaeologically sensitive and has few unique qualities.

12.3 Impacts to landscape quality

Compared with the turbines the impact of the grid connection will be small in comparison, and not particular aggressive in the context of the recent 765 kV lines that pass close to the site. In many instances there will be backdrop scenery which will help absorb the silhouette lines and substation. If lattice towers are used, the impact to the landscape will be very low but monopoles will still be acceptable or of low impact.

Table 16. Impacts to landscape quality

Impact Phase: Construction and operation							
Possible Impact or Risk: Alteration of sense of place, destruction of landscape quality.							
	Extent	Duration	Intensity	Status	Significance	Probability	Confidence
Without Mitigation	L	H	L	Negative-	Medium	Likely	High
With Mitigation	L	H	L	Negative	Very low – Medium	Likely	High
Can the impact be reversed?	Impact can be reversed after the life of the facility.						
Will impact cause irreplaceable loss or resources?	No, not if rehabilitation can be achieved after life of the facility.						
Can impact be avoided, managed or mitigated?	Yes, this can be achieved through tower choice and alignment adjustment although either tower type will be acceptable						
Mitigation measures: 1. Do not disturb and old stone kraals or ruins, do not remove stone from walls, or artefacts from the earth or earth surface. 2. Avoid farm yards and buildings (none in the alignment). 3. Report any chance discoveries of human remains to an archaeologist or a heritage authority.							
Can any residual risk be monitored/managed?	Yes, through good rehabilitation after life of facility, removal of towers.						
Will this impact contribute to any cumulative impacts?	Yes, this will make a minor contribution to a general aesthetic degeneration of the Great Escar area, a remote scenic region of the Western Cape Karoo. It has been deemed an ideal locality in terms of it wind resources, however the high volume of proposasl for the area will result in complete industrialisation of a natural place of good aesthetic value.. The contribution of the grid connection is of low significance.						

13 Accumulative Impacts

As is the case with renewable energy projects the major impacts to the character of very large areas as well as a significant radius of land are a concern. The impacts are almost inevitably significant and very difficult to mitigate successfully, especially in highly sensitive landscapes that have good scenic value. The study area lies in an optimal area for wind with the result that numerous renewable energy proposals have been forthcoming for the landscape below the Great Escarpment of Sutherland. If all of these are approved, the landscape impacts will be significant changing the character of the local area (Moordenaars-Roggeveld Karoo).

14 Alternatives

Impacts of the alternative turbines positions for Komsberg East and Komsberg West are as for the preferred positions. No preferences are offered.

Impacts for the alternative grid connections for Komsberg East and Komsberg West are as for the preferred grid connections. No preferences are offered.

15 General mitigation and conservation

15.1 Palaeontological heritage

Given the apparent rarity of significant fossil sites within the Komsberg West and East WEF study areas, no specialist palaeontological monitoring or mitigation for this project is recommended, pending the discovery of significant new fossil sites during development (*e.g.* well-preserved vertebrate bones, teeth and trackways, concentrations of petrified wood and/ or other plant fossils). The ECO responsible for the construction phase of the project should be aware of the necessity of conserving fossils and should monitor all substantial excavations into sedimentary rocks for fossil remains.

Recommended mitigation of chance fossil finds during the construction phase involves safeguarding of the fossils (preferably *in situ*) by the responsible ECO and reporting of finds to:

- Heritage Western Cape (HWC. Protea Assurance Building, Green Market Square, Cape Town 8000. Private Bag X9067, Cape Town 8001. Tel: 086-142 142. Fax: 021-483 9842. Email: hwc@pgwc.gov.za)
- or to SAHRA for the Northern Cape (Contact details: SAHRA, 111 Harrington Street, Cape Town. PO Box 4637, Cape Town 8000, South Africa. Phone: +27 (0)21 462 4502. Fax: +27 (0)21 462 4509. Web: www.sahra.org.za).

Where appropriate, judicious sampling and recording of fossil material and associated geological data by a qualified palaeontologist may be required by the heritage regulatory authorities. Any fossil material collected should be curated within an approved repository (museum / university fossil collection) by a qualified palaeontologist. These recommendations should be included within the Environmental Management Programme for the proposed alternative energy project.

Given the internationally recognised value of Karoo fossil heritage (*e.g.* Macrae 1999, McCarthy & Rubidge 2005), the known occurrence of scientifically valuable fossil material in the Sutherland / Moordenaarskaroo region, as well as the legal protection of all fossil remains under the National Heritage Resources Act (1999), these mitigation measures are considered to be essential.

15.2 Archaeolology

The archaeology of the Komsberg East and Komsberg West wind energy facilities does not warrant any specific mitigation.

15.3 Built environment and colonial period sites

No mitigations is required for any colonial period structures or heritage sites apart from observing general good practise. That is do not demolish or reuse the stone from ruins, walls or kraals. Leaving them “as is “, and do not remove any artefacts or materials.

15.4 Cultural landscape and setting

Some recommendations of the VIA apply in terms of heritage (after Oberholzer and Lawson 2015) and that report must be referred to for these.

With respect to turbines (Komsberg East and Komsberg West).

a) Visually sensitive peaks, major ridgelines and scarp edges, including 500m buffers, to be avoided, because of silhouette effect on the skyline over large distances.
b) Mountain peaks and ridge lines as identified in the VIA must be avoided.
c) Slopes steeper than 1:5 gradient to be avoided.
d) Cultural landscapes or valuable cultivated land, particularly along alluvial river terraces to be avoided.
e) Stream features, including 250m buffers, to be avoided.
f) Buffers around settlements, farmsteads and roads to be observed.

With respect to grid connections (Komsberg East and Komsberg West).

a) Powerlines to avoid visually sensitive peaks, major ridgelines, scarp edges and slopes steeper than 1:5 gradient.
b) Internal connecting powerlines to be below ground where possible, particularly on visually exposed ridges.
c) Substations to be sited in unobtrusive, low-lying areas, away from roads and habitations, and screened by berms and/or tree-planting where feasible.
d) Operations and maintenance buildings and parking areas to be located in an unobtrusive area and consolidated to avoid sprawl of buildings in the open landscape.
e) Access roads to be in sympathy with the contours, avoid steep 1:5 slopes and drainage courses, and kept as narrow as possible.

15.5 Human remains

Although only one grave was positively identified, graves are generally found associated with historic farms and appear to be confined to alluvial deposits in river valleys as elsewhere soil depth is very shallow, if not non-existent. Because of this it is anticipated that the likelihood of graves existing in the project area is extremely low (but the possibility cannot be completely ruled out). Such remains are protected by a plethora of legislation including the Human Tissues Act (Act No 65 of 1983), the Exhumation Ordinance of 1980 and the National Heritage Resources Act (Act No 25 of 1999). In the event of human bones being found on site, an archaeologist must be informed immediately and the remains removed under an emergency permit. This process will incur some expense as removal of human remains is at the cost of the developer. Time delays may result while application is made to the authorities and an archaeologist is appointed to do the work.

15.6 Evolution of the final layout

The compilation of constraints from a wide variety of disciplines – visual impacts, heritage, planning and the various ecological disciplines have been considered by the EAP together with the proponent to develop a final proposed layout. These are indicated below as Figure 17 -18. The study showed that in terms of general heritage, most heritage occurrences as well as other environmental constraints occur in river valleys, all of which have been successfully avoided which means that the physical impacts to heritage sites, buildings and places are generally low. The issues of impacts to landscape and sense of place are difficult to resolve with structures the size of wind turbines. This impact will remain of medium significance.

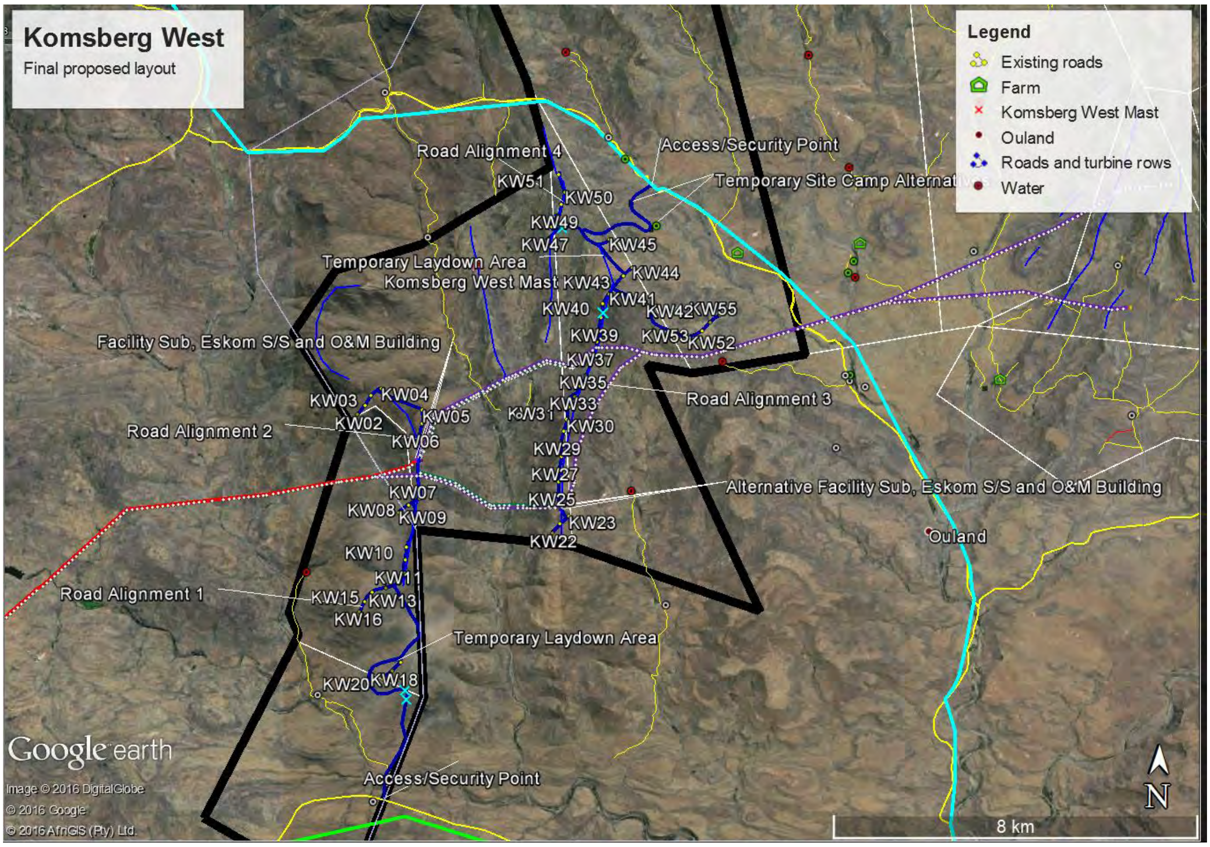

Figure 17 The proposed final Komsberg West layout after environmental constraints are considered.

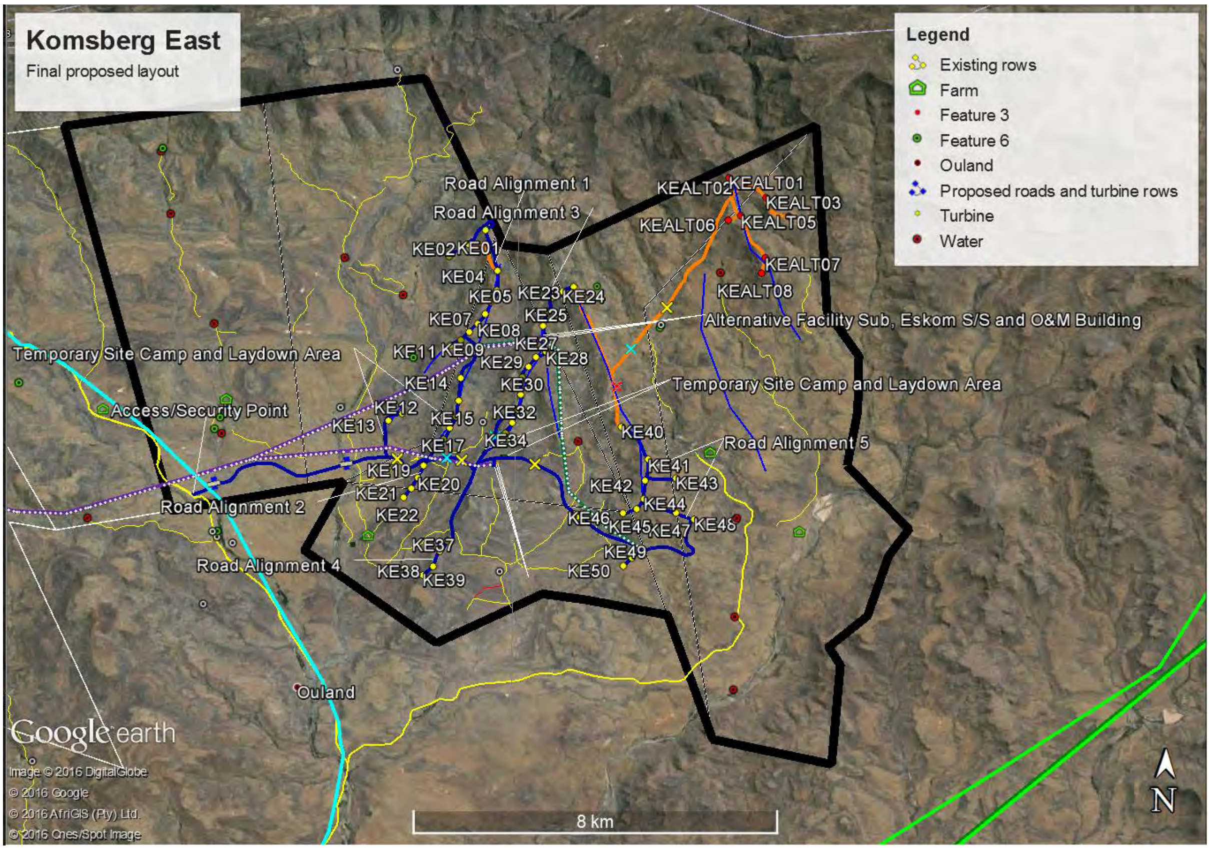

Figure 28. The proposed final Komsberg Eest layout after environmental constraints are considered.

16 Conclusion

- The palaeontological heritage of the project area is both sparse and rare. While impacts are generally unlikely due to this factor, any destruction of material in this environment would be considered a loss, however its timeous reporting and successful mitigation would be a positive outcome.

- In terms of archaeological heritage and built environment indications are that virtually no impacts will occur. In these terms the project area and siting of activities is optimal.

- The setting and landscape qualities of the site have been given a grade IIIb field rating indicating that it is of local significance. These qualities will be impacted negatively by the development proposal to a medium extent. The remoteness of the turbine sites and their positioning on bleak and desolate ridgetops goes some way to conserving the landscapes and cliffs of the valley bottoms, some of which have good scenic qualities.

- Cumulative impacts: As is the case with renewable energy projects the accumulative impacts to the character of very large areas are a concern. The impacts are almost inevitably significant and very difficult to mitigate successfully, especially in highly sensitive landscapes that have good scenic value. The study area lies in an optimal area for wind with the result that numerous renewable energy proposals have been forthcoming for the landscape below the Great Escarpment of Sutherland. If all of these are approved, the landscape impacts will be significant changing the character of the Moordenaars-Roggeveld region.

The Karoo landscape and it cultural landscapes date from the palaeontological past to the historical present have a history, ambience and appearance that in today's world is unique. The Karoo's role in the South African identity, culture and image is significant. It needs to be conserved in such a way that its cultural value to the country is not diminished or if development occurs in the area, that it happens in a considered manner. This report has considered the potential heritage impacts of the proposed projects and the assessment has found that the majority of the impacts are of low negative significance (archaeological findings) and low positive significance to medium negative significance (sense of place). "

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Appendix 1

Palaeontological scoping assessment: combined desktop and field-based study

KOMSBERG WEST WIND ENERGY FACILITY NEAR SUTHERLAND, LAINGSBURG AND SUTHERLAND DISTRICTS, WESTERN AND NORTHERN CAPE

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EXECUTIVE SUMMARY

The Komsberg West WEF study area, situated on the southern side of the Great Escarpment, *c*. 40 - 50 km southeast of Sutherland, is underlain by fluvial sediments of the Abrahamskraal Formation (Lower Beaufort Group, Karoo Supergroup) of Permian age. Levels of bedrock tectonic deformation are generally low, although folding, faulting and quartz veining are locally apparent, especially close to the Komsberg Escarpment. Early Jurassic dolerite intrusions are not mapped within the study area.

The thick Abrahamskraal succession is well known for its diverse fossil assemblages of the Middle Permian *Tapinocephalus* Assemblage Zone. These include a wide range of fossil vertebrates - notably various small- to large-bodied therapsids ("mammal-like reptiles") and reptiles - as well as fossil plants of the *Glossopteris* Flora and low diversity trace fossil assemblages. Numerous important fossil sites have been documented in the Moordenaarskaroo region just to the southeast of the Komsberg WEF study area but very few sites are known from the study area itself. There are local verbal reports of large fossil bones and petrified wood having been found here, but most of the material appears to have been misplaced, and precise locality details are currently unavailable. Bedrock exposure levels in the broader Komsberg – Moordenaarskaroo study region are generally poor due to the pervasive cover by superficial sediments (colluvium, alluvium, soils, calcrete) and vegetation. Nevertheless, a sufficiently large outcrop area of Abrahamskraal Formation sediments, exposed in stream and riverbanks as well as steep hillslopes and erosion gullies, has been examined during the present field study to infer that macroscopic fossil remains are rare here. Exceptions include low-diversity trace fossil assemblages (small-scale invertebrate burrows, possible plant stem or root casts) and fragmentary plant remains. The latter include horsetail ferns (arthrophytes), moulds of woody plant material and locally abundant blocks of ferruginised and silicified wood that have weathered out from the base of channel sandstones.

The only fossil vertebrate remains recorded during the present field assessment are isolated fragments of fossil bone within downwasted surface gravels or channel breccia lenses. An important new vertebrate trackway site was identified on a rippled channel sandstone surface just outside the Komsberg West WEF study area. The trackways and associated traces are attributed to meter-sized walking and floating temnospondyl amphibians. A comparable amphibian trackway site is known from the outskirts of Sutherland and other examples might be present within the study area itself. No fossil remains have been recorded from the various Late Caenozoic superficial deposits – such as colluvium, alluvium, High Level Gravels, sheetwash deposits, soils and surface gravels - in the study area, apart from rare bone fragments reworked from the underlying Permian bedrocks.

Give the apparent rarity of well-preserved, scientifically valuable fossil material (notably vertebrate skeletons and trackways, petrified wood) within the study area, the impact

significance of the proposed Komsberg West WEF on local fossil heritage resources is assessed as medium (negative) for the construction phase. The operational and decommissioning phases of the wind energy facility are unlikely to involve further adverse impacts on local palaeontological heritage. Levels of confidence for this assessment are *medium*, given (1) the unpredictable occurrence of well-preserved fossils and (2) uncertainties regarding the levels of sedimentary bedrock exposure as well as the distribution of older consolidated alluvial deposits within the final development footprint.

No specialist palaeontological monitoring or mitigation for this project is recommended, pending the discovery of significant new fossil sites during development (*e.g.* well-preserved vertebrate bones, teeth and trackways, concentrations of petrified wood and/ or other plant fossils). Recommended mitigation of chance fossil finds during the construction phase involves safeguarding of the fossils (preferably *in situ*) by the responsible ECO, reporting of finds to Heritage Western Cape (HWC. Protea Assurance Building, Green Market Square, Cape Town 8000. Private Bag X9067, Cape Town 8001. Tel: 086-142 142. Fax: 021-483 9842. Email: hwc@pgwc.gov.za) or SAHRA for the Northern Cape (Contact details: SAHRA, 111 Harrington Street, Cape Town. PO Box 4637, Cape Town 8000, South Africa. Phone: +27 (0)21 462 4502. Fax: +27 (0)21 462 4509. Web: www.sahra.org.za). Where appropriate, judicious sampling and recording of fossil material and associated geological data by a qualified palaeontologist may be required by the heritage regulatory authorities. These recommendations should be included within the Environmental Management Programme for the proposed alternative energy project.

Please note 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 from SAHRA or the relevant Provincial Heritage Resources Agency (in this case, Heritage Western Cape for the Western Cape and SAHRA for the Northern Cape).

- The palaeontologist concerned with mitigation work will need a valid fossil collection permit from HWC / SAHRA and any material collected would have to be curated in an approved depository (*e.g.* museum or university collection).

- All palaeontological specialist 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 as far as possible to the minimum standards for Phase 2 palaeontological studies recently developed by SAHRA (2013).

1. APPROACH TO THE PALAEONTOLOGICAL HERITAGE STUDY

The approach to this palaeontological heritage study is briefly as follows. Fossil bearing rock units occurring within the broader study area are determined from geological maps and satellite images. Known fossil heritage in each rock unit is inventoried from scientific literature, previous assessments of the broader study region, and the author's field experience and palaeontological database. Based on this data as well as field examination of representative exposures of all major sedimentary rock units present, the impact significance of the proposed development is assessed with recommendations for any further studies or mitigation.

In preparing a palaeontological desktop study the potentially fossiliferous rock units (groups, formations *etc*) represented within the study area are determined from geological maps and satellite images. The known fossil heritage within each rock unit is inventoried from the published scientific literature, previous palaeontological impact studies in the same region, and the author's field experience (consultation with professional colleagues as well as examination of institutional fossil collections may play a role here, or later following field assessment during the compilation of the final report). This data is then used to assess the palaeontological sensitivity of each rock unit to development (provisional tabulations of palaeontological sensitivity of all formations in the Western 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 significantly the extent of fresh bedrock excavation envisaged. When rock units of moderate to high palaeontological sensitivity are present within the development footprint, a Phase 1 field assessment study by a professional palaeontologist is usually warranted to identify any palaeontological hotspots and make specific recommendations for any monitoring or mitigation required before or during the construction phase of the development.

On the basis of the desktop and Phase 1 field assessment studies, the likely impact of the proposed development on local fossil heritage and any need for specialist mitigation are determined. Adverse palaeontological impacts normally occur during the construction rather than the operational or decommissioning phase. Phase 2 mitigation by a professional palaeontologist – normally involving the recording and sampling of fossil material and associated geological information (*e.g.* sedimentological data) may be required (a) in the pre-construction phase where important fossils are already exposed at or near the land surface and / or (b) during the construction phase when fresh fossiliferous bedrock has been exposed by excavations. To carry out mitigation, the palaeontologist involved will need to apply for palaeontological collection permits from the relevant heritage management authorities, *i.e.*. Heritage Western Cape for the Western Cape (Contact details: Heritage Western Cape contact details: Protea Assurance Building, Green Market Square, Cape Town 8000. Private Bag X9067, Cape Town 8001. Tel: 086-142 142. Fax: 021-483 9842. Email: hwc@pgwc.gov.za) and SAHRA for the Northern Cape (Contact details: SAHRA, 111 Harrington Street, Cape Town. PO Box 4637, Cape Town 8000, South Africa. Phone: +27 (0)21 462 4502. Fax: +27 (0)21 462 4509. Web: www.sahra.org.za). 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.

1.1. Information sources

The information used in this scoping palaeontological heritage study was based on the following:

1. A short project description, maps and kmz files kindly provided by ARCUS and ACO Associates, Cape Town;

2. A review of the relevant satellite images, topographical maps and scientific literature, including published geological maps and accompanying sheet explanations, as well as several previous desktop and field-based palaeontological assessment studies in the broader Klein Roggeveld – Moordenaarskaroo study region (*e.g.* Almond 2010a, 2014, 2015a, 2015b, 2015c);

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

4. A five-day palaeontological reconnaissance field assessment of the Komsberg WEF project area on 27-31 October 2015 by the author and one assistant.

5. Palaeontological data from the Karoo Fossil Database maintained by the Evolutionary Studies Institute, Wits University (courtesy of Dr Mike Day).

1.2. Assumptions & limitations

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

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

2. Variable accuracy of geological maps which underpin these desktop studies. For large areas of terrain these maps are largely based on aerial photographs alone, without ground-truthing. The maps generally depict only significant ("mappable") bedrock units as well as major areas of superficial "drift" deposits (alluvium, colluvium) but for most regions give little or no idea of the level of bedrock outcrop, depth of superficial cover (soil *etc*), degree of bedrock weathering or levels of small-scale tectonic deformation, such as cleavage. All of these factors may have a major influence on the impact significance of a given development on fossil heritage and can only be reliably assessed in the field.

3. Inadequate sheet explanations for geological maps, with little or no attention paid to palaeontological issues in many cases, including poor locality information.

4. The extensive relevant palaeontological "grey literature" - in the form of unpublished university theses, impact studies and other reports (*e.g*. of commercial mining companies) - that is not readily available for desktop studies.

5. Absence of a comprehensive computerized database of fossil collections in major RSA institutions which can be consulted for impact studies. A Karoo fossil vertebrate database is now accessible for impact study work.

In the case of palaeontological desktop studies without supporting Phase 1 field assessments these limitations may variously lead to either:

(a) *underestimation* of the palaeontological significance of a given study area due to ignorance of significant recorded or unrecorded fossils preserved there, or

(b) *overestimation* of the palaeontological sensitivity of a study area, for example when originally rich fossil assemblages inferred from geological maps have in fact been destroyed by tectonism or weathering, or are buried beneath a thick mantle of un-fossiliferous "drift" (soil, alluvium *etc.*).

Since most areas of the RSA have not been studied palaeontologically, a palaeontological desktop study usually entails *inferring* the presence of buried fossil heritage within the study area from relevant fossil data collected from similar or the same rock units elsewhere, sometimes at localities far away. Where substantial exposures of bedrocks or potentially fossiliferous superficial sediments are present in the study area, the reliability of a palaeontological impact assessment may be significantly enhanced through field assessment by a professional palaeontologist.

In the case of the Komsberg WEF study area near Sutherland in the Northern and Western Cape preservation of potentially fossiliferous bedrocks is favoured by the semi-arid climate and sparse vegetation but bedrock exposure is limited by extensive superficial deposits, especially in areas of low relief, as well as pervasive Karoo *bossieveld* vegetation. Vehicle access to most of the upland ridge areas that will be the locus of most of the WEF infrastructure is currently very limited. However, it is considered that sufficient bedrock exposures were examined during the course of this study to assess the broader palaeontological heritage sensitivity of the study area (See Appendix). Comparatively few academic palaeontological studies or field-based fossil heritage impact studies have been carried out in the region, so any new data from impact studies here are of scientific interest.

1.3. Legislative context for palaeontological assessment studies

The Komsberg West WEF alternative energy project is located in an area that is underlain by potentially fossiliferous sedimentary rocks of Late Palaeozoic and younger, Late Tertiary or Quaternary, age (Sections 2 and 3). The construction phase of the proposed development will entail substantial excavations into the superficial sediment cover and locally into the underlying bedrock as well. These include, for example, excavations for the wind turbine foundations, hardstanding areas, internal access roads, underground cables, transmission line pylon footings, electrical substations, operations and maintenance building, construction laydown areas and construction camp. All these developments may adversely affect potential fossil heritage within the study area by destroying, disturbing or permanently sealing-in fossils at or beneath the surface of the ground that are then no longer available for scientific research or other public good. The operational and decommissioning phases of the wind energy facility are unlikely to involve further adverse impacts on local palaeontological heritage, however.

The present combined desktop and field-based palaeontological heritage study contributes to the Scoping Assessment for the Komsberg West WEF project and falls under the South African Heritage Resources Act (Act No. 25 of 1999). It will also inform the Environmental Management Programme for this project.

The various categories of heritage resources recognised as part of the National Estate in Section 3 of the National Heritage Resources Act include, among others:

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

According to Section 35 of the National Heritage Resources Act, dealing with archaeology, palaeontology and meteorites:

(1) The protection of archaeological and palaeontological sites and material and meteorites is the responsibility of a provincial heritage resources authority.

(2) All archaeological objects, palaeontological material and meteorites are the property of the State.

(3) Any person who discovers archaeological or palaeontological objects or material or a meteorite in the course of development or agricultural activity must immediately report the find to the responsible heritage resources authority, or to the nearest local authority offices or museum, which must immediately notify such heritage resources authority.

(4) No person may, without a permit issued by the responsible heritage resources authority—

(a) destroy, damage, excavate, alter, deface or otherwise disturb any archaeological or palaeontological site or any meteorite;

(b) destroy, damage, excavate, remove from its original position, collect or own any archaeological or palaeontological material or object or any meteorite;

(c) trade in, sell for private gain, export or attempt to export from the Republic any category of archaeological or palaeontological material or object, or any meteorite; or

(d) bring onto or use at an archaeological or palaeontological site any excavation equipment or any equipment which assist in the detection or recovery of metals or archaeological and palaeontological material or objects, or use such equipment for the recovery of meteorites.

(5) When the responsible heritage resources authority has reasonable cause to believe that any activity or development which will destroy, damage or alter any archaeological or palaeontological site is under way, and where no application for a permit has been submitted and no heritage resources management procedure in terms of section 38 has been followed, it may—

(a) serve on the owner or occupier of the site or on the person undertaking such development an order for the development to cease immediately for such period as is specified in the order;

(b) carry out an investigation for the purpose of obtaining information on whether or not an archaeological or palaeontological site exists and whether mitigation is necessary;

(c) if mitigation is deemed by the heritage resources authority to be necessary, assist the person on whom the order has been served under paragraph *(a)* to apply for a permit as required in subsection (4); and

(d) recover the costs of such investigation from the owner or occupier of the land on which it is believed an archaeological or palaeontological site is located or from the person proposing to undertake the development if no application for a permit is received within two weeks of the order being served.

Minimum standards for the palaeontological component of heritage impact assessment reports (PIAs) have recently been published by SAHRA (2013).

2. GEOLOGICAL CONTEXT

The proposed Komsberg West WEF is situated in highly-dissected, semi-arid terrain on the southern side of the Komsberg Escarpment (a sector of the Great Escarpment of South Africa) in the Great Karoo region, some 40 to 50 km southeast of Sutherland, Western and Northern Cape. The study area features several roughly north-south aligned spurs and mountainous ridges extending southwards from the Escarpment zone. These uplands reach elevations of *c*. 1330 - 1440 m amsl in the south (*e.g.* Janjieskop, Middelberg, Die Helfte se Berg) and 1470 m along the Escarpment. The narrow ridges are separated by narrow stream valleys carved by tributaries of the extensive Buffelsrivier drainage network, such as the Ventersrivier and Komsbergrivier. The uplands and mountain slopes are very rocky, with limited bedrock exposure apart from the numerous horizontal to gently-sloping sandstone *kranzes* of the Lower Beaufort Group (Figs. 2 to 5). Mudrock exposures are mainly limited to stream gullies and steep riverbank cliffs, but there are also a few extensive exposures in the low-lying *vlaktes* and lower hilly areas that lack alluvial cover (Fig. 6).

The geology of the Sutherland region is outlined on the 1: 250 000 scale geology sheet 3220 Sutherland (Theron 1983) (Fig. 1) as well as the updated 1: 250 000 Sutherland metallogenic map that includes important new stratigraphic detail for the Lower Beaufort Group succession (Cole & Vorster 1999) (Fig. 9). The study area is entirely underlain by Middle Permian continental sediments of the **Lower Beaufort Group** (Adelaide Subgroup, Karoo Supergroup), and in particular the very thick **Abrahamskraal Formation** (Pa) located at the base of the Lower Beaufort Group succession (Johnson *et al.* 2006 and references cited below). The Beaufort Group sediments here are folded along numerous west-east trending fold axes that are especially well-developed in the Escarpment zone (Fig. 4), associated with local minor faulting and quartz veining. In the Sutherland area, 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. No dolerite intrusions are mapped within the Komsberg WEF study region to the south of the Great Escarpment, however.

The Palaeozoic sedimentary bedrocks in the study area are extensively overlain by Late Caenozoic **superficial deposits** such as scree and other slope deposits (colluvium and hillwash), stream alluvium, sheetwash, down-wasted surface gravels, calcretes and various soils. These geologically youthful sediments are generally of low palaeontological sensitivity and are only treated briefly in this report.

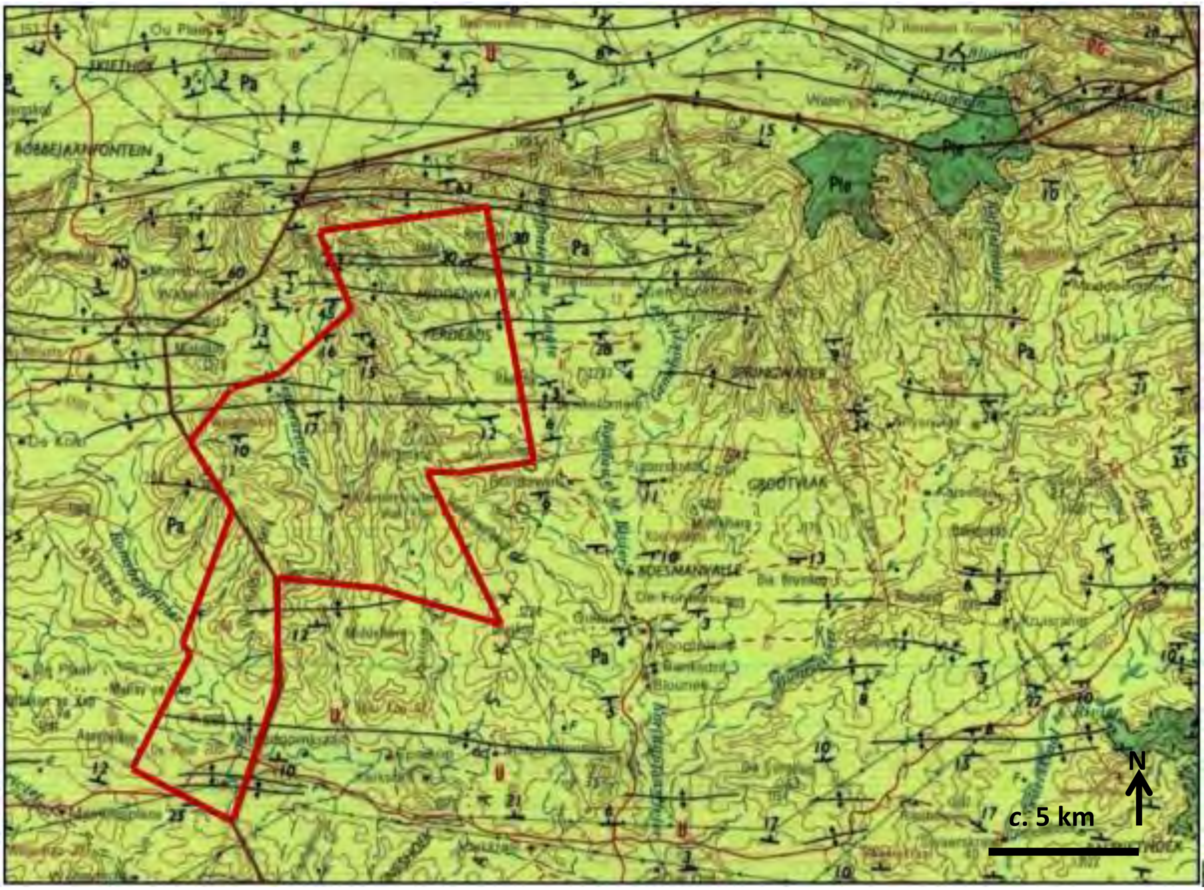

Figure 1. Extract from the 1: 250 000 scale geology sheet 3220 Sutherland (Council for Geoscience, Pretoria, 1999) showing the location of the proposed Komsberg West WEF study area, *c*. 40-50 km southeast of Sutherland, Western and Northern Cape Province (reddish-brown polygon). The study area is entirely underlain by Middle Permian sediments of the Abrahamskraal Formation, Lower Beaufort Group (Pa, pale green). Note numerous west-east trending fold axes (black lines) in the northern part of the study area and the absence of Karoo dolerite intrusions here.

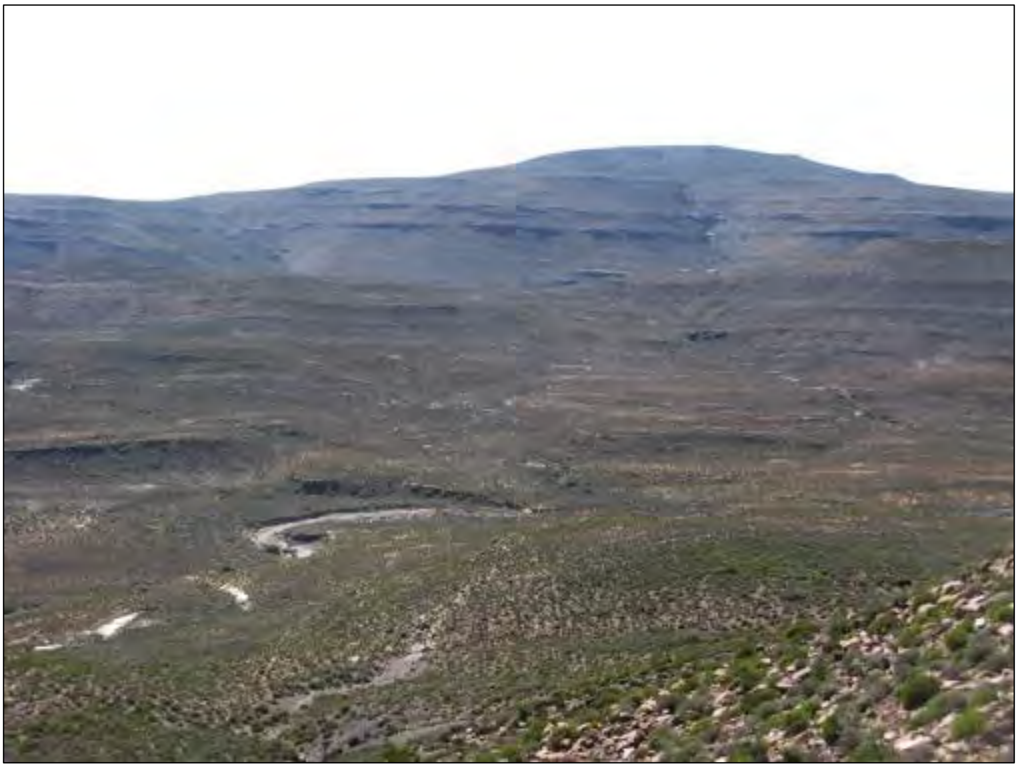

Figure 2. View north-eastwards from a point close to the wind mast on Welgemoed 268 showing typical stepped topography of the mountain ridges due to the closely-spaced, tabular sandstones of the Abrahamskraal Formation (Loc. 025).

Figure 3. Limited bedrock exposure along the crest of a mountain ridge on Welgemoed 268, looking northwards towards the Komsberg Escarpment (wind mast in middle distance).

Figure 4. Southwards-downstepping monoclonal fold within sandstones of the Abrahamskraal Formation, Welgemoed 268 (Seen from Loc. 025).

Figure 5. Typical rocky terrain on the higher western slopes of Die Helfte se Berg (Schalkwykskraal 204) (Loc. 049). Note limited bedrock exposure on mountain slopes here.

Figure 6. Extensive exposure of Lower Beaufort Group mudrocks SW of Perdebos homestead (Taayboschkraal 12) showing downwasted surface gravels of grey calcrete and rusty-brown ferruginous carbonate.

2.1. 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 to subtabular 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 Group 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 Middle Permian Karoo. This is also indicated by the common occurrence of sand-infilled mudcracks and silicified gypsum "desert roses" (Smith 1980, 1990, 1993a, 1993b, Almond 2010a). 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; see also recent discussion of Beaufort Group mudrock colours by Wilson *et al.* 2014).

2.1.2. 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, Cole & Vorster 1999, McCarthy & Rubidge 2005, Johnson *et al*., 2006, Almond 2010a, Day 2013a, Day & Rubidge 2014, Wilson *et al.* 2014). 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, blue-grey to purple-brown floodplain mudrocks with sparse to 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, tuffites). A wide range of sedimentological and palaeontological observations point to deposition of the Abrahamskraal sediments under seasonally arid climates. These include, for example, the abundance of pedogenic 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 (Fig. 1). 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 (*cf* Day & Rubidge 2010, Day 2013a, Day & Rubidge 2014). 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 (Fig. 8). Several of these members have since been mapped in the Sutherland area by Cole and Vorster (1999) (Fig. 9).

According to the 1: 250 000 metallogenic map of Cole and Vorster (1999) the majority of the Komsberg West WEF study area lies stratigraphically below the Moordenaars Member. Based on the widespread occurrence of yellow-weathering, tabular sandstone bodies, the great majority of the Abrahamskraal Formation outcrop area here probably belongs to the **Koornplaats Member** (Figs. 10, 11). It is possible that the underlying **Leeuvlei Member** is represented along some valley floors, however. The sandstone package capping the Komsberg Escarpment north of the study area as well as the southernmost portions of several north-south mountain ridges within the area are assigned to the **Moordenaars Member** on the metallogenic map. The mudrock-dominated interval between these two sandstone packages - visible, for example, in the escarpment zone towards the top of the Komsberg Pass – belongs to the **Wilgerbos Member** (renamed the **Swaerskraal Member** by Day & Rubidge 2014) (Fig. 7).

Very brief descriptions of these Abrahamskraal Formation subunits are given by Loock *et al.* (1994). The interested reader should refer to earlier works by Le Roux (1985) and Jordaan (1990) as well as informative recent papers by Day and Rubidge (2014) and Wilson *et al.* (2014) for detailed stratigraphic and sedimentological data on the Abrahamskraal Formation that is beyond the scope of the present palaeontological heritage study.

According to Loock *et al.* (1995) the **Koornplaats Member** of the Abrahamskraal Formation. is characterized by:

- Yellow-weathering sheet-like channel sandstone packages with heavy mineral laminations (up to 2 cm thick) towards the top and basal lag breccio-conglomerates. A prominent, laterally-persistent package of five yellowish fine-grained sandstone units marks the upper part of the member in the Roggeveld – Nuweveld Escarpment area. The sandstones are associated with fossil tetrapod material and reworked plant material, including silicified wood (rarely with exotic extra-basinal pebbles) and *Vertebraria* glossopterid roots. Uranium mineralization may be associated with transported plant material.
- Grey and maroon overbank mudrocks with calcrete horizons, tetrapod fossils.

The **Wilgerbos Member** comprises some 120 m of recessive-weathering, grey-green to purple-brown mudrocks with subordinate thin sandstones. Extensive playa lake deposits have been recognized within this unit (Loock *et al.*1994). The revised stratigraphic scheme of Day and Rubidge (2014) refer to the mudrock interval between the Koornplaats and Moordenaars Members as the **Swaerskraal Member**.

The **Moordenaars Member** is a thick (*c.* 360 m), very extensive package – possibly composite - of pale-weathering, fine-grained sandstones that can be traced along the crest of the Komsberg Escarpment from the Komsberg Pass eastwards. Heavy mineral lamination is ubiquitous within the sandstones, which also host uranium ore deposits associated with *koffieklip* (rusty-brown ferruginous carbonate) in the Sutherland area. A series of southwards down-stepping monoclinal folds brings the Moordenaars Member beds down to lower elevations in the northern sector of the Komsberg WEF project areas.

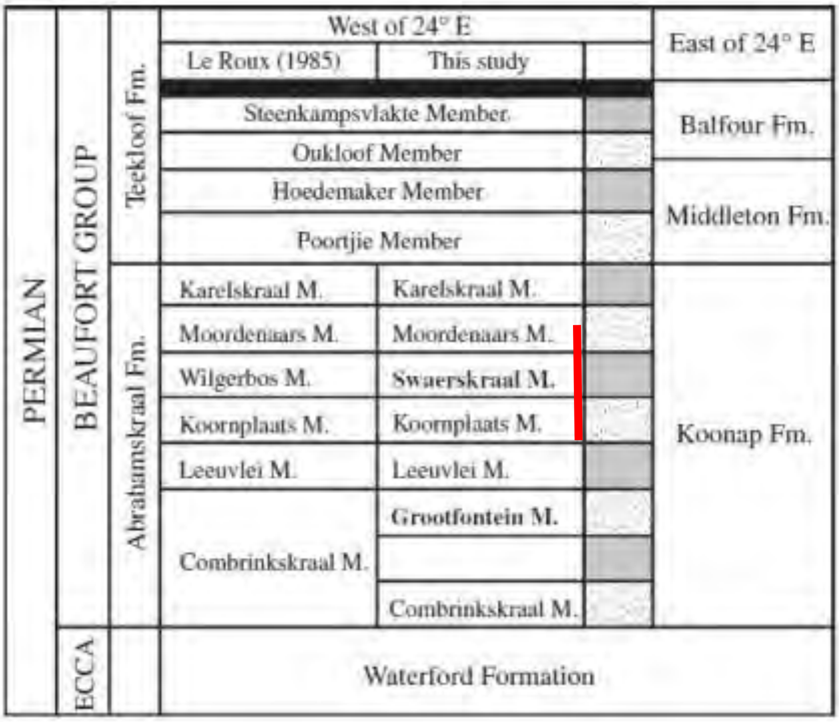

Figure 7. Revised subdivision of the Abrahamskraal Formation of Day and Rubidge (2014). The red bar indicated members represented within the Komsberg WEF study area.

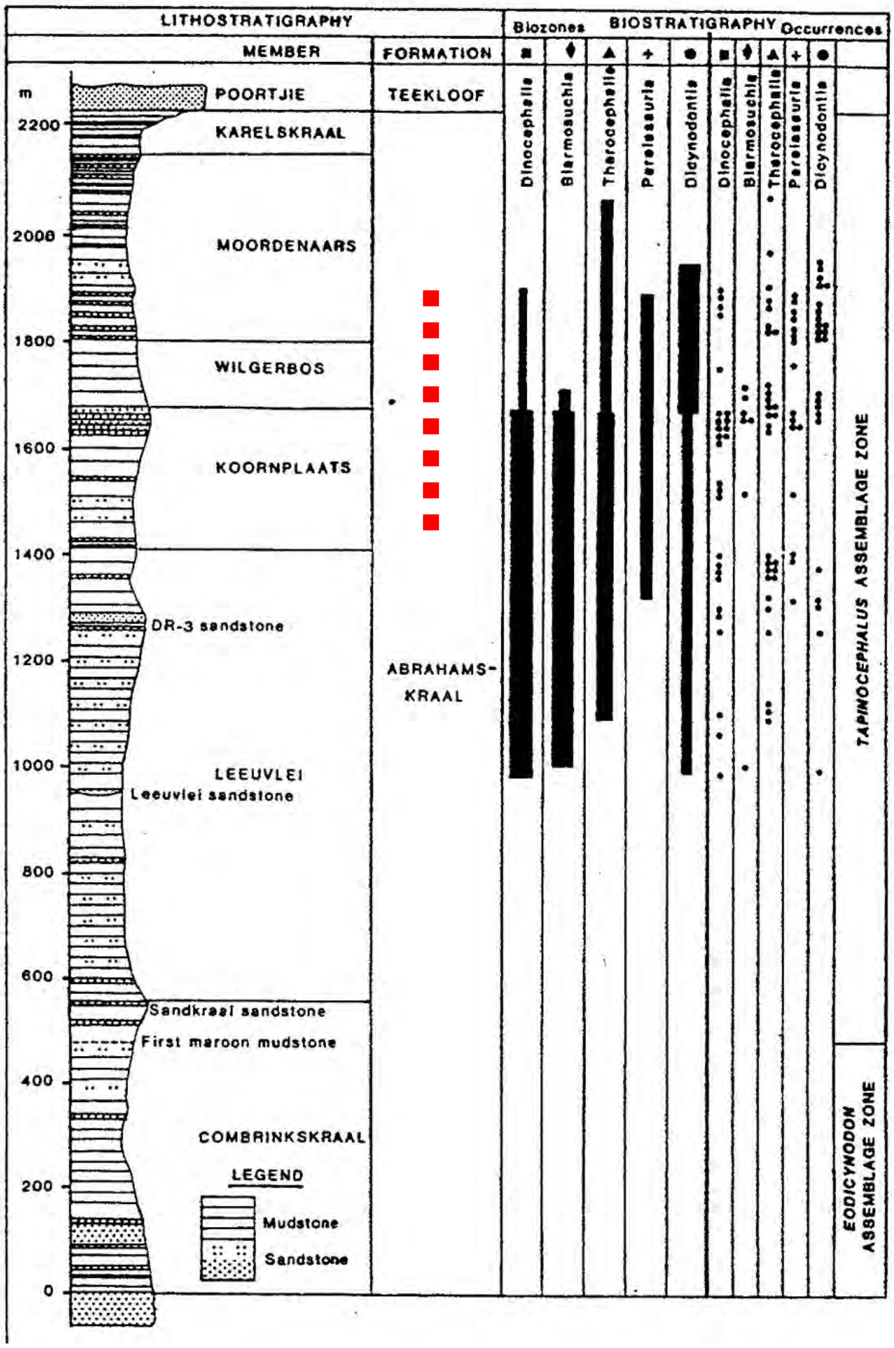

Figure 8. Chart showing the subdivision of the Abrahamskraal Formation in the western Karoo region with stratigraphic distribution of the major fossil vertebrate groups (Loock *et al*. 1994). The majority of the Komsberg WEF study area is underlain by sediments within the Koornplaats Member with small areas of Wilgerbos and Moordenaars Members represented on higher-lying mountain ridges (dotted red bar). The upper part of the Leeuvlei Member might also be represented here on some valley floors.

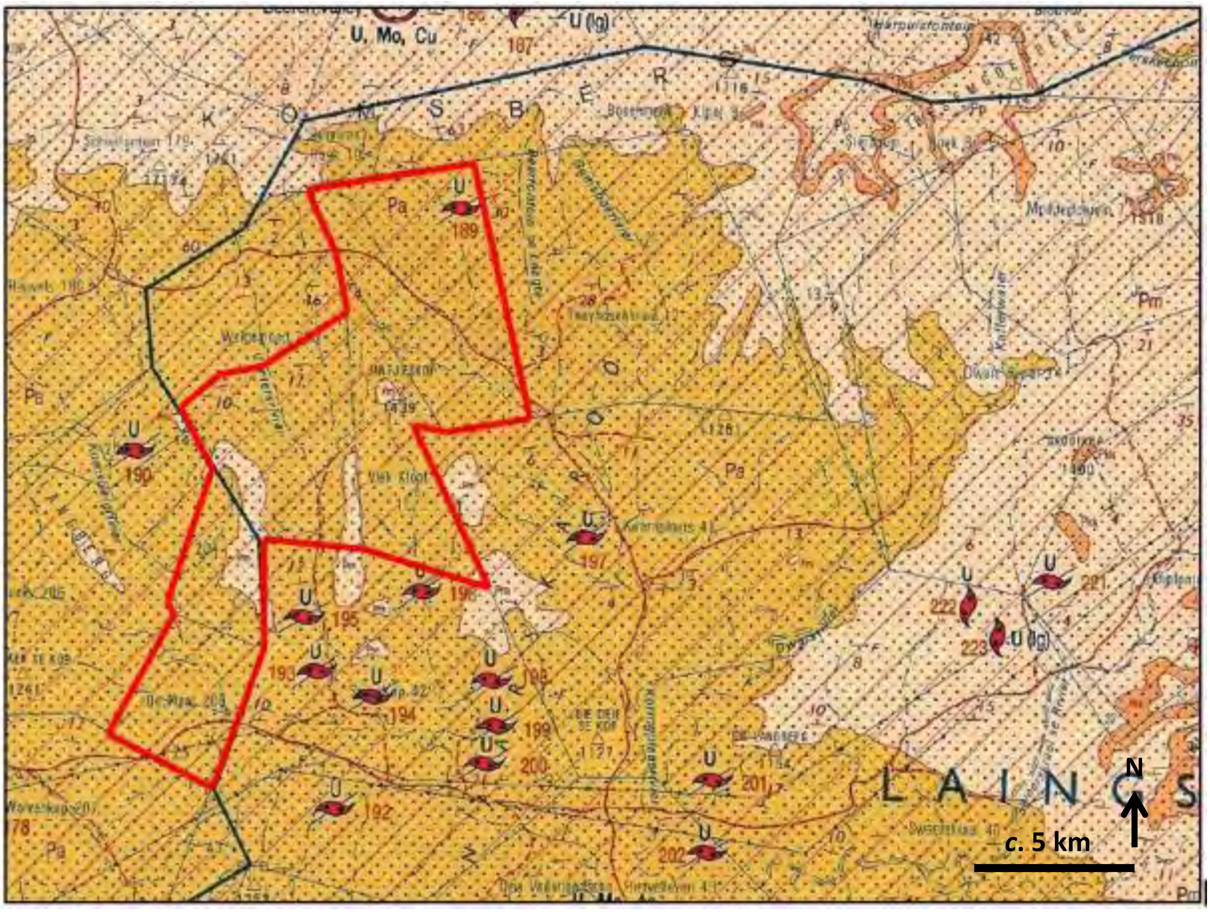

Figure 9. Extract from 1: 250 000 metallogenic map 3220 Sutherland (Council for Geoscience, Pretoria) showing the subunits of the Abrahamskraal Formation represented within the Komsberg West WEF study area. These include the Moordenaars Member (pink) and undifferentiated underlying units (dark yellow). The red symbols labelled 'U' refer to known uranium ore deposits.

The Abrahamskraal Formation in the Klein-Roggeveld - Moordenaarskaroo study region is a very thick succession of continental fluvial rocks characterized by numerous lenticular to sheet-like sandstones with intervening, more recessive-weathering mudrocks (Stear 1980, Le Roux 1985, Loock *et al.* 1994, Cole & Vorster 1999, Day & Rubidge 2014, Wilson *et al.* 2014). The channel sandstone units are up to several (5 m or more) meters thick and vary in geometry from extensive, subtabular sheets to single-storey lenticles or multi-storey channel bodies with several partially superimposed, cross-cutting lenticular subunits, often demarcated at the base by thin mudrocks and / or basal breccio-conglomerates. Obliquely side-steeping, successively higher channel bodies of laterally-migrating river systems are also seen within some intervals. The prominent, laterally-persistent sandstone ledges generate a distinctive stepped or terraced topography on hill slopes in the area (Figs.2, 10 & 11). The sheet sandstones are generally pale-weathering (enhanced by epilithic lichens), fine- to medium-grained, well-sorted and variously massive or structured by horizontal lamination (flaggy, with primary current lineation), or more rarely tabular to trough cross-bedding. Greyish hues of some freshly broken sandstone surfaces suggest an "impure" clay-rich mineralogy (*i.e.* wackes). Very fine-scale, bar code-like dark banding reflects laterally persistent heavy mineral lamination in some sandstone facies. Current ripple cross-lamination is common towards the tops of the sandstone beds which may also feature undulose bars and swales. The lower contacts of the channel sandstones are sharp and erosive on a small scale. In some cases they are associated with lenticular basal breccias that may infill small-scale erosive gullies. The breccias may also occur within the body of the channel sandstone unit, especialy towards the base. They are largely composed of reworked mudflake intraclasts as well as small gravel-sized calcrete nodules, occasional blocks of overbank mudrock and local concentrations of fossil material (plant debris, including petrified wood, rolled bones and teeth of vertebrates). Heterolithic, thinly-interbedded sandstone and mudrock packages associated with some channel sandstones may represent delta-like levee deposits.

Although general mudrock exposure levels within the Komsberg WEF study area are low to very low, there are in fact numerous small exposures available along stream gullies on steeper mountain slopes and in dissected foothills as well as river banks in larger valleys (Figs. 12, 13, 16 to 18, 22, 23). Much of the Abrahamskraal succession shows low dips (see geological map Fig. **), but occasionally dips may be fairly steep, especially associated with monoclinal folds along the Escarpment zone (*e.g.* Fig. 4). Local faulting is indicated by zones of quartz mineral lineation in zones of pervasive, steeply-inclined spaced cleavage that transects both mudrocks and fine-grained sandstones.

Channel sandstones within the Koornplaats Member that underlies the majority of the study area are mainly tabular in geometry, imparting a stepped weathering profile to mountain slopes (Figs. 10 & 11). Grain-size is medium to coarse, with a slightly crumbly, only moderately well-consolidated texture, frequently speckled or clotted in appearance. Weathering hues vary from yellowish to brown (though often lichen-covered). Fabrics are variously massive, horizontally-laminated (*e.g.* flaggy, with primary current lineation), ripple cross-laminated to occasionally trough cross-bedded. Cannonball-sized to meter-scale spheroidal concretions of ferruginous carbonate enclosed within the sandstones are of diagenetic origin (Fig. 15). The channel bases are moderately to markedly erosional and often gullied. They are often associated with lenticular to laterally-persistent, prominent- to recessive-weathering, well-consolidated basal breccias up to a meter or more thick composed of reworked mudflakes and calcrete nodules, and occasionally also plant debris including rare petrified wood (Figs. 20 & 21). Basal breccia lenses may be incorporated towards as well as at the base of the channel sandstone package and are often ferruginised. Flaggy sandstones within these successions may show well-developed, laterally-persistent, fine-scale heavy mineral banding.

A high proportion of the Abrahamskraal Formation overbank mudrocks within the study area are grey-green to blue-grey, with subordinate purple-brown to maroon facies. Horizons of small to large pedogenic calcrete are moderately common within the overbank mudrock packages at all stratigraphic levels. Larger-scale pedogenic calcretes are usually ferruginous, rusty brown, and often lenticular to irregular in form (Fig. 16), while smaller sphaeroidal calcrete nodules are usually pale grey; they occasonally show a septarian structure. Subrounded to irregular, pinkish clusters of lenticular silica pseudomorphs after gypsum ("desert roses") are common at certain horizons indicating highly arid climatic phases on the Middle Permian floodplain.

Packages of several meters of thin-bedded, blue-grey siltstones with local development of small-scale wave-rippled bedding planes on associated sandstones may be playa lake facies on the distal floodplain or pond areas within abandoned channels. Wave-rippled palaeosurfaces may be associated with a range of sedimentary structures reflecting evolving shallow water to emergent conditions, such as pustulose algal mat textures, rill marks, wash-and-swash terraces, sand-infilled desiccation cracks and planed-off ripple crests, as well as vertebrate and invertebrate trace fossils (Fig. 13 & Section 3) (Smith 1993a). Thin- to medium-bedded heterolithic intervals (interbedded fine-grained sandstone and mudrock) are usually closely-associated with channel sandstones and are probably levee facies. Lenticular channel sandstones may pass laterally into heterolithic facies, supporting this interpretation. Thin, single-storey tabular sandstones of probable crevasse splay origin may occasionally be loaded at the base, suggesting soupy substrates on the floodplain.

Figure 10. Distinctive package of several closely-spaced, yellowish-weathering sandstone units of the Koornplaats Member on the eastern side of the Ventersrivier Valley, Welgemoed 268 (Loc. 026).

Figure 11. Western slopes of the Middelburg ridge on Welgemoed 268 showing closely-spaced, tabular sandstones of the Koornplaats Member on the lower slopes. The sandstone-poor upper slopes *might* belong to the Wilgebos Member with the Moordenaars Member sandstone package on the skyline.

Figure 12. Good riverbank exposures of Lower Beaufort Group mudrocks and sandstones on Welgemoed 268 (Loc. 033).

Figure 13. Sandstone palaeosurface featuring small-scale wave ripples overlain by flood plain or lacustrine mudrocks and a thin channel sandstone, Welgemoed 268 (Loc. 036).

Figure 14. Current-rippled top of a fine-grained channel sandstone, Welgemoed 268 (Loc. 042) (Hammer = 30 cm). The small pits *might* represent molds of reedy plant stems.

Figure 15. Large oblate diagenetic concretions of rusty-brown ferruginous carbonate enclosed within a channel sandstone, Welgemoed 268 (Loc. 051) (Hammer = 30 cm).

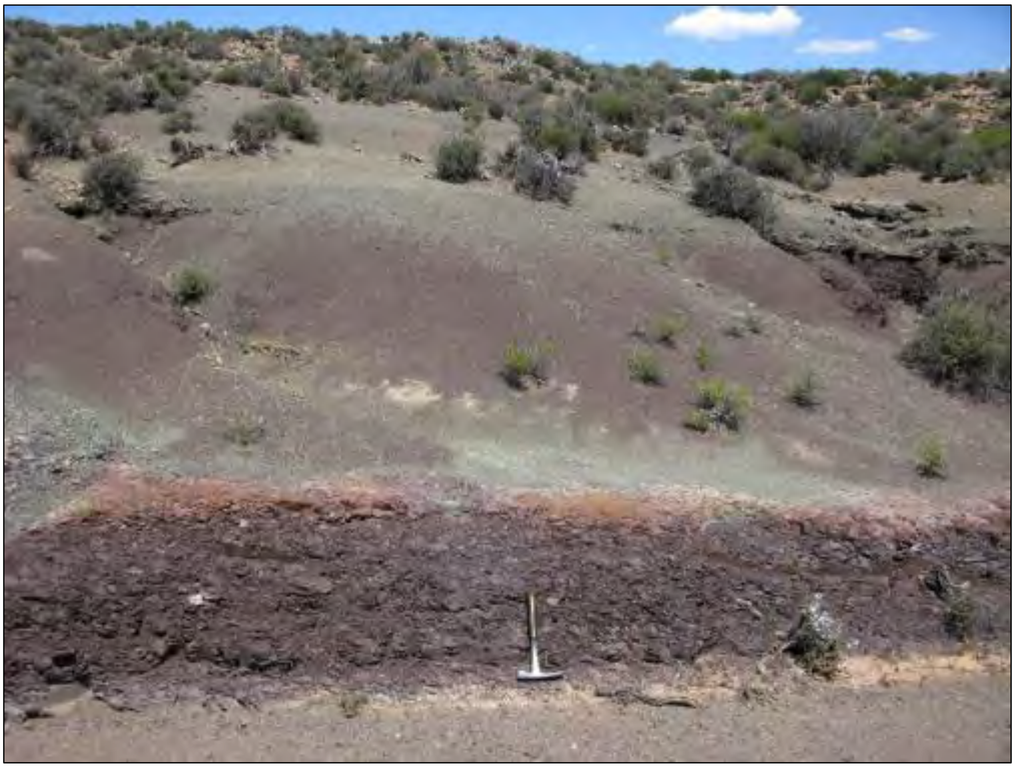

Figure 16. Hillslope exposure of purple-brown and grey-green overbank mudrocks on Welgemoed 268 (Loc. 037) (Hammer = 30 cm). Note laterally-persistent horizon of secondary ferruginous carbonate (rusty-brown).

Figure. 17. Excellent stream gulley exposure of Lower Beaufort Group bedrocks on Welgemoed 268 (Loc. 040). The following three photos show successively higher portions of the succession here.

Figure 18. Thick package of thin-bedded to massive overbank mudrocks – probably within the lower portion of the Koornplaats Member (Loc. 040).

Figure. 19. Two successive packages of erosive-based channel sandstone or wacke showing blocky weathering and grey-green coloration (Loc. 040).

Figure. 20. Typical yellow-weathering channel sandstone of the Koornplaats Member showing large-scale cross-bedding and internal breccio-conglomerates (Loc. 041).

Figure. 21. Close-up of the near-basal channel lag breccias seen in the previous photo, here mainly composed of reworked grey-green mudrock intraclasts overlain by parallel-laminated sheet sandstones (Hammer = 30 cm) (Loc. 041).

Figure 22. Package of grey-green and maroon mudrocks with fine-grained sandstone interbeds underlying Koornplaats Member yellow-weathering sandstones, Schalkwykskraal 204 (Loc. 048).

Figure 23. Hillslope exposure of thin-bedded grey-green mudrocks and thin, cross-bedded sandstones just west of Ventersrivier farmstead, Welgemoed 268 (Loc. 056). This section has yielded sparse petrified wood as well as trace fossils (Figs. 39 & 40).

2.2. Late Caenozoic Superficial Deposits

Coarse, bouldery to finer, gravelly or silty alluvial deposits in the study area, as exposed in river- or stream-bank and erosion gulley sections, reach thicknesses of up to few meters. Younger (probably Holocene) unconsolidated alluvium is dominated by well-bedded to massive pale buff silts, sands and gravelly sands, with lenticles of coarse-grained to fine gravel (Figs. 24, 26). There is often a basal lag of poorly-sorted, subangular to well-rounded gravels dominated by Beaufort Group sandstone and indurated mudrock with minor ferruginous palaeocalcrete nodules, reworked younger (Quaternary – Recent) calcrete and vein quartz.

Relicts bands of older (possibly Pleistocene or earlier) High Level Gravels situated at elevations of up to 7 m above present day drainage occur along the banks of major drainage lines (*e.g.* Ventersrivier). These clast-suported, semi-consolidated older gravels are up to 2-3 m thick and are dominated by moderately well-rounded cobbly to boulder-sized sandstone clasts with a gritty to fine gravelly matrix (Figs. 25, 27). They generally show a partial calcrete cementation of clasts and matrix. Platy clasts show well-developed current imbrication. Comparable calcrete-cemented coarse gravel facies also occur along, or just above, the present day river beds (Fig. 26).

Mixed alluvial, colluvial and sheetwash deposits up to 5 m thick on mountain slopes are exposed by gulley erosion where they are seen to consist of poorly-sorted sandy matrix as well as angular, blocky sandstone clasts. Conical fans of scree may be banked up against even steep slopes, completely obscuring the underlying bedrocks (Fig. 28). Prominent-weathering sandstone *kranzes* on mountain slopes and ridge crests are associated with aprons of angular to well-rounded blocks and corestones of Beaufort Group sandstone (Fig. 29). Gentler slopes and plateau areas along ridge crests are also mantled with dispersed to pervasive downwasted sandstone colluvial rubble (Figs 5 & 30). Locally, some of the sandstone clasts show complex, pitted and furrowed karstic (solution) weathering patterns. Resistant-weathering surface gravels of sandstone, vein quartz, calcrete nodules, *koffieklip* and occasional fossils (bones, petrified wood) have been concentrated by downwasting and sheet flood processes on gentler hillslopes and *vlaktes* in low-lying areas. In areas of mudrock exposure, surface gravels are concentrated into shallow erosion gullies (Fig. 6).

Figure 24. Poorly-consolidated younger alluvial deposits on De Plaat 205/1 (Loc. 045) showing coarse basal gravels overlain by bedded sandstones and surface gravels (Hammer = 30 cm).

Figure 25. Vertical sections through well-bedded sandy alluvium of the Ventersrivier sharply overlain by thick, semi-consolidated High Level Gravels several meters above modern river level, Welgemoed 268 (Loc. 053).

Figure 26. Bench of well-calcretised bouldery alluvium along the Ventersrivier, capped by unconsolidated, sandier younger alluvial deposits (Loc. 054).

Figure 27. Calcretised, coarse High Level Gravels perched on Lower Beaufort Group bedrocks several meters above present-day river level, Welgemoed 268 (Loc. 026).

Figure 28. Scree fans obscuring underlying bedrocks of the Koornpaats Member on steep mountain slopes south of Ventersrivier farmstead, Welgemoed 268 (Loc. 027).

Figure 29. Coarse, downwasted sandstone rubble on upper western slopes of Die Helfte se Berg, Schalkwykskraal 204 (Loc. 049).

Figure 30. Poor bedrock exposure on the plateau running along the crest of the mountain ridge to the south of the wind mast on Welgemoed 268 (Loc. 025).

3. PALAEONTOLOGICAL HERITAGE

In this section of the report the fossil heritage recorded elsewhere within the main rock units that are represented within the Komsberg West WEF study area, together with any fossils observed here during the present field assessment, are outlined.

3.1. 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, Smith *et al.* 2012). 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, Van der Walt *et al.* 2010). Maps showing the distribution of the Beaufort Group assemblage zones within the Main Karoo Basin have been provided by Keyser and Smith (1979, Fig. 31 herein) and Rubidge (1995, 2005). A recently updated version is now available (Nicolas 2007, Van der Walt *et al.* 2010). The fossil assemblage zone represented within the present study area is the Middle Permian ***Tapinocephalus* Assemblage Zone** (Theron 1983, Rubidge 1995).

The main categories of fossils recorded within the *Tapinocephalus* fossil biozone (Keyser & Smith 1977-78, Anderson & Anderson 1985, Smith & Keyser 1995a, MacRae 1999, Rubidge 2005, Nicolas 2007, Almond 2010a, Smith *et al.* 2012, Day 2013a, Day 2013b, Day *et al.* 2015a) 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. 33), small insectivorous millerettids), rare pelycosaurs, and diverse **therapsids** or "mammal-like reptiles" (*e.g.* numerous genera of large-bodied dinocephalians (Figs. 33 & 34), herbivorous dicynodonts, flesh-eating biarmosuchians, gorgonopsians and therocephalians);
- aquatic vertebrates such as large **temnospondyl amphibians** (*Rhinesuchus*, usually disarticulated) (Fig. 38), 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 stem and 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 (horsetail ferns).

In general, tetrapod fossil assemblages in the *Tapinocephalus* Assemblage 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, Smith *et al.* 2014 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 (Loock *et al.* 1994) (Fig. 8).

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), Boonstra (1969) and Day (2013b). Numerous fossil sites recorded in the region are marked on the published 1: 250 000 Sutherland geology sheet 3220, albeit not in the present study area (Fig. 1), Beaufort West sheet 3222, and on the map in Keyser and Smith (1977-78; Fig. 31). 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.* arthrophyte stems and leaves). A large number of 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) (Fig. 8). A recent palaeontological heritage study was carried out by the author within the Abrahamskraal Formation of the Moordenaarskaroo just to the south of the present study area (Almond 2010a). 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. The Karoo Fossil Database maintained by the Evolutionary Studies Institute (Wits University, Johannesburg) has records of some twenty or so fossil specimens from Moordenaarskaroo farms within 10 km of the broader Komsberg WEF study area (*e.g.* Swaerskraal, Rietfontein, Koornplaats, Banksdrif). Identified taxa include a wide range of dinocephalians *plus* pareiasaurs (*Bradysaurus*) and several genera of small-bodied dicynodonts (Dr Mike Day, pers. com., 2015).

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). Tetrapod bones actually occur in a wide range of taphonomic settings in the *Tapinocephalus* Assemblage Zone (2010a). For example they are recorded as:

1. Disarticulated bones within thin intraformational conglomerates at the base of shallow (unistorey) channel sandstones. The bones are often impregnated with secondary iron and manganese minerals (coffee brown and black respectively). They vary from highly-weathered and rounded fragments to intact and well-preserved specimens. Bones occur at the base of, within, or floating at the top of the conglomerates in association with calcrete nodules, mudflakes, petrified wood and gypsum pseudomorphs. Bones in these channel lags were variously eroded out of riverbanks or washed into drainage channels from upland areas, riverine areas and floodplains during floods or episodes of landscape denudation.

2. Disarticulated bones within or at the top of channel sandstones.

3. Bones coated with calcrete or embedded within calcrete nodules associated with arid climate palaeosols (ancient soils). These bones are often suncracked, showing that lay exposed on the land surface for a long time before burial.

4. Isolated bones or articulated skeletons (possible mummies) embedded within levee or floodplain mudrocks.

5. Well-articulated skeletons preserved within fossil burrows (Botha-Brink & Modesto, 2007).

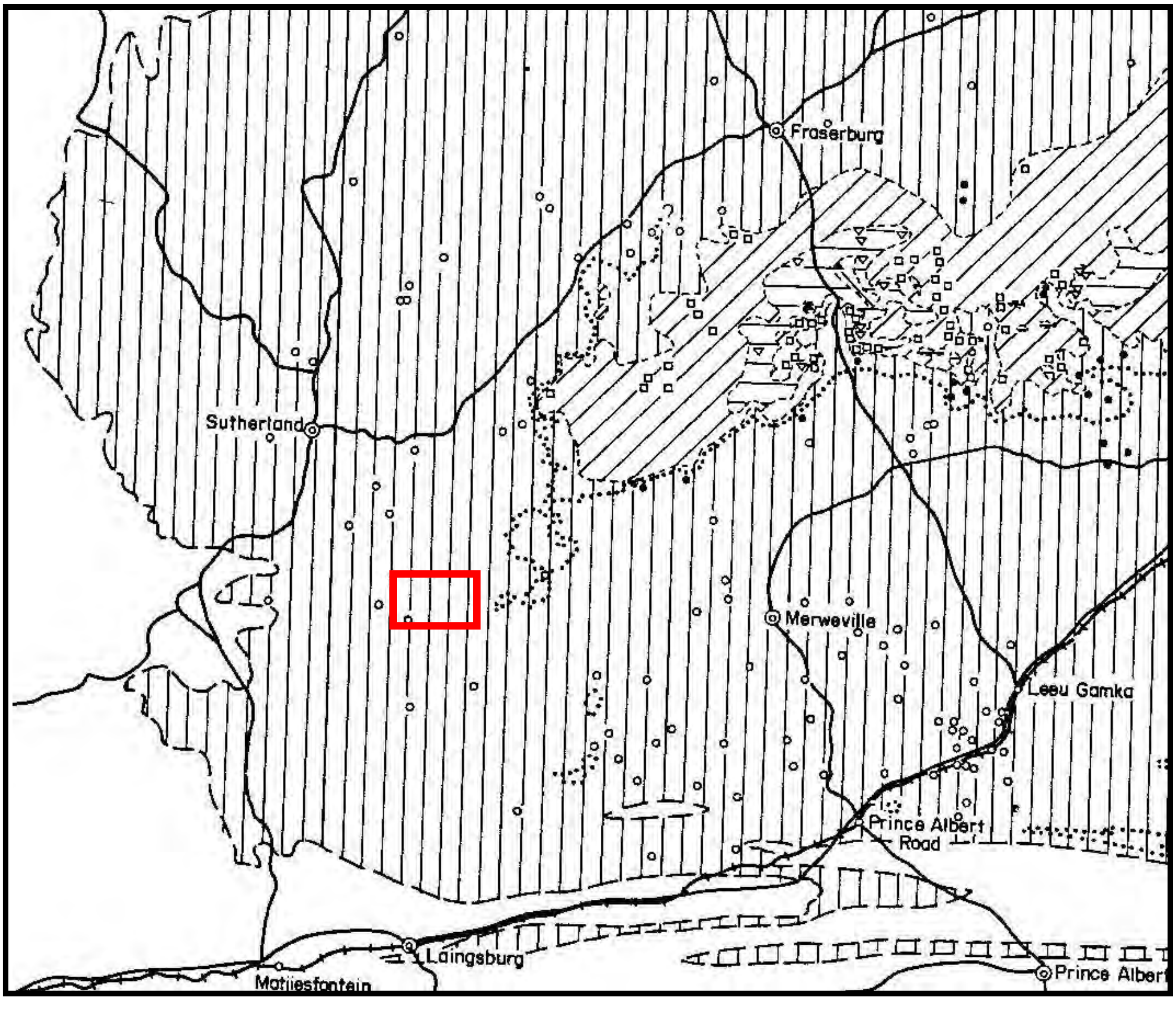

Figure 31. Vertebrate fossil localities within the Lower Beaufort Group in the south-western Karoo region (Map abstracted from Keyser & Smith 1977-78). Outcrop areas with a vertical lined ornament

are assigned to the Middle Permian *Tapinocephalus* Assemblage Zone. Note the virtual absence of fossil records from the the Abrahamskraal Formation in the Komsberg WEF study area to the southeast of Sutherland (red rectangle).

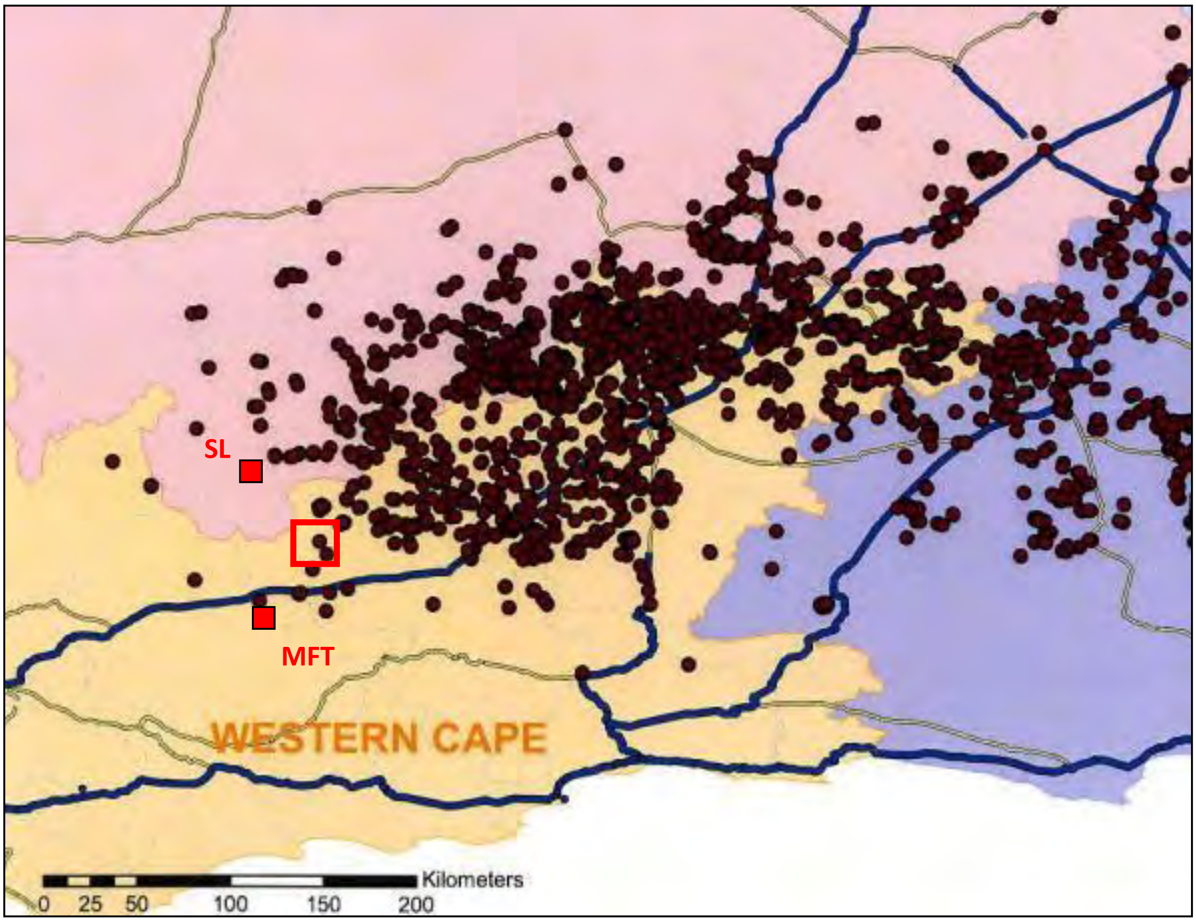

Figure 32. Distribution of recorded vertebrate fossil sites within the south-western portion of the Main Karoo Basin (modified from Nicolas 2007). The *approximate* location of the Komsberg WEF study area is indicated by the open red square. Note the scarcity of known fossil sites here. SL = Sutherland. MFT = Matjiesfontein.

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. 8 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 lithostratgraphic as well as biostratigraphic basis, emphasizing the range zones of various genera of small dicynodonts such as *Eodicynodon, Robertia* and *Diictodon* (*e.g.* Day & Rubidge 2010, Jirah & Rubidge 2010, 2014, Day 2013a, 2013b, Day & Rubidge 2014, Day *et al.* 2015a, 2015b).

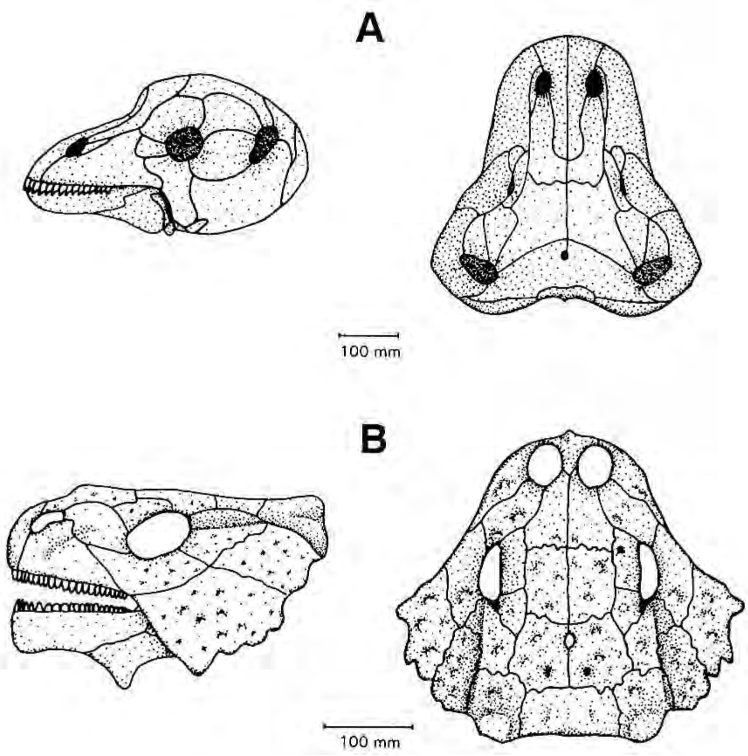

Figure 33. Skulls of two key large-bodied tetrapods of the *Tapinocephalus* Assemblage Zone: A – the dinocephalian therapsid *Tapinocephalus*; B – the pareiasaur *Bradysaurus* (From Smith & Keyser 1995b).

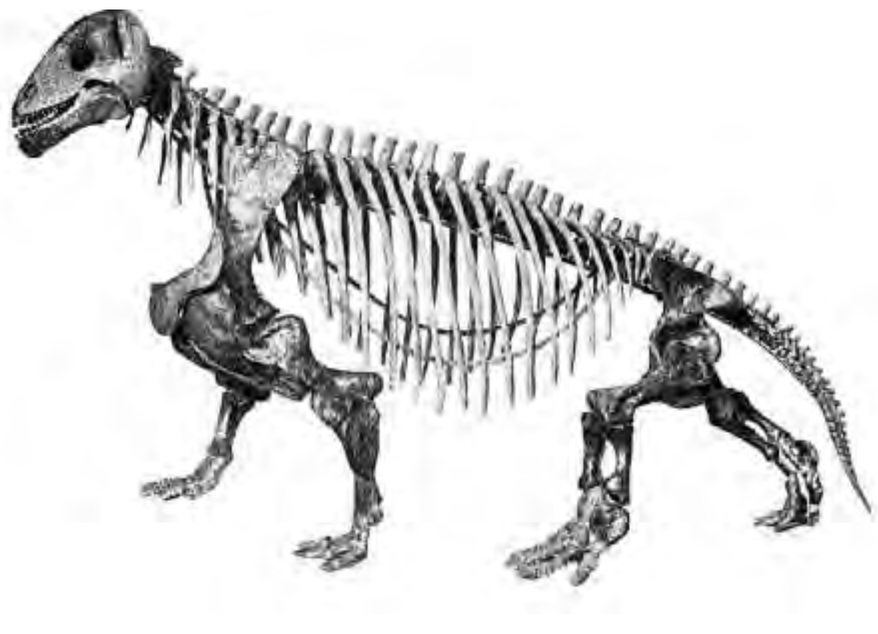

Figure 34. Skeleton of the tapinocephalid (thick-skulled) dinocephalian *Moschops*, a rhino-sized herbivorous therapsid that reached lengths of 2.5 to 3 m and may have lived in small herds.

Selected fossil sites recorded within the *Tapinocephalus* Assemblage Zones in the Sutherland region are indicated on outline maps by Kitching (1977), Keyser and Smith (1977-78) (Fig. 31) and Nicolas (2007) (Fig. 32). Several fossil sites near Sutherland are also shown on the 1: 250 000 geological sheet 3220 Sutherland published by the Council for Geoscience, Pretoria. 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 vertebrate fossil finds in the present study area to the southeast of Sutherland, although several important localities are recorded from the Moordenaars Karoo. This palaeontological impoverishment seems to apply even to the excellent exposures of Abrahamskraal Formation sediments within the Verlatekloof Pass near Sutherland. The reasons for the lack of fossils even here - despite appropriate facies and good bedrock exposure - is currently unresolved and may have a palaeoenvironmental component. A previous palaeontological field assessment of Moordenaars 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. Reworked silicified wood from surface gravels, scattered, fragmentary plant remains associated with channel sandstones and rare disarticulated bones were reported from a Moordenaars Member study site *c*. 1 km south of Sutherland by Almond (2011). Spectacular amphibian trackways have recently been found on the outskirts of Sutherland (Jaco Groenewald, pers. comm., 2015). A traverse through the Leeuvlei and Koornplaats Members along the Gamma – Omega 765 kV transmission line corridor to the south of the present study area did not yield fossil vertebrate remains in this area, although locally abundant plant material (*e.g.* sphenophytes, possible floating log tool marks) and sizeable vertical burrows (possibly casts of plant stems / roots) were seen, mainly further to the east in the Moordenaarskaroo region (Almond 2010a).

The only fossil remains recorded from the Abrahamskraal Formation within the Karreebosch Wind Farm study area located to the west of the present study area (Almond 2014) include rare, fragmentary remains of vascular plants - notably disarticulated sphenophyte (horsetail fern) stems embedded within massive siltstones – as well as widely occurring, low-diversity trace fossil assemblages of the *Scoyenia* ichnofacies that have been attributed to earthworms and / or insect larvae (*cf* Seilacher 2007). Recent fieldwork within the Karusa and Soetwater Wind Farm study areas just to the west of the present study area has only yielded sparse sphenophyte plant stems, rare petrified wood fragments, low diversity invertebrate trace fossil assemblages of the *Scoyenia* ichnofacies and unidentified large cylindrical vertical burrows (Almond 2015a, 2015b). It is notable that no vertebrate fossil material was recorded within any of the Lower Beaufort Group facies reported within the Karusa and Soetwater Wind Farm study areas, including the channel lag deposits, although a substantial number of Abrahamskraal Formation bedrock exposures were examined during the course of the field studies.

Very few vertebrate fossil occurrences were recorded within the Komsberg West WEF study area during the present field assessment, despite the presence here of several excellent exposures of Lower Beaufort Group mudrocks (with well-developed pedocrete horizons) as well as a range of sandstone facies. Isolated fragments of fossil bone were observed within downwasted surface gravels (*e.g.* Fig. 35) but no *in situ* material or well-preserved, articulated specimens were seen, with the exception of a few small fragments of rolled bone in channel lag breccias (Fig. 36). Although several scientifically important specimens are recorded from equivalent geological horizons and facies just outside the study area. There are verbal accounts of sizeable fossil bones seen by local farm workers, and occasional collected specimens can be seen at farmsteads in the region (*e.g.* Gemsbokfontein in the Komsberg East WEF study area). This material has mostly been lost or locality data is unavailable. Vertebrate fossils clearly occur here, but are apparently rare.

From a scientific viewpoint, the most interesting fossil site recorded during the present field study is a moderately extensive palaeosurface on the upper surface of a channel sandstone bed. The palaeosurface – the bed of an ancient river or pond - preserves numerous tetrapod tracks as well as a few recognisable trackways and other trace fossils (*N.B.* This site occurs just *outside* the Komsberg West study area and, given its sensitivity, precise localities details are not provided here). The palaeosurface features subdued, slightly-asymmetrical current ripples as well as delicate rill marks indicating very shallow, falling water levels. The associated tetrapod trackways were apparently generated by meter-sized animals with a sprawling posture – as suggested by occasional belly marks, cuspate tail impressions and arcuate digit impressions (*cf* Marsicano *et al.* 2014). The most likely candidates are predatory rhinesuchid temnospondyls ("labyrinthodont" amphibians) that are represented by rare body fossils in the Abrahamskraal Formation and are the only temnospondyls recorded from the *Tapinocephalus* Assemblage Zone (Damiani & Rubidge 2003, Damiani 2004). A curious feature of the trace fossil assemblage is the paired sets of straight, bipartite or tripartite "tram lines" that may have been generated by trailing temnospondyl digits as they floated above the pond or riverbed, or were swept along by a current while the river was still actively flowing. Very impressive, and much longer, trackways of Middle Permian temnospondyl amphibians have recently been recorded from the slightly younger Moordenaars Member on the outskirts of Sutherland (Prof. Bruce Rubidge, Wits University and Mnr Jaco Gronewald, pers. comm.,2015). Flaggy, thin-bedded sandstones exposed near Ventersrivier homestead feature trace fossils on their soles, including sinuous paired hypichnial ridges and paired deep prod marks associated with polygonal sandy desiccation crack infills (Fig. 39). Invertebrate traces recorded in the region include bioturbation by *Scoyenia* arthropod burrows and indistinct epichnial horizontal "worm burrows" on wave-rippled sandstone surfaces.

Fossil plants in the Lower Beaufort Group rocks of the study area are represented by locally abundant, comminuted plant stems (notably sphenophyte ferns) and unidentifiable plant debris. These fossils are preserved as ferruginised moulds within breccio-congomerate lenses at or close to the base of channel sandstones of the Kooornplaats Member (Figs. 20, 21 & 41). Several blocks of dense, heavily-ferruginised and -silicified fossil wood have been found as float but not, so far, *in situ* (Fig. 40). However, there is little doubt that this material has also weathered out of nearby channel sandstone bodies. The presence of sizeable petrified logs is indicated by the local concentration and size of some fossil wood blocks as well as by drag marks incised into channel sandstone surfaces that are most plausibly attributed to floating logs (Fig. 43). Occasional pebbles and cobbles of weathered, exotic granite overlying Lower Beaufort Group mudrocks in the Komsberg East study area might have been introduced among the roots of floating logs (See Almond 2010a and refs. therein) (*N.B.* Whitish quartz mineral lineation along fracture zones might be mistaken for fossil wood but is abiogenic in origin). Assemblages of closely-spaced, vertical, sand-infilled or empty tubes within thin-bedded sandstones and siltstones at several sites probably represent stem casts of dense reedy vegetation (*e.g.* equisetaleans) on the margins of water bodies (Fig. 42).

3.2. Fossils within the superficial deposits

The diverse superficial deposits within the South African interior have been comparatively neglected in palaeontological terms. However, sediments associated with ancient drainage systems, springs and pans in particular may occasionally contain important fossil biotas, notably the bones, teeth and horn cores of mammals as well as remains of reptiles like tortoises (*e.g.* Skead 1980, Klein 1984b, Brink, J.S. 1987, Bousman *et al.* 1988, Bender & Brink 1992, Brink *et al*. 1995, MacRae 1999, Meadows & Watkeys 1999, Churchill *et al*. 2000, Partridge & Scott 2000, Brink & Rossouw 2000, Rossouw 2006). Other late Caenozoic fossil biotas that may occur within these superficial deposits include non-marine molluscs (bivalves, gastropods), ostrich egg shells, trace fossils (*e.g.* calcretised termitaria, coprolites, invertebrate burrows, rhizocretions), and plant material such as peats or palynomorphs (pollens) in organic-rich alluvial horizons (Scott 2000) and diatoms in pan sediments. In Quaternary deposits, fossil remains may be associated with human artefacts such as stone tools and are also of archaeological interest (*e.g.* Smith 1999 and refs. therein). Ancient solution hollows within extensive calcrete hardpans may have acted as animal traps in the past. As with coastal and interior limestones, they might occasionally contain mammalian bones and teeth (perhaps associated with hyaena dens) or invertebrate remains such as snail shells.

No fossils were observed within the various Late Caenozoic superficial deposits represented within the Komsberg WEF study area during the present field study.

Figure 35. Unidentified fragment of fossil bone among downwasted surface gravels, Koornplaats Member, Schalkwykskraal 204 (Loc. 050). Maximum dimension of block is 7 cm.

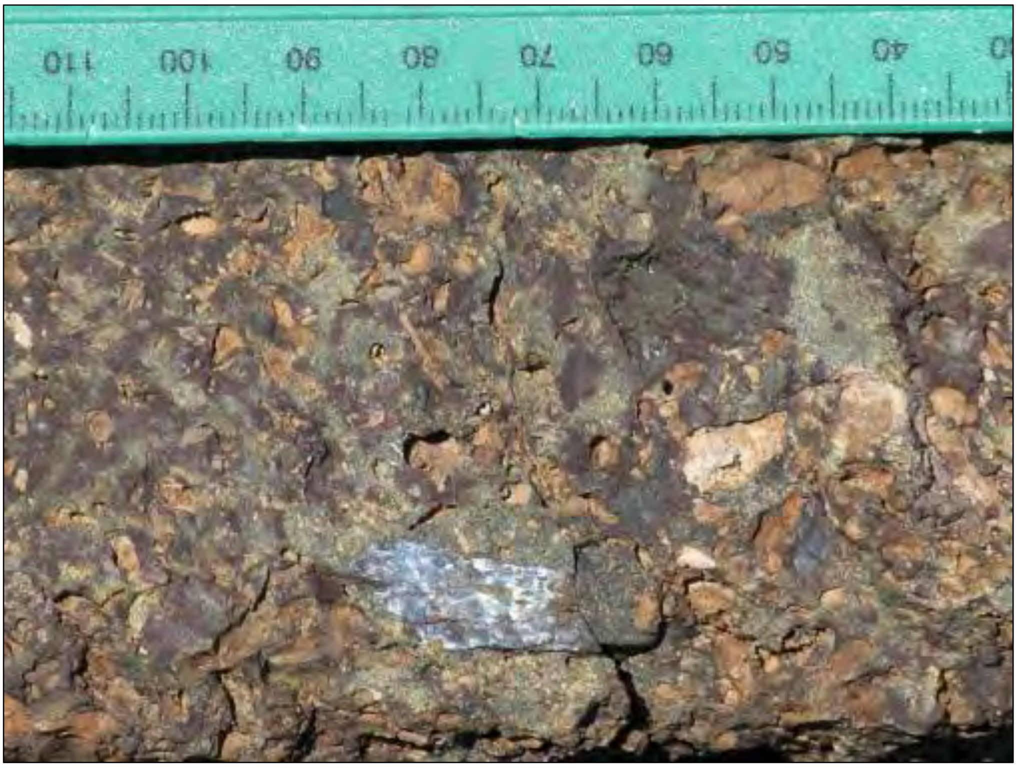

Figure 36. Small fragment of reworked fossil bone within a ferruginous basal channel breccia, Schalkwykskraal 204 (Loc. 050) (Scale in cm).

Figure 37. Rippled sandstone palaeosurface bearing temnospondyl amphibian tracks as well as parallel sets of straight “tram lines”, possibly made by trailing digits of floating amphibians (Welgemoed 268).

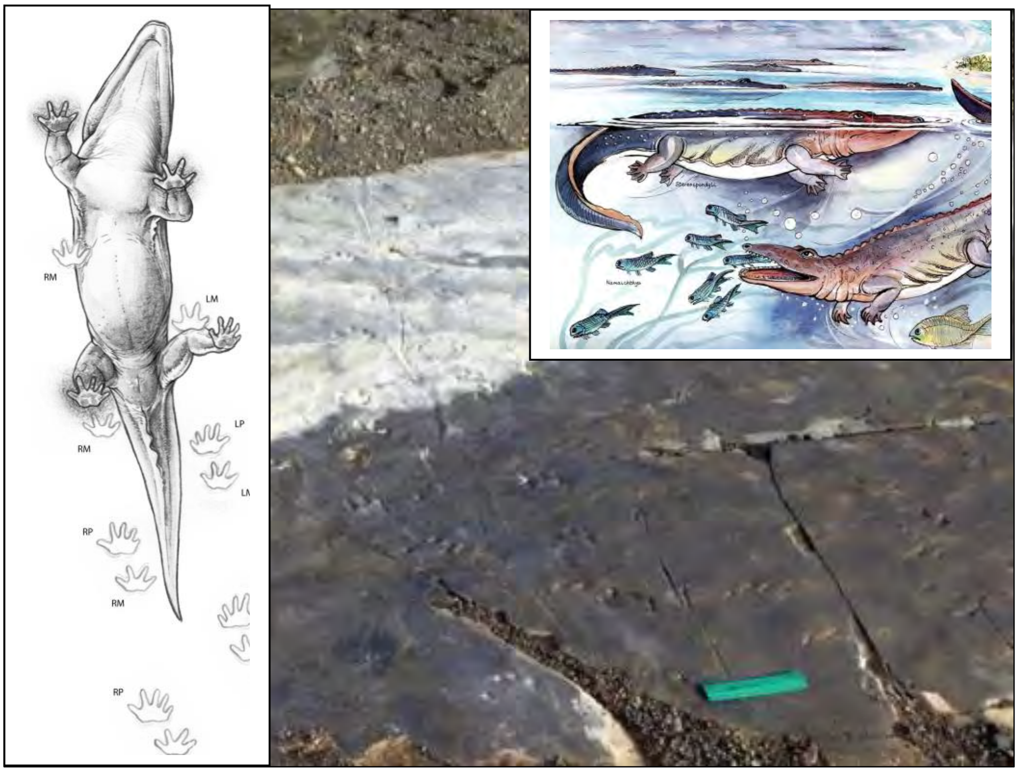

Figure 38. Same palaeosurface showing a partially-exposed temnospondyl amphibian trackway towards the left, including scalloped median trail impressions (Scale = *c*. 15 cm). Additional artwork from Marsicano *et al.* (2014) and Schneider & Marais (2004).

Figure 39. Sole surface of thin-bedded sandstone showing polygonal mudcrack casts and trace fossils including paired sinuous hypichnial ridges (LHS) and a pair of deeply-incised scoop or prod marks (possibly made by a tetrapod), Welgemoed 268 (Loc. 056) (Scale in cm).

Figure 40. Blocks of ferruginised silicified wood recorded as float, but probably weathered out from petrified logs embedded within channel sandstones, Welgemoed 268 (Loc. 056) (Scale in cm).

Figure 41. Ferruginised mould of segmented, longitudinally-ridged equisetalean fern stem preserved within a basal channel sandstone, Koornplaats Member, Welgemoed 268 (Loc. 041) (Scale in cm and mm).

Figure 42. Thin-bedded sandstone associated with the tetrapod-tracked palaeosurface shown in Fig. 38 above. The rounded structures are probably sections through sand-infilled casts of reedy plant stems (*e.g.* equisetalean ferns) (Scale in cm and mm).

Figure 43. Upper surface of a well-jointed channel sandstone showing large-scale incised grooves (arrowed) that are possibly drag marks generated by floating logs swept downstream by the river, Welgemoed 039 (Loc. 039).

4. EVALUATION OF IMPACTS ON PALAEONTOLOGICAL HERITAGE

The Komsberg West WEF study area is located in a region of the Great Karoo that is underlain by potentially fossiliferous sedimentary rocks of Late Palaeozoic and younger, Late Tertiary or Quaternary, age (Sections 2 & 3). The construction phase of the proposed wind energy facility will entail substantial excavations into the superficial sediment cover and locally into the underlying bedrock as well. These include, for example, site clearance and excavations for the wind turbine foundations, laydown and hardstanding areas, internal access roads, underground cables, transmission line pylon footings, electrical substations, operations and maintenance buildings and construction camps. All these developments may adversely affect potential fossil heritage within the study area by destroying, disturbing or permanently sealing-in fossils preserved at or beneath the surface of the ground that are then no longer available for scientific research or other public good.

The inferred impact of the proposed Komsberg West WEF on local fossil heritage resources is evaluated in Table 1 below, based on the system used by ARCUS. This assessment applies only to the construction phase of the development since further significant impacts on fossil heritage during the planning, operational and decommissioning phases of the facilities are not anticipated.

In general, the destruction, damage or disturbance out of context of fossils preserved at the ground surface or below ground that may occur during construction represents a *negative* impact that is limited to the development footprint (*local / within site boundary*). Such impacts can usually be mitigated but cannot be fully rectified or reversed (*i.e. long-term, irreversible*). Most of the sedimentary formations represented within the study area contain fossils of some sort, so impacts at some level on fossil heritage are definite. However, most fossil occurrences probably occur widely within the study region (*i.e. not unique / irreplaceable*). Exceptional fossils such as well-preserved, well-articulated vertebrate skeletons as well as vertebrate trackways that are scientifically valuable but very rare in the study area. They are considered to be irreplaceable, but the probability of their loss due to the proposed development is considered to be *low*. This is because of (a) the very sparsely-scattered distribution of exceptional, well-preserved fossils within the bedrocks as well as within the overlying superficial sediments (*e.g.* older alluvium, surface gravels), (b) the mantling of the bedrocks with thick superficial sediments in most areas, so that major impacts on potentially-fossiliferous fresh (*i.e.* unweathered) bedrock are limited. The intensity of the anticipated impacts on palaeontological heritage is therefore assessed as *low* (*negative*) without mitigation. The significance of low-intensity impacts on fossil heritage that are restricted to the site boundary and of permanent duration is rated as *medium (negative)* without mitigation. Levels of confidence for this assessment are *medium*, given (1) the unpredictable occurrence of well-preserved fossils and (2) uncertainties regarding the levels of sedimentary bedrock exposure as well as the distribution of older consolidated alluvial deposits within the final development footprint.

It should be noted that, should the recommended mitigation measures for the pre-construction and construction phase of the WEF development be consistently followed-though, the impact significance would remain *medium* but would entail both positive and negative impacts (Table 1). Residual negative impacts from inevitable loss of some fossil heritage would be partially offset by an improved palaeontological database for the study region as a direct result of appropriate mitigation. This is a *positive* outcome because any new, well-recorded and suitably-curated fossil material from this palaeontologically little-known region would constitute a useful addition to our scientific understanding of Karoo Basin fossil heritage.

5. RECOMMENDATIONS FOR MONITORING AND MITIGATION

Given the apparent rarity of significant fossil sites within the Komsberg West WEF study area no specialist palaeontological monitoring or mitigation for this project is recommended, pending the discovery of significant new fossil sites during development (*e.g.* well-preserved vertebrate bones, teeth and trackways, concentrations of petrified wood and/ or other plant fossils). The ECO responsible for the construction phase of the project should be aware of the necessity of conserving fossils and should monitor all substantial excavations into sedimentary rocks for fossil remains.

Recommended mitigation of chance fossil finds during the construction phase involves safeguarding of the fossils (preferably *in situ*) by the responsible ECO and reporting of finds to Heritage Western Cape (HWC. Protea Assurance Building, Green Market Square, Cape Town 8000. Private Bag X9067, Cape Town 8001. Tel: 086-142 142. Fax: 021-483 9842. Email: hwc@pgwc.gov.za) or to SAHRA for the Northern Cape (Contact details: SAHRA, 111 Harrington Street, Cape Town. PO Box 4637, Cape Town 8000, South Africa. Phone: +27 (0)21 462 4502. Fax: +27 (0)21 462 4509. Web: www.sahra.org.za). Where appropriate, judicious sampling and recording of fossil material and associated geological data by a qualified palaeontologist may be required by the heritage regulatory authorities. Any fossil material collected should be curated within an approved repository (museum / university fossil collection) by a qualified palaeontologist. These recommendations should be included within the Environmental Management Programme for the proposed alternative energy project.

Given the internationally recognised value of Karoo fossil heritage (*e.g.* Macrae 1999, McCarthy & Rubidge 2005), the known occurrence of scientifically valuable fossil material in the Sutherland / Moordenaarskaroo region, as well as the legal protection of all fossil remains under the National Heritage Resources Act (1999), these mitigation measures are considered to be essential.

Table 1. Evaluation of anticipated impacts on palaeontological heritage resources of the proposed Komsberg West WEF (Construction Phase)

<table>
<tr><td colspan="8">Construction Phase</td></tr>
<tr><td colspan="8"><u>Possible</u> Impact or Risk for Alternative 1: Potential disturbance, damage or destruction of fossil heritage resources due to surface clearance as well as excavations (e.g. for wind turbine footings, underground cables, access roads, building foundations) during the construction phase.</td></tr>
<tr><td></td><td>Extent</td><td>Duration</td><td>Intensity</td><td>Status</td><td>Significance</td><td>Probability</td><td>Confidence</td></tr>
<tr><td>Without Mitigation</td><td>L</td><td>H</td><td>L-</td><td>Negative</td><td>Medium -</td><td>L</td><td>M</td></tr>
<tr><td>With Mitigation</td><td>L</td><td>H</td><td>L-</td><td>Negative & Positive</td><td>Medium</td><td>L</td><td>M</td></tr>
<tr><td colspan="3">Can the impact be reversed?</td><td colspan="5">NO – palaeontological heritage resources are non-renewable and key contextual data for fossils (sedimentology, taphonomy) is difficult to reconstruct following disturbance.</td></tr>
<tr><td colspan="3">Will impact cause irreplaceable loss or resources?</td><td colspan="5">Possible but UNLIKELY – well-preserved, scientifically valuable fossils are scarce within the project area. Many of the fossils concerned are probably of widespread occurrence (Exceptions: well-preserved, articulated vertebrate skeletons, vertebrate trackways).</td></tr>
<tr><td colspan="3">Can impact be avoided, managed or mitigated?</td><td colspan="5">YES – effective mitigation of chance fossil finds by the ECO and a professional palaeontologist is possible.</td></tr>
<tr><td colspan="8">Mitigation measures:
1) Safeguarding of chance fossil finds (preferably in situ) during the construction phase by the responsible ECO, followed by reporting of finds to Heritage Western Cape / SAHRA.
2) Recording and judicious sampling of significant chance fossil finds by a qualified palaeontologist, together with pertinent contextual data (stratigraphy, sedimentology, taphonomy) within the final footprint.
3) Curation of fossil material within an approved repository (museum / university fossil collection) by a qualified palaeontologist.</td></tr>
<tr><td colspan="3">Can any residual risk be monitored/managed?</td><td colspan="5">YES, through ongoing application of the fossil chance finds procedure by ECO.</td></tr>
<tr><td colspan="3">Will this impact contribute to any cumulative impacts?</td><td colspan="5">YES. Cumulative impacts, albeit low-level, on local fossil heritage resources are anticipated as a result of construction of the considerable number of wind energy facilities that have been proposed for the Sutherland area.</td></tr>
</table>

6. CONCLUSIONS

Several important Middle Permian fossil vertebrate sites are known from the Komsberg – Moordenaarskaroo region but outside the present study area. Numerous good exposures of Lower Beaufort Group bedrocks are available within the area but only isolated fossil bone fragments were observed during the present scoping assessment. There are local verbal accounts of sizeable fossil bones being seen here, but the material has apparently been removed or detailed site data is not available. Plant fossils, including poorly-preserved petrified wood from sizeable logs, is locally common and well-preserved trackways of large (meter-sized) amphibians are known to occur in this region.

Give the apparent rarity of well-preserved, scientifically valuable fossil material (notably vertebrate skeletons and trackways, petrified wood) within the study area, the impact significance of the proposed Komsberg West WEF on local fossil heritage resources is assessed as *medium (negative)* for the construction phase. The operational and decommissioning phases of the wind energy facility are unlikely to involve further adverse impacts on local palaeontological heritage. Levels of confidence for this assessment are *medium*, due to (1) the unpredictable occurrence of well-preserved fossils and (2) uncertainties regarding the levels of sedimentary bedrock exposure as well as the distribution of older consolidated alluvial deposits within the final development footprint.

No specialist palaeontological monitoring or mitigation for this project is recommended, pending the discovery of significant new fossil sites during development (*e.g.* well-preserved vertebrate bones, teeth and trackways, concentrations of petrified wood and/ or other plant fossils). Recommended mitigation of chance fossil finds during the construction phase involves safeguarding of the fossils (preferably *in situ*) by the responsible ECO, reporting of finds to Heritage Western Cape (HWC. Protea Assurance Building, Green Market Square, Cape Town 8000. Private Bag X9067, Cape Town 8001. Tel: 086-142 142. Fax: 021-483 9842. Email: hwc@pgwc.gov.za) or SAHRA for the Northern Cape (Contact details: SAHRA, 111 Harrington Street, Cape Town. PO Box 4637, Cape Town 8000, South Africa. Phone: +27 (0)21 462 4502. Fax: +27 (0)21 462 4509. Web: www.sahra.org.za). Where appropriate, judicious sampling and recording of fossil material and associated geological data by a qualified palaeontologist may be required by the heritage regulatory authorities. These recommendations should be included within the Environmental Management Programme for the proposed alternative energy project.

Please note 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 from SAHRA or the relevant Provincial Heritage Resources Agency (in this case, Heritage Western Cape for the Western Cape and SAHRA for the Northern Cape).

- The palaeontologist concerned with mitigation work will need a valid fossil collection permit from HWC / SAHRA and any material collected would have to be curated in an approved depository (*e.g.* museum or university collection).

- All palaeontological specialist 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 as far as possible to the minimum standards for Phase 2 palaeontological studies recently developed by SAHRA (2013).

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APPENDIX: GPS LOCALITY DATA

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