HERITAGE IMPACT ASSESSMENT FOR THE PROPOSED UMSINDE EMOYENI WIND ENERGY FACILITY.

Prepared for Arcus Consulting PTY Ltd on behalf of

EMOYENI WIND FARM PROJECT Proprietary Limited (EFWP)

Prepared by:

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Executive summary

ACO Associates CC has been appointed by Arcus Consultancy Services Ltd to provide specialists services (heritage) for the proposed Umsinde Emoyeni wind energy facility (Phases 1 & 2). The proponent, Emoyeni Wind Farm Project Proprietary Limited (EFWP) has proposed the construction of the facility in mainly agricultural land, near the town of Murraysburg, Central Karoo Region. This study is conducted under section 38.8 of the National Heritage Resources Act of 1999 as part of an environmental impact assessment (EIA).

The project will be located 30 km north of the town of Murraysburg in the Western Cape Province. A small part of the study area lies within the Northern Cape which means that the Northern Cape heritage authority will share jurisdiction. The location of the project is shown on the Location Plan, and covers a total area of approximately 93,038 hectares. Only a relatively small portion of the land parcel will be used for development of the proposed 2 phases of the wind farm development.

The proposed wind energy facility (WEF) will be developed in two phases. Each phase will comprise up to 98 wind turbines that will each have a capacity to generate between 1.5 and 3.5 megawatts (MW) of power. Each turbine will have a maximum height to the tip of 180 m. Each phase of the WEF will have a contracted capacity of up to 140 MW, with an installed capacity of up to 147 MW in line with the Renewable Energy Independent Producers Procurement Program.

The study area lies in the eastern part of the Great Karoo, above the escarpment of the Camdeboo Plains in the Northern and Western Cape Provinces. Since this landscape is generally only moderately transformed, it contains a wealth of well-preserved archaeological sites; one of the deepest palaeontological sequences in the world, and in later years was the last refuge of the Southern African San before their ancient lifestyle became extinct during settlement of the land by Dutch colonists.

The study area was subject to a 2 week survey by ACO Associates during which time staff worked in the general survey area recording a diversity of heritage sites, the characteristics of which are summarized hereafter.

Palaeontology: The proposed Umsinde Emoyeni WEF project area is largely underlain by Permian fluvial sediments of the Lower Beaufort Group (Karoo Supergroup) that have yielded a wealth of important fossil remains from the Murraysburg region over the past century or more. These include diverse vertebrate fossils of the Late Permian

Cistecephalus and *Dicynodon* Assemblage Zones such as gorgonopsian, therocephalian and cynodont predators as well as small- to large-bodied herbivorous dicynodonts, among others. Recent palaeontological fieldwork confirms that well-preserved fossils belonging to a range of tetrapod groups are present at the surface in a high proportion of sites where Lower Beaufort Group bedrocks are well-exposed. Other fossil groups represented here include concentrations of medium to large vertebrate burrows, low-diversity invertebrate trace fossils and vascular plant remains (*e.g.* horsetail ferns). The palaeosensitivity of the UmsindeUmsinde Emoyeni study area is therefore rated as high.

The proposed layouts of wind turbines, access roads and associated infrastructure for the various phases of the Umsinde Emoyeni WEF are mainly concentrated on higher-lying terrain in the central and eastern portions of the study area that are largely underlain by unfossiliferous Karoo dolerite. Only a small proportion of the development footprint will be underlain by potentially fossiliferous Lower Beaufort Group sedimentary bedrocks and older, consolidated alluvium. Substantial impacts on local fossil heritage – conservatively rated as of *medium* (*negative*) significance - may be expected in these more sensitive sectors during the construction phase of the WEF, notably as a result of surface clearance and excavations for wind turbine footings, hard standing areas and laydown areas, access roads and underground cables. To a large extent, these impacts can be mitigated through pre-construction recording and collection of scientifically valuable fossil material as well as through the application of a chance-finds procedure during development itself. Impact significance following mitigation is rated as *low* (*negative*), and would be partially offset by *positive* impacts as a result of improved understanding of local fossil heritage resources (*i.e.* new palaeontological data and specimens). This assessment applies to all proposed phases and alternative layouts of the WEF as well as the associated grid connections. Mitigation must involve a pre-disturbance walkthrough/check and if necessary sampling of all infrastructure positions that are on fossiliferous bed rock areas (Beaufort shales), as well as a finds protocol for collection of fossil material during construction.

Pre-colonial heritage: This consists of occasional open air scatters, several rock shelters, and San rock painting sites. The spatial patterning of the heritage sites indicates that the locations of sites were related to the availability of water sources. Valley bottoms and sides proved to be the most sensitive areas, most of which have been excluded from both Phase 1 and Phase 2 areas. Rock engraving sites were fairly common, including some that appear to be ancient. The range includes very complex patterns, animal forms and mere scribblings. The engravings on dolerite boulders are found throughout the project area. There is one rock painting site in the study area worthy of Grade 2 status. This site must be formally documented before construction commences. It is not anticipated that archaeological sites and overhangs will be significantly impacted by the proposal. However, the construction of both the Phase 1 & 2 WEFs, and grid connections will impact rock engravings on dolerite surfaces and boulders. Mitigation will be required to identify, protect and move them if need be.

Colonial period heritage: Farm houses and structures within the project area are of interest, and at least 5 buildings are worthy of formal grading. These are 19th century farm houses and barns that are of heritage interest graded between 3A and 3B. There are numerous stone kraals and lesser stone features in many areas. Most of the historic farm houses are no longer lived in and are deteriorating. There are also formal and informal cemeteries all situated in alluvial soils. These will not be affected by the proposals. No structures will be physically impacted by the proposals, however sensitive re-use of abandoned farm houses is encouraged.

Landscape and setting: The overall project area is highly scenic, comprising of varied topography, ranging from high dolerite plateaus, ridges, canyons and plains. Overall a landscape quality grading of 3A – 3B is warranted. The proposed activities have avoided many sensitive areas by siting both phases of the wind energy facility on the more remote and desolate high dolerite hills. None-the-less there will be a tangible change to the sense of place through a loss of remoteness and wilderness qualities after the industrial presence is established. Because wind turbines are typically so large, their visibility radius is up to 20 km which will affect the scenic qualities of the area well beyond the borders of the phase 1 and phase 2 WEFs. Unfortunately the impact cannot be mitigated. The accumulative impact of this and other proposals in the area could result in impacts to the iconic context of the Great Karoo at large.

Impact	*Consequence*	*Probability*	*Significance*	*Status*	*Confidence*
Paeontology	Medium-high	Probable	**MED - HIGH**	-ve	Medium
With mitigation	Medium	Probable	**MEDIUM**	+ve & -ve	Medium
Pre-colonial heritage	Medium	Probable	**MEDIUM**	–ve	High
With mitigation	Low	Improbable	**V LOW**	Neutral	High
Colonial heritage	Medium	Probable	**MEDIUM**	-ve	High
With mitigation	Medium	Probable	**MEDIUM**	+ve	High
Landscape/setting	Medium	Likely	**MEDIUM**	-ve	High
With mitigation	Medium	Likely	**MEDIUM**	-ve	High

Mitigation

Precolonial heritage: Given the size of the original project area and the fact that the level of coverage of the assessment survey was quite thin, a walk down survey is essential to check final road positions and infrastructures sites.

The presence of rock engravings on dolerite outcrops at unpredictable localities in the project areas are a concern. Road alignments and infrastructure sites will have to be walked, the rock engravings identified and recorded and where possible moved to the side of the road/off site. The work should be done by an archaeologist (certainly at first) however an ECO with some heritage training may be able to assume this role.

A work plan to be submitted to Heritage Western Cape must detail how this is to be done, the level of sampling required and a dossier or catalogue of images and descriptions compiled.

Colonial period sites: *Turbines:* While no historic structures are likely to be directly impacted and mitigation in these terms will not be required, a positive impact could be achieved if the more habitable of these structures could be re-used and subject to basic repairs to prolong their lives. Several of the buildings are interesting examples of combinations of vernacular architecture and 19th century English influence.

Powerline: The proposed powerline must be adjusted to avoid Bakensklip and Hartebeestfontein by at least 500 m as these sits have heritage qualities.

Cultural landscape and setting: Pro-active planning has reduced the impact of the layouts for phases 1 and 2. Some recommendations of the VIA apply in terms of heritage (after Oberholzer and Lawson 2015)

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.

For grid connections (phase 1 and 2)

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. (in areas of shallow bedrock, powerlines could be covered with overburden).

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.

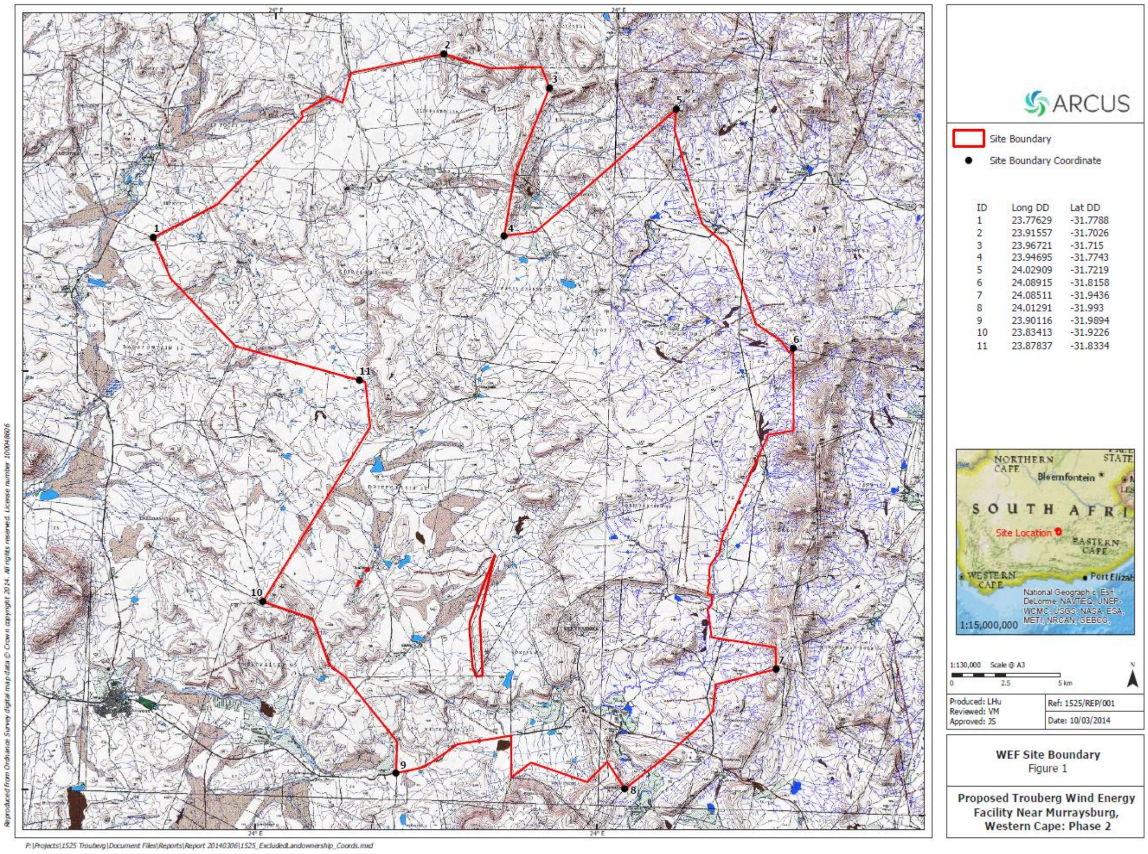
Human remains: All identified grave yards were mapped and co-ordinates given to the proponent for planning purposes however the possibility remains that un-marked graves may be found. In the event of human bones being found on site, an archaeologist must be informed immediately and the remains removed 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.

Conclusion

- In terms of archaeological heritage and built environment indications are that few impacts will occur. Proper mitigation will keep these to a minimum.

- The setting and landscape qualities of the site have been given a grade 3A field rating indicating high local significance. These qualities will be impacted negatively by the development proposal.

As is the case with renewable energy projects the 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 and physical heritage. Both phases on Umsinde Emoyeni are no exception being elements that contribute to a fast growing accumulative impact. The Karoo’s vast open landscape together with its layered cultural landscapes dating 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 something that should not be underestimated. Decisions to sacrifice this deeply layered cultural and natural landscape should be considered with care as in totality it is a heritage resource beyond comparison.



Location of the project area

Declarations

Tim Hart (MA) is an archaeologist with 25 years of working experience in heritage throughout southern Africa. He is accredited with Principal Investigator status with the Association of Professional Archaeologists of Southern Africa. He is a member of compliance committees of both SAHRA and Heritage Western Cape.

I, Tim Hart declare that I am an independent specialist consultant who is in no way connected with the proponent, other than delivery of consulting services.

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

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

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

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

GLOSSARY

Archaeology: Remains resulting from human activities, 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.

Early Stone Age: The archaeology of the Stone Age between 200 000 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.

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.

Pleistocene: A geological time period (of 3 million – 20 000 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.

Trekboer. A farmer who moves stock from locality to locality on a seasonal cycle.

Wreck (protected): A ship or an aeroplane or any part thereof that lies on land or in the sea within South Africa is protected if it is more than 60 years old.

Acronyms

DEA	Department of Environmental Affairs
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
PHS	Provincial Heritage site

Contents

1 Introduction

ACO Associates CC has been appointed by Arcus Consultancy Services Ltd to provide specialists services (heritage) for the proposed Umsinde Emoyeni wind energy facility (Phases 1 & 2). The proponent, Emoyeni Wind Farm Project Proprietary Limited (EFWP) has proposed the construction of the facilities (Figure 1) in mainly agricultural land near the town of Murraysburg, Central Karoo Region. The project area lies mainly in the Western Cape with a small portion in the Northern Cape Province. This study is conducted under section 38.8 of the National Heritage Resources Act of 1999 as part of an environmental impact assessment (EIA).

This report documents the different kinds of heritage that that has been identified in the project area and then indicates the sorts of impacts that are likely to take place. It indicates (based on previous experience) how heritage resources will be affected and provides recommendations as to how successful mitigation can be achieved. This study will also identify any issues which are likely to be significant restrictions to the proposed activity.

1.1 The proposed development activity

The project will be located 30 km north of the town of Murraysburg in the Western Cape Province. A small part of the study area lies within the Northern Cape which means that the Northern Cape heritage authority will have some jurisdiction. The location of the project is shown on the Location Plan and covers a total area of approximately 93,038 hectares (Figure 1). Only a relatively small portion of the land parcel will be used for development of the proposed 2 phases of the wind farm development. The aim of the project is to generate electricity, which is likely to be sold through the Department of Energy's (DoE) Renewable Energy Independent Power Producer Procurement Programme. This WEF will deliver electricity into the existing electricity grid via a high voltage grid connection (Arcus renewables 2014. There are 4 components to the project representing two development phases, each phase has an associated electrical grid connection project.

- Umsinde Emoyeni WEF near Murraysburg, Western Cape: Phase 1;
- Umsinde Emoyeni WEF near Murraysburg, Western Cape: Phase 2; and
- Electrical Grid Connection and Associated Infrastructure for Umsinde Emoyeni WEF near Murraysburg, Western Cape (Phase 1)
- Electrical Grid Connection and Associated Infrastructure for Umsinde Emoyeni WEF near Murraysburg, Western Cape (Phase 2).

The WEF will be developed in two phases. Each phase will comprise up to 98 wind turbines which will each have a capacity to generate between 1.5 and 3.5 megawatts (MW) of power. Each turbine will have a maximum height to the tip of 180 m. Each Phase of the WEF will have a contracted capacity of up to 140 MW, with an installed capacity of up to 147 MW in line with the Renewable Energy Independent Producers Procurement Program.

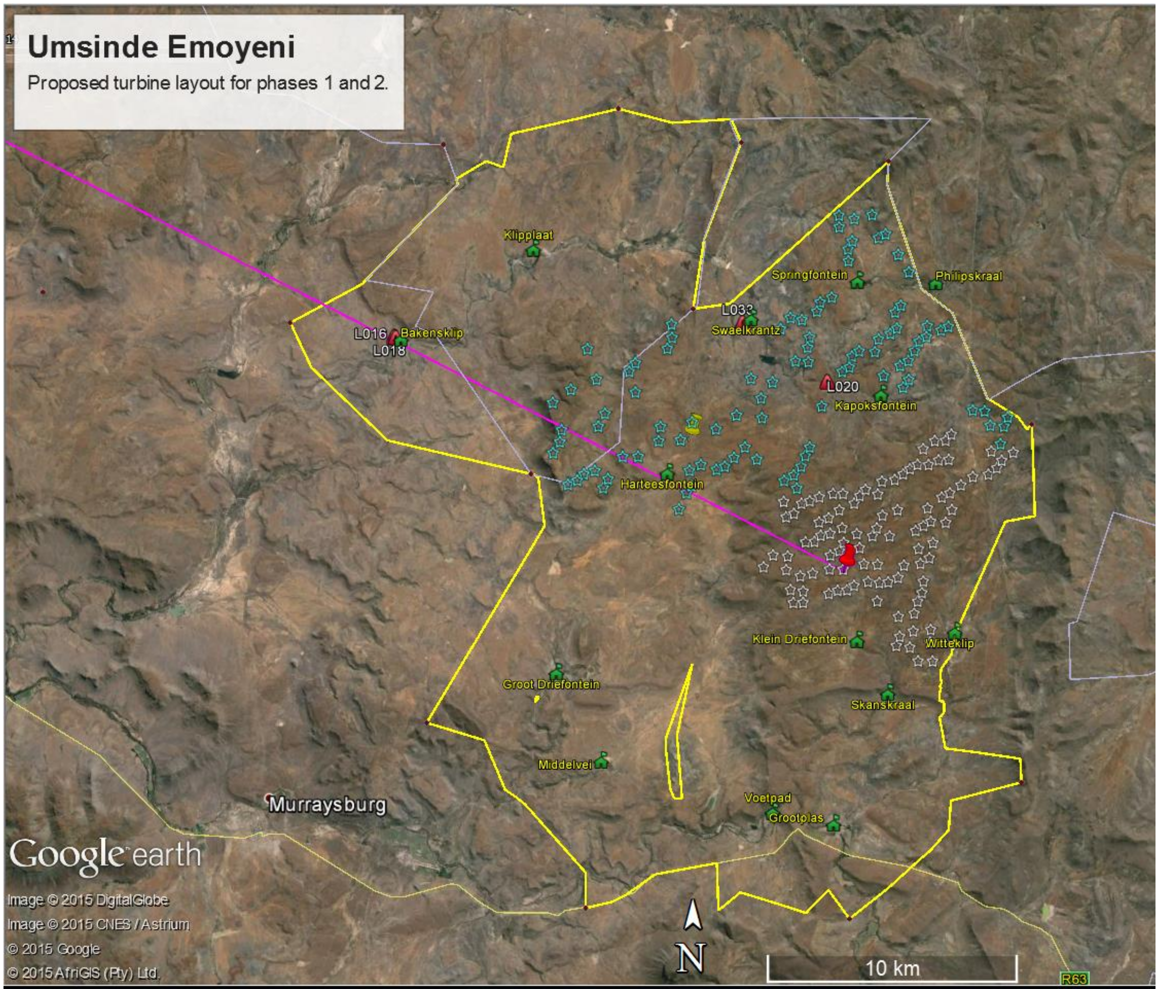


Figure 1 The project area with phase 1 turbines (white) and phase 2 turbines (blue). The purple line and red marker indicate the on-site substation and power line corridor.

Table 1: Description of Energy Facilities at the Umsinde Emoyeni Site

Facility	**Footprint**	**Height**	**Comments**
Total site area WEF area:	58100 ha Phase 1: 5 484ha Phase 2: 9 668ha	n/a n/a	Leased areas. Development areas may be smaller.
No. of wind turbines: Phase 1 Phase 2	1.5 to 4.5MW max. 98 turbines max. 98 turbines	Hub ht. up to 140m Rotor diam. up to 130m (depending on final selection of turbine type)	Each phase 140MW (contracted capacity of up to 140 MW, and an installed capacity of up to 147 MW) Off-white / grey
Electrical turbine transformer.	4m^2 (2x2m)? each turbine.	2.5 m	Colour: Off-white / grey
Turbine pad. Hardstanding area / crane pad.	Approx. 400m^2 Approx. 60 x 30m	n/a n/a	Visible concrete pad after construction. Compacted gravel hardstanding.
Internal access tracks: Phase 1 Phase 2	 79.99km 118.88km	 n/a	Max. 9m wide during construction. 6m wide during operation. Gravel surface.
Electrical substation	200 x 250 m substation	Single storey buildings Gantries approx. 10m	Earth-colour building and roof finish.
Wind measuring masts	5 x 80 m met masts remain on site post construction at each phase.		Mast type: monopole or lattice with guy-lines.
Transmission lines: 132kV line between on-site substation and Ishwati Emoyeni WEF.	 38.5km	 up to 40m height.	33 or 66kV internal lines are mainly underground. Monopole or lattice pylon.
Operations and maintenance buildings (O&M building) and possible visitor/education centre.	150 x 80 m	Single storey	Earth-colour plastered and painted masonry buildings or steel portal frame structures. No reflective finishes.
Fuel storage			Unknown
Security fencing	n/a	2 m	Possibly around around substation and O&M buildings.
Security Lighting Navigation lights	n/a For selected turbine nacelles as per CAA	 At hub height.	At substation and O&M buildings. Flashing red light on selected turbines only (to CAA requirements).
Construction Phase:			
Lay down area, construction camp and batching plant	150 x 60 m (for each phase)	Single storey	Temporary gravel hard standing and prefab structures. No on-site construction accommodation.
Borrow pits	Not established	n/a	From development site and/or imported from the district.

2 Methodology

2.1 Literature review

The source of information that is used for this process is based on a literature review of publications and reports relating to historical, archaeological and palaeontological work in the region. Extensive use has been made of the SAHRIS heritage database. The study area has been subjected to very few comprehensive archaeological assessments in the past, however the extensive body of literature produced by Prof C.G. Sampson and other members of his project team (which includes the author of this report) has direct relevance. Sampson (previously of Southern Methodist University, Dallas Texas (SMU)) commenced working in central Karoo in the 1960’s and continues to do so to this day (pers. comm.). His survey of the Zeekoei River catchment area, which lies some 20 km to the north east of the study area, is considered to be one of the largest and most comprehensive archaeological surveys in the world. The completeness of this survey and its direct applicability to the study area allows for its use as a predictive tool in determining the significance of impacts on archaeological heritage (the geology, climate, fauna and flora are similar).

The palaeontology sections of this report are contributed by Dr John Almond of Natura Viva cc. The work is based on known palaeontology of the study area and a field survey.

2.2 Assessing physical heritage sites: field survey

A key component of this work has been a site visit of some two weeks duration during which time the team tried to cover the range of environments that exist in the project area. Shape files provided by the proponent where converted to GPX format and uploaded to three Garmin *GPSmap 62s* units (among the most accurate hand-held GPS units) for use in the field. Whatever roads were accessible were driven in an-off road vehicle. During the trip, historic sites and buildings were visited and assessed and numerous random walks carried out in the landscape. Virtually every passable farm track was driven or walked by the ACO team. The vastness of the site is such that despite the amount of time spent in the field coverage was quite thin. Close attention has been paid to landform which in the Karoo does work as a predictive indicator for the presence of archaeological material. It was decided that the landscape should be *covered as broadly as possible and as wide a range as possible of the kinds of environments within* the project area be considered so as to gain a sense of the kinds of heritage that were present and how it was distributed on the landscape. Hence the study is not a saturation survey but a heritage overview that provided input into the project planning. During the surveys the positions of finds were recorded on a hand-held GPS receiver set to the WGS84 datum. Photographs were taken at times in order to capture representative samples of both the affected heritage and the landscape setting of the proposed development.

After the physical site survey was carried out shape files indicating the spatial patterning of identified heritage sites was sent to the EAP and proponent so that the planning of infrastructure for both phases could be carried out as sensitively as possible.

These include:

- Shape files with buffers for historic farms
- Shape files for archaeological sites and rock engravings
- Generous buffer zones around heritage sensitive landscapes such as river valleys and canyons. These were defined by topography.

The results of this are that physical impacts to identified heritage sites (as well as other environmental constraints) have been kept very low as the sensitivities were determined before the site design phase.

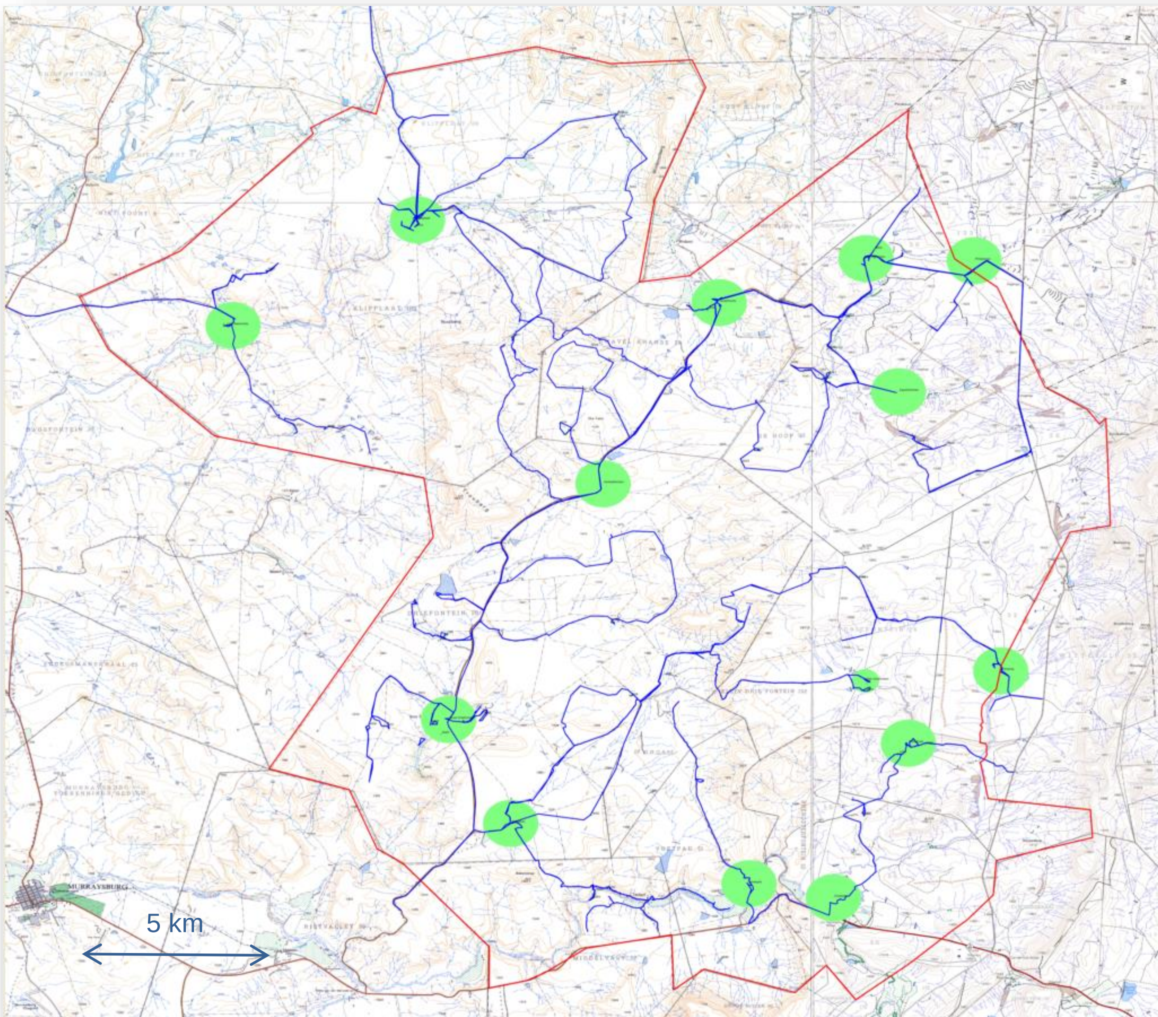


Figure 2 Track log of routes travelled during the site inspection are indicated by light blue lines. The green shapes indicate clusters of farm buildings.

2.3 Assessing landscape

Assessment of landscape takes cognisance of both international and local guidelines. Furthermore as it is considered a heritage resource and under the provisions of the NHRA, it has to be assigned a grade in terms of Heritage Western Cape's grading criteria (discussed previously).

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

(i) The **clearly defined landscape** designed and created intentionally. This embraces garden and parkland landscapes constructed for aesthetic reasons
(ii) 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:
• 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.
• 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.
(iii) 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 decision making 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 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 study area lies within a rural context. In terms of the UNESCO guidelines it is a organically evolving landscape. The character of the landscape is dominantly natural although technically it is agricultural in terms of its zoning. 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 relatively few.

2.4 Assessing heritage in the context wind energy developments

The impacts of clusters of wind turbines on cultural landscape can be of high significance, 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, there are no pro-active detailed local regional studies that can be consulted which make objective and standardised assessment of impacts quite difficult. It is generally recognized that while impacts can occur, the heritage authorities generally recognize the desirability of clean energy and the need to build clean energy facilities in landscapes that can tolerate them.

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/natural and heritage areas will affect 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.

2.5 The grading of heritage

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 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.

Table 2: Grading of heritage resources (Source: Winter & Baumann 2005).

Grade	Level of significance	Description

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

1	National	Of high intrinsic, associational and contextual heritage value within a national context, i.e. formally declared or potential Grade 1 heritage resources.
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 the 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. Grades A-C in the third tier of grades are not a legal grade as prescribed by the NHRA but a working tool used by Heritage Western Cape to express relative importance.

2.6 Limitations

At the time of conducting fieldwork, layouts of proposed turbine positions, power lines and roads were not available therefore the study area was assessed in general terms. The study area is vast, a detailed survey of which would require many months of work. The survey on which this report is based is not comprehensive as the two weeks that was spent in the field was only enough to obtain an impression of the heritage qualities and nature of heritage sites on the landscape. The full distribution of archaeological sites is not known but the different kind of heritage that is present on the landscape has been established. Most historic farm houses and buildings were inspected. The phase 1 project area has not been assessed in detail; however it was identified as being least sensitive in terms of the known spatial distribution of heritage sites.

Visibility of the land surface across the site was good, but accessing many farms proved difficult with many hours spent tracking down landowners to obtain keys to locked gates. Roads within the project area were poor requiring the use of an off-road vehicle most of the time. In some areas roads were cut through by dongas as to be impassable to an off-road vehicle, this was particularly so in the first phase areas of the project. Very low winter temperatures (below zero most days) precluded taking hikes of more than a few hours duration.

2.7 GPS Co-ordinates

Co-ordinates of sites found are not presented in this report but will be separately lodged with the relevant heritage authorities. Public release of such information has resulted in illegal collection of both fossils and archaeological material.

3 Legislative context

The basis for all heritage impact assessment is the National Heritage Resources Act 25 (NHRA) of 1999, which in turn prescribes the manner in which heritage is assessed and managed.

Loosely defined, heritage is that which is inherited. The National Heritage Resources Act 25 of 1999 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 as well as the aesthetics qualities of any place that recognized as being significant. Generally protected heritage which must be considered in any heritage assessment includes:

- Cultural landscapes
- 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
- Living heritage

Section 38 of the NHRA requires that Heritage Impact Assessments (HIA's) are required for certain kinds of development such as rezoning of land greater than 10 000 sq m in extent or exceeding 3 or more sub-divisions, or for any activity that will alter the character or landscape of a site greater than 5000 sq m. "Stand alone HIA's" are not required where an EIA is carried out, however section 38.8 of NHRA compels the EIA process to include a heritage assessment that fulfills Section 38 provisions.

3.1 Cultural Landscapes

Section 3(3) of the 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.

3.2 **Scenic Routes**

While not specifically mentioned in the NHRA, No 25 of 1999, Scenic Routes are recognised as a category of heritage resources. In the DEA&DP (Western Cape) guidelines for involving heritage specialists in the EIA process, Baumann & Winter (2005) comment that the visual intrusion of development on a scenic route should be considered a heritage issue.

4 Background to heritage of the Karoo

4.1 Physical characteristics

Much of the Eastern and Western Cape Provinces as well as the southern part of the Free State is known as the Karoo. Most people who pass through the Karoo today do not realize that what seems to be a vast expanse of arid landscape was once home to many groups of pre-colonial people, early transhumant farmers and vast herds of game. A deep understanding of this seemingly harsh environment enabled pre-historic humans to exploit the many hidden resources that this region had to offer.

Figure 3 Typical Karoo landscape within the study area. Mudstone plains punctuated by dolerite dykes and sills.

The Karoo geology gives rise to numerous aquifers and fountains which has effectively made this land viable farming country. By the same token the land was habitable for prehistoric people and animals. Ground water in the Great Karoo is usually associated with dolerite dykes and to a lesser extent, sills. Cracks in the Karoo shales along dolerite intrusions (Figure 5) serve as aquifers which get topped up by seasonal rains. Intensive borehole pumping and donga formation has lowered the water table in historic times. Many natural fountains no longer flow because of this.

The Karoo is arid or semi-arid with characteristic vegetation that consists of dwarf shrublands and open grasslands (Cowling and Roux 1987). Much of the Karoo has been of high economic value to South Africa. During the last 2 centuries the region has been subjected to intensive sheep grazing, at the expense of indigenous fauna and flora. Hoffman and Cowling (1987) have divided the Karoo into 2 regions on the basis of rainfall. The Succulent Karoo in the west is subject to winter rainfall, while the Nama Karoo, which covers the central interior of the country, experiences a late summer/autumn rainfall. The Karoo climate is one of extremes of temperature with heavily fluctuating yearly rainfall. Venter, Mocke and de Jager (1986) noted that South Africa's average annual rainfall decreases from east to west. The south eastern part of the country receives some 600 mm of rain per year whereas the north west gets little more than 100 mm per year. The eastern-central part of the Great Karoo (study area) has a mostly summer rainfall of about 200-300 mm per year. Winter rain can occur but this tends to be less than 10% of the total average rainfall. In the study area most of the yearly rain tends to fall in the months of February and March but the quantity can fluctuate greatly from year to year. Periods of extended drought that seriously affect grazing are a feature of this rainfall pattern. Temperatures in the Great Karoo are extreme with cold winters and bitter winds that blow from the south. For 60 days a year minimum temperatures are below freezing and frost may occur for some 160 days a year. Snowfalls on higher ground are quite common. The summers are warm with an average temperature in the summer month of January in excess of 30 degrees.

Many species of indigenous fauna in the Karoo have become depleted as the area is used for the rearing of sheep. The mammalian fauna of the area is, in comparison with that mentioned in historic texts, depleted. Large herds of *Eguus quagga* (quagga) , *Connochaetes sp*. (gnu) and *Alcelaphus buselaphus* (hartebeest) no longer exist. The huge herds of trek springbok (Green 1955) have been fragmented with the advent of barbed wire fences. Acocks (1953) is of the opinion that the great diversity and mobility of game in the Karoo would have resulted in diverse grazing habits and so maintained the veld in climax state. The identification of warthog bones from an archaeological site near Richmond (Hart 1989) indicates that at times in the past there was enough grassland during the mini-ice age of 1200-1400 AD to maintain grazing animals.

4.2 Pre-history and history of the study area

The Karoo has been occupied by people for hundreds of thousands of years. This information is borne out by solid scientific studies by researchers both local and international who have worked in the central interior of the country since the early years of the 20th century. Virtually the entire full range of material evidence of human evolution is manifested in the archaeological sites of this area (Figure 4). To limit the scope of this study and maintain its relevancy, an impression of what the Karoo around the project area was like prior to European settlement is presented in the following historic accounts.

Sir John Barrow journeyed through the Sneeuberg Mountains in 1789 and followed the course of the Seekoei River to the Orange. By the time that Barrow reached the Graafff Reinet district there were no independent "Hottentots" in the area as they were all employed by the Dutch. There was a bitter state of conflict between the colonists and the San of the Karoo. In 1789 it was impossible for a farmer to venture out of his home unarmed less he be attacked by raiding San. In turn the Boers were actively hunting the San by means of *Kommandos* (Barrow 1801, Moodie 1838). Sheep farming, despite the circumstances, was very well entrenched and some farmers were already managing between 3-4000 animals (Barrow 1801). It is of interest to note the Barrow passed directly through the project area mentioning a farm at "Three Fountains". Today this farm is known as Driefontein, one of the major farms in the project area. Barrow (1801:259) found the plains of the Great Karoo covered with countless herds of wildebeest, eland, springbok, hartebeest and quagga. Carnivores also abounded. Interestingly, within the project area farms that Barrow mentions in his travels were all informally occupied with the first formal granting of land Middelvaly (Middelvei) being granted in 1828 (Deeds Office 10/1928).

In 1812 William Burchell crossed into the Great Karoo on his journey to the border of the colony from the Kuruman district. He too would have passed through, or very close to the study area south of the Kompasberg. He was the last person to encounter the last free groups of indigenous San people. He travelled over many miles of Karoo and wrote one of the most detailed accounts available. While travelling somewhere between where De Aar and Hanover are today in the summer of 1812 Burchell crossed several huge plains where no true grasses were seen except for "Cyperus usitatus" intermingled in various places with low bushes such "*as are generally met within the lands partaking of the nature of the Karoo* (Burchell 1822; Vii :71)." As the party penetrated deeper into the colony towards the Agtersneeuberge the amount of grasses increased and many new species of bush were seen. Somewhere between present day Hanover and Richmond Burchell found himself on a huge plain where large herds of springbok and wildebeest were grazing. The plain was covered with low bushes not more than nine inches high and mat rushes grew in abundance along the banks of the Seekoei River (Burchell 1822, vii: 79) as he approached the project area. Once in the colony, a much frequented road lay along the Seekoei River (a source of permanent water which became a travellers corridor) which serviced the needs of the transhumant *trekboers*.

Burchell makes mention of people he met while on his journey from the Orange River to the colony. The Khoekhoen group, the "Koras" (sometimes known as the Koranas) were at that time, encamped along the banks of the Orange River (Burchell 1922; Vii: 6-7) where they were keeping cattle and sheep. 'Bushmen' were only seen in the central Karoo. Burchell made contact with these people with the help of a “half bushman” acting as an interpreter. *Kaabi,* a bushman eventually led Burchell to a kraal of some people that he knew. Burchell took this as an act of friendship as the 'Bushmen' concealed the position of their kraals from the colonists. The kraal was situated on the summit of a ridge and consisted of "*half a dozen wretched worn huts*" (Burchell 1822; Vii: 27). This kraal, according to Burchell was a melancholy picture of poverty which inspired him to depart with liberal quantities of tobacco and meat.

Once Burchell entered the colony no more kraals were seen so it was quite clear that by 1812 indigenous people were only to be found beyond the borders of the colony in what is now the Northern Cape. The area south of Colesberg had been cleared and occupied by the colonists even though by that time very little land had been formally granted.

The demise of the indigenous peoples of the Karoo came with the advent of European farmers. In 1770 a war of attrition lasting some 40 years began. Reports came back to the Cape that the colonists were being raided by San who were making forays from places of refuge in the mountains onto farms (Van der Merwe 1935). By 1774 the situation became so serious that many of the trekboer farmers of the Eastern Karoo were abandoning their farms. Calls for assistance were made to the Cape, while on the war front intensified *kommando* activity began to take place. The *kommando* was an informal detachment of *freeburgers* and armed Hottentots who actively hunted out the marauding San with the blessing of the government. The notorious actions of the veld cornet Adriaan van Jaarsveld resulted in the slaying of scores of San with 120 people being killed in a single incident (Moodie 1838; viii: 43). Accounts in Moodie's Record (1838) indicate that the colonists were facing a united front of unprecedented San resistance in 1776. In 1777 legislation passed at the Cape opened the way for the formal annihilation of the San. By the time that Burchell had passed through the region in 1812, very few San were seen.

The formal granting of farms to wandering *trekboers* saw the vast landscapes of the Karoo partitioned in 5000 morgen allocations (Sampson, Sampson and Neville 1994). These were situated close to fountains and in the best grazing land. Indigenous people were increasingly marginalised onto the few remaining patches of as yet unclaimed land. Deprived of the ability to hunt (by the early 1800's the game herds had been shot out) and with traditional social structures disrupted they had little choice but to seek work on farms or settle at mission stations established for their emancipation (Sampson, Sampson and Neville 1994). A life-style thousands of years old ended, however the archaeological heritage that has survived is prolific and is manifested in the form of thousands of archaeological sites.

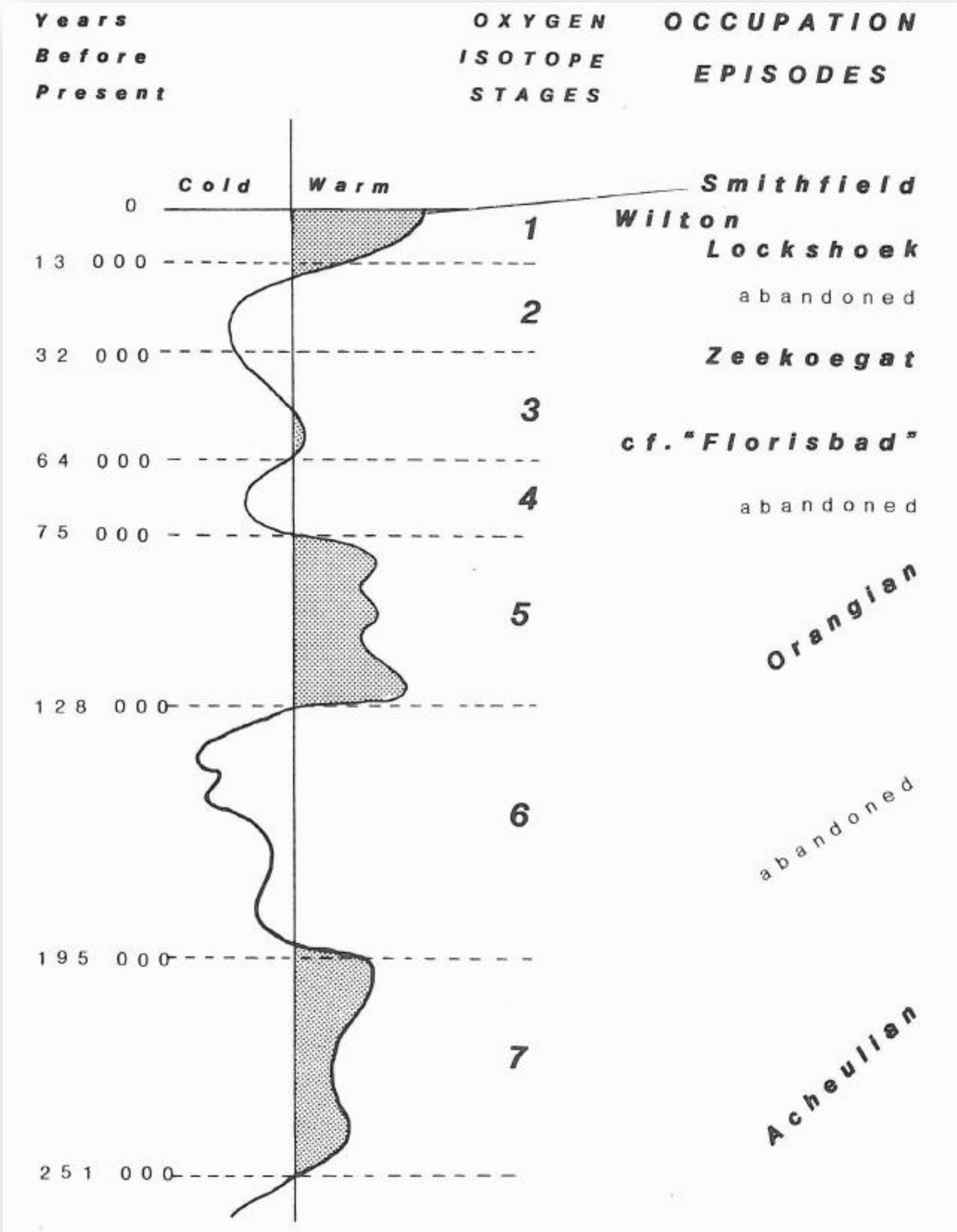


Figure 4 The sequence of occupation of the Karoo by humans as proposed by Sampson 1985 (after Sampson 1985)

5 Heritage indicators within the receiving environment

This study has focused on the notion of the project area as a series of layered cultural landscapes which form the main heritage indicators assessed in this study. The study area is a typical slice of this eastern Karoo landscape.

5.1 The Karoo as a cultural landscape

The central Karoo is almost entirely given over to sheep and game farming. Overgrazing since the advent of formal farming in the 19^{th} century has caused some changes to the landscape in terms of the composition of vegetation. Acocks (1953) has claimed that pure grass veld gave way to Karoo scrub only after livestock was introduced; however it is apparent that rainfall fluctuation does cause seasonal and even cyclical oscillations with respect to prevalence of Karoo scrub versus grasslands.

Overall, the damage caused by modern surface development has been slight. To all intents and purposes the project area has the qualities of an intact natural area, which on a world scale is fast becoming a rare resource. In areas where transformation has taken place – sheet erosion and donga formation has had an impact. The settlements and farms represent a comparatively ephemeral imposition of the landscape of colonial settlement. The flood zones of major water courses have been transformed by agriculture. Aside from these comparatively moderate interventions the Karoo remains dominated by its wilderness qualities. Indications are that this situation is changing: there are numerous proposals for the establishments of renewable energy facilities which will have a significant impact in terms of industrialisation of the landscape, there is a possibility of *fracking* taking place, as well as the construction of the Square Kilometer Array, will accumulatively add a significant 21^{st} century development layer that will significantly impact the status-quo and probably irreversibly.

The heritage of the Karoo is essentially a series of layers of events (or landscapes) that has become superimposed on the land surface. The earliest of these is the Karoo palaeontology – an ancient landscape that was deposited as a result of a vast inland sea. The shores and swamps of this landscape abounded with ancient species of fish, plants, invertebrates and early mammal-like reptiles. After the breakup of Gondwanaland the Karoo took on the geology that has resulted in its particular character. Millions of years later it was home to successions of early human occupation. Stone Age occupations of the Early, Middle and Later Stone age left half a million years of human made debris on the land surface. Superimposed on the Karoo landscape one more is the history of European colonisation and the wars that went with it.

5.2 The Palaeontological Landscape

The Karoo is to all intents and purposes is a massive palaeontological landscape consisting of multiple layers of sediments that contain a vast array of fossils ranging from fish, early vertebrates, plant remains and trace fossils. It is considered to be one of the most complete fossil repositories on the planet. Generally the Karoo fossils predate the age of the life forms popularly known as *dinosaurs* by some scores of millions of years. The vertebrates of these times are known as early mammal-like reptiles which were ancestral to dinosaurs, hence the Karoo palaeontological sequence has contributed on a world scale to understanding the development of life forms on the planet. A specialist report by Dr John Almond is included as appendix 4. The project area lies in the heart of one of the most fossiliferous areas of the Karoo.

The geology and paleontology of the region has been a subject of research since the early 20^{th} century. The flat plains of the Nama Karoo are underlain by a series of shale and mudstone strata which represent some 400 million years of depositional events (Visser 1986). The basal rocks of the Karoo sequence are known as the Dwyka formation which was deposited by a wet based glacier during the Permo-Carboniferous glaciation. This was followed by the deposition of the Ecca formation which is made up of sediments deposited in a shallow lake that covered what is now the interior of Southern Africa. Ecca shales form many of the large flat plains of the Northern Karoo (Truswell 1977; Tankard et al 1982; Visser 1986). The best known depositional event of the Karoo sequence is the laying down of the Beaufort shales about 230 million years ago. These shales are rich in a stratified sequence of fish, reptilian and amphibian remains that lie fossilized in Permian and Triassic period swamp deposits (Truswell 1977; Visser 1986; Oelofsen and Loock 1987). At the end of the Triassic period a series of geological upheavals took place with the fragmentation of the Gondwanaland continent. These were largely responsible for giving the Karoo its characteristic landscape (Figure 3). Triassic period volcanic activity took place over an extended period of time beginning at 187 million years ago (Truswell 1977). During this time the horizontal volcanics of the Drakensberg were laid down and the shales of the Karoo were penetrated by dolerite intrusions and extrusions in the form of vertical dykes and horizontal sills following the bedding planes of the shales. These geological structures give rise to a very characteristic topography with general occurrences of mesas, hillocks and sharp ridges (Visser 1986).In the study area extruding dolerite dykes and hillocks exposed through differential erosion are dominant features of the landscape giving rise to the vast flat plains of mudstones dolerite outcrops and hills that are so characteristic of this area (Figure 3). These igneous events resulted in the formation of Hornfels a fine grained black rock with a conchoidal fracture. Hornfels is formed when a dolerite intrusion takes place and bakes the surrounding mudstone to a metamorphic form (Visser 1986). Millions of years later prehistoric peoples enthusiastically exploited hornfels exposures for raw material for making artefacts – a staple resource in the Karoo for hundreds of thousands of years.

5.3 The pre-colonial cultural landscape

Sampson (1985) stated that one of the many reasons for him choosing to undertake archaeological research in to the Karoo was that it was that the heritage was intact and untouched by ploughing and recent intervention. The pre-colonial archaeology of the Karoo was not only visible, but also prolific and in exceptionally good condition. A comprehensive survey of a 5000 square kilometre catchment area (the Valley of the Zeekoei River from the Sneeuberg Mountains to the Gariep River Valley) which lies some 20 km north east of the project area revealed the presence of some 10 000 archaeological sites representing a history of human occupation that dates back at least 250 000 years (or more). Of the 10 000 sites recorded and identified to industry (phases), some 6000 were attributable to the Late Stone Age. Sampson identified some 7 industries (phases) of human history within his study area – each of which are legible on the landscape today, and each of which represent a pre-colonial layer of the human history of the Karoo (Figure 4). A deep discussion of technicalities of Karoo archaeology is not warranted in this report as it is complex and pre-supposes knowledge of archaeology that most members of the general public don't have. Figure 4 depicts the phasing of the human occupation of the Karoo (directly applicable to Northern Cape and Free State). It would be inappropriate to discuss the details of the specific occupation phases in this report, other than to mention that each one the phases of human occupation described by Sampson (1985) represents a pulse of human occupation of the central Karoo – the population of people at any given time reflecting variations in climate and the degrees of aridity and temperature that dictate the viability of the landscape as a place suitable for people to live. Each phase of occupation has left its archaeological signature on the landscape which is identifiable by the kinds of stone artefacts that have been left behind. The different phases are broadly termed the Early Stone Age and Middle Stone Age. Artefacts of both the Early and Middle Stone Age are widespread and may generally be described as an ancient litter that occurs at a low frequency across the landscape. Where definable scatters of Early and Middle Stone Age material occur, they are considered to be significant heritage sites. More intensive occupation of the Karoo started around 13 000 years ago during the Later Stone

Age, which is essentially the heritage of Khoisan groups who lived throughout the region.

The latest phase of occupation of the Great Karoo is a period known as the Late Stone Age. It is a very important layer on the landscape as this represents the heritage of the Khoekhoen (historically known as “Hottentot” by early writers) and San (popularly known as Bushman) people of South Africa. The direct descendants of these groups make up a significant proportion of the population today. This heritage is represented by two industries (phases). These are the Interior Wilton which is characterised by a microlithic stone artefact industry characterised by lightly patinated hornfels (indurated shale stone) and the later Smithfield industry characterised by specific classes of stone artefacts and the presence of grass tempered ceramics.

The scarcity of natural caves and shelters in the Karoo landscape has resulted in the majority of archaeological sites being open occurrences of stone artefacts, ostrich eggshell fragments and occasionally, pottery. Bone remains are rarely preserved in open contexts. The most recent archaeological remains relating to the San have been historically described as the “Smithfield Industry”, and are found from the Free State to the Northern and Eastern Cape. The Smithfield typically contains flaked lithics (on unpatinated blue-black hornfels), grinding equipment, bored stones, and potsherds (typically relating to bowl-shaped pots with stamp impressed decoration). Formal stone tools include end scrapers. Sampson also recognized a Khoekhoen ceramic tradition and he speculates on the chronological ordering of the settlement in the valley (1988, 2010). Also associated with the Late Stone age of the Karoo are rare rock paintings which occur in the few caves and shelters to be found in the dolerites, however more plentiful are engraved rocks and stones and stone surfaces.

After 1000 years BP (before present) people who were herding sheep/goats and possibly cattle, made an incursion into Karoo and established a new economic order based on transhumant pastoralism (Hart 1989, Sampson, Hart, Wallsmith and Blagg 1989, Sampson 2010). The presence of herding people is represented by stone walled structures that occur throughout the Karoo. They have been recorded within the Zeekoei River Valley, between De Aar and Victoria West (within this project study area) and even in the inhospitable high Karoo near Sutherland (Hart 2005) and on the West Coast (Sadr 2007).

The spatial distribution of Late Stone Archaeological sites in the Karoo is quite patterned. People needed to be close to water so rivers, pans and springs played an important role in influencing where people lived. The climate of the Karoo also played a key role. The winters can be extremely cold with temperatures dropping well below zero, made worse by freezing winds. The summers in contrast are harsh, hot and rainfall is unreliable. Sampson has observed that almost all Late Stone Age sites are situated at the bottom of the breaks of dolerite dykes, in sheltered areas on the crests of dolerite dykes, as well as in dolerite mazes and outcrops. So too, are the stone circles and circle complexes (Figure 14) built by Khoekhoen groups after 1000 AD which are almost always built on the edges of low ridges and dykes. The higher ridges provided a view, some security, loose stones with which to build kraals and screens and allowed people to be elevated above the frost levels in winter. Definable sites of the Late Stone Age are sparse on the vast flat shale plains as these areas offered little protection from the wind and collect frost in winter. Hence, natural features such as rock outcrops and dolerite dykes played a significant role for Late Stone Age people.

The archaeology of the Karoo is so intact that Sampson (1988) was able to gather enough observations to postulate the existence on the landscape the territorial boundaries of different groups of people based on the variations on the decorative motifs on pottery. Recent evidence (Sampson 2010) indicates that once herding groups settle in the Karoo, their presence was continuous until the incursion of European *trekboere* in the 1700's.

Earlier archaeological sites (ESA and MSA) may also be found associated with natural foci, however indications are that the location of this kind of material is more widely broadcast. Distinct foci are few and in places scatters of dispersed and eroded material may be found over vast expanses of landscape.

5.4 The landscape of colonial settlement

The indigenous people of Karoo waged a bitter war against colonial expansion as they gradually lost control of their traditional land. Penn (2005) notes the most determined indigenous resistance to *trekboer* expansion occurred when they entered the harsh environment of the escarpment of the interior plateau (namely Hantam, Roggeveld and Nieuweveld Mountains). Similarly *trekboer* settlers find their progress onto the upper escarpment halted as the Sneeuberg close to the project area. San launched an almost successful campaign to drive them out. Numerous place names throughout the Karoo such as Oorlogspoort and Oorlogskloof are testimony the skirmishes of the late 18th century. The situation became so desperate that the colonists fought back by establishing the "Kommando" system – the "hunting" of San was officially sanctioned in 1777 (Dooling 2007) and in some instances bounties were obtainable from the local landrost (on presentation of body parts). The Drosdy of Graaff Reinett played a significant role in this long and bitter war which eventually saw the almost complete destruction of the Karoo

San.

The advent of the early European Settlers into the Great Karoo is one which is largely un-documented. These European pastoralists were highly mobile; trekking between winter and summer grazing on and off the escarpment. Land ownership was informal, and only became regulated after the implementation of the quitrent system of the 19th century used by the Government to control the lives and activities of the farmers.

The Europeans moved onto land associated with water sources or perennial fountains (Westbury and Sampson 1993). Many of the early settlers first attempted to cultivate wheat, and to all accounts were successful at first. Almost all historic ruins of farm houses have associated *traplvloere* – floors where wheat was winnowed in all likelihood for domestic use. The San resisted the presence of the Europeans vigorously – life on the frontiers of the Cape was no easy matter for all parties involved. The San saw their traditional territories and hunting areas diminishing, the vast game herds of the Karoo dwindled. The San used every opportunity to impede the progress of the Europeans by raiding lonely farms, murdering the occupants and stealing stock. The Europeans were allowed by law to shoot San males on sight and take women and children into servitude. By 1770 the Karoo was the furthest frontier of the Cape Colony. By 1820 after the suppression of the San the Karoo was quickly divided into quitrent or loan farms, the process of land seizure from the indigenous inhabitants was formalized through a government regulated process of formal land grants. Even in the early 19th century there were tracts of landscape simply known as “crown land” – much of this was marginal being away from rivers and fountains. It was on these patches of crown land that the last surviving groups of San eked out a meager existence. As the land parcels that were available to them diminished, they found themselves with little option other than to work as herdsmen and servants for the colonists (Sampson, Sampson and Neville 1994, Penn 2004).

The two major regional centers in the area, Beaufort West and Graaff Reinet were established as administrative centers to exert hegemony over the activities of the *Trekboere* who were prone to behave as free agents without governance. Of the two centers, Graaff Reinett, is the oldest being establish under the Dutch rule at the Cape as a legal and administrative center. The town has an extraordinarily colourful history, as being so remote from Cape Town, its citizens were inclined to exert independence to the point that Graaff Reinet was the seat of several rebellions, and for a period a self-proclaimed republic. The appointment of the a firm-handed administrator, Andries Stockenstroom saw the dissent quelled, and ongoing problems for farmers caused by the Sneeuberg San brought to an end by force of arms (Franzen 2006).

5.4.1 Murraysberg and the study area

European settlement of the project area began well before the development of the town. The area lay in the heart of the conflict zone with the San until Kommando operations completed their genocide in the first half of the 19th century. Murraysberg was one of a cluster of church towns (Aberdeen. Richmond) that developed in the area once the "Bushman wars" were over and the region was safe for settlement. Isolated farming communities needed regional centres where an NG Church could be built and stores established by entrepreneurs. Generally the regional towns two were a two day horse/ox wagons trip from outlying farms. Murraysberg was founded in 1855 at the instigation of the community and the NG Church (Malherbe, Conradie and Pienaar 2011) on the farm Toorfontein. The town was named after Andrew Murray, a Scottish missionary who was posted to South Africa. He played an important role in the community, the nearby town Aberdeen being named after his home town in Scotland. The town itself became established as a regional agricultural centre, its farmers playing an important role in development of the wool industry. The region was affected by the Boer War – a number of small confrontations and fire fights took place in the district. In 1966 Murraysberg enjoyed a brief period of fame as the Nationalist Government of the time attempted to sink an oil well believing that the Great Karoo harboured this resource. Dr Verwoerd, a key role player in this enterprise was murdered after drilling began. Thereafter the operation was suspended. Oil was never struck. Today Murraysberg remains an active regional town, but unfortunately like much of RSA has its social issues to contend with. Its urban fabric, although very historical has the appearance of not being well conserved.

Within the project area a title deeds survey has revealed that the earliest formal grants were Middelvaly which was formalized in 1829 and neighboring farm Swavel Krans in 1826. A batch of farms were formalized in 1826 and a further batch just before and after 1900. A number of the existing farm buildings clearly pre-date some of these grants which is further evidence for informal occupation. The 1829 survey diagram for Middelvaly (which probably incorporates Driefontein before subdivision) shows a significant communal outspan, a dwelling house and a number of fresh water pools and springs in the river (called Zeekoegatte). These two farms were surrounded by much "government land".

6 Summary of heritage findings

6.1 Paleontology

Details of the specialist findings are presented in appendix 4. The proposed Umsinde Emoyeni WEF project area is largely underlain by Permian fluvial sediments of the Lower Beaufort Group (Karoo Supergroup) that have yielded a wealth of important fossil remains from the Murraysburg region over the past century or more. These include diverse vertebrate fossils of the Late Permian *Cistecephalus* and *Dicynodon* Assemblage Zones such as gorgonopsian, therocephalian and cynodont predators as well as small- to large-bodied herbivorous dicynodonts, among others. Recent palaeontological fieldwork confirms that well-preserved fossils belonging to a range of tetrapod groups are present at the surface in a high proportion of sites where Lower Beaufort Group bedrocks are well-exposed. Other fossil groups represented here include concentrations of medium to large vertebrate burrows, low-diversity invertebrate trace fossils and vascular plant remains (*e.g.* horsetail ferns). The palaeosensitivity of the Umsinde Emoyeni study area is therefore rated as ***high***.

The proposed layouts of wind turbines, access roads and associated infrastructure for the various phases of the Umsinde Emoyeni WEF are mainly concentrated on higher-lying terrain in the central and eastern portions of the study area that are largely underlain by unfossiliferous Karoo dolerite. Only a small proportion of the development footprint will be underlain by potentially fossiliferous Lower Beaufort Group sedimentary bedrocks and older, consolidated alluvium. Substantial impacts on local fossil heritage – conservatively rated as of *medium* (*negative*) significance - may be expected in these more sensitive sectors during the construction phase of the WEF, notably as a result of surface clearance and excavations for wind turbine footings, hard standing areas and laydown areas, access roads and underground cables. To a large extent, these impacts can be mitigated through pre-construction recording and collection of scientifically valuable fossil material as well as through the application of a chance-finds procedure during development itself. Impact significance following mitigation is rated as *low* (*negative*), and would be partially offset by *positive* impacts as a result of improved understanding of local fossil heritage resources (*i.e.* new palaeontological data and specimens). This assessment applies to all proposed phases and alternative layouts of the WEF as well as the associated transmission line. Obviously, the anticipated impacts will broadly increase in step with the number of wind turbines and length of new access roads and other infrastructure involved. Levels of confidence for the assessment are *medium*, given the unpredictable occurrence of well-preserved fossils as well as uncertainties regarding the levels of sedimentary bedrock exposure within the final development footprint. These uncertainties can be largely resolved through further specialist fieldwork during the pre-construction phase.

6.2 Open archaeological sites

Details of archaeological sites are presented in Appendix 1. Given that the distribution of archaeological sites on the landscape is thin, and that sensitivity information furnished to the proponent has been observed in the design of the wind farms, indications are that impacts will be of low significance. Furthermore, the areas chosen for phase 1 and phase 2 of Umsinde Emoyeni are high and remote, characterised by inhospitable expanses of rough dolerite scree that renders the likelihood of impacts to precolonial archaeological sites to be low.

Almost all the pre-colonial archaeological sites that were observed were associated with watercourses that had some form of perennial water or springs. These range from Late Stone Age open sites with stone artefacts (Figure 5) and/or pottery to remnants of low circular stone features (that probably date to after the introduction of domestic stock in the Karoo between 1000 and 2000 years ago). Middle and Early Stone Age archaeological

Figure 5 Colleague Natalie Kendrick examines contents of a Late Stone Age site. The material found includes numerous hornfels stone artefacts (photograph above), Cape Coastal type pottery and a number of European items.

material was extremely sparse (which is unusual in the Karoo), however Almond (per com) has report finding Acheulian artefacts on dolerite in gravel lenses in alluvial riverine soils. ACO responded to these observations by providing the proponent with a 200m+ buffer zone around all major water courses within the project area. Again, these precautions have been observed thus protecting the bulk of precolonial heritage in the study area.

6.2.1 Rock paintings

San rock painters occur in the project area including a number of notable panels (Figure 6) (worthy of grade 2 significance) that depict both human, animal and abstract forms (location not disclosed to protect the site). All the rock paintings found were observed on rock faces and shelters on the edge of gulley's and rivers therefore appear to share the same spatial patterning of other archaeological sites. The buffer zones around riverine areas will result in very low or no impacts to these sites. Impacts can occur as a result of irresponsible actions of people in a recreational context. Damage caused by paint, graffiti, scratching and even attempted theft of parts of panels has been a significant problem throughout RSA. One rock painting site will require mitigation in the form of hi-resolution photography and tracing (Figure 6). While it is unlikely it will be physically impacted, the site is considered too valuable to place at any form of risk, direct or indirect.

Figure 6 Abstract forms that can be attributed to the proto-historic period overlie very large and older images of elephants and figures that are executed in a darker pigment. This site that lies within the study area will need formal recording**.**

6.2.2 Rock engravings

Rock engravings occur within the study area. These can be found on weathered black dolerite boulders and lone boulder clusters and dolerite mazes that occur throughout. Almost every dolerite outcrop and even loose boulders in the veld were found to be engraved. Many of the engravings were simple scratches (significance unknown) however complex patterns and abstract forms and animals were identified; some of them deeply patinated indicating great age of possibly thousands of years. There are also a number of colonial period engravings – some may be construed as graffiti by shepherds, but other forms are more serious and historic; notably a prayer (Figure 7) engraved on rock close to Klein Driefontein (a prayer for the return and protection of a son).

Figure 7 A prayer engraved on weathered dolerite (scale 10 cm)**.**

Unfortunately it is very difficult to predict where rock engravings occur as their distribution does not follow the pattern of archaeological sites. What can be said is that there are hundreds of them (if not thousands) in the study area. They are particularly vulnerable in the case of road construction and site clearing which will see many of them potentially damaged and displaced by road clearing. This is an impact that will require mitigation.

6.2.3 Built environment and ruins

Structures within the study area almost exclusively relate to farming activities. Almost every farm in the study area contains some historic elements while some 6 farm houses are conservation-worthy enough to merit a heritage grading. The wool boom of the mid-20th century was not kind to the built environment of the study area as a number of what would today be considered to be historic buildings were demolished and replaced with contemporary buildings. Old out-buildings and barns that have survived attest to the age of the farms. Unfortunately a number of these gradable structures are in very poor condition, locked and abandoned. Notable examples are a fine Karoo-style homestead at Skanskraal along with associated kraals, barns and wagon (grade 3B), Witteklip – a 19th century homestead that has both vernacular and Georgian elements as well as Grootplaas that is not dissimilar (Grade 3B). All of these old farm yards are complete in terms of their various elements (barn, outbuildings and kraals) however they are underutilised and will in time be un-restorable (Figures 9-10).

Other notable structures such as Springfontein – a well preserved (and conserved by its owner) Victorian Karoo house together with its possibly earlier barn/coach house also merit a high heritage grading (3A). Voetpad is also another heritage-worthy locality where the farm house is an exceptionally fine Cape Dutch revivalist structure with possibly earlier outbuildings and a watermill (grade 3B).

Figure 8 Ruins of a 19th century vernacular farm house at Klein Driefontein

Neither phase 1 nor phase 2 of the proposed activity will directly affect any of the above heritage structures. The recommended buffer zones have been acknowledged resulting in no physical impacts being anticipated with the likelihood that people who are resident on the affected properties will be able to continue to live there. An ideal scenario would see re-occupation of some of the heritage-worthy structures however any restoration would have to be done in a sensitive way. A positive impact could result if the proponent could negotiate use of some of these structures and implement basic repairs.

Figure 9 An un-occupied vernacular farm house at Skanskraal with wagons and out-buildings

Figure 10 Un-occupied vernacular H-shaped house at Witteklip.

6.2.4 Places of conflict

What appears to be a fortified ridge top was identified close to Groot Driefontein. This was an extensive area overlooking the Springfontein road where the rocks on the top of a ridge had been moved to create an extensive low wall that was so irregular it was only visible once one was on the ridge top. There were no associated artefacts or cartridge cases in the area. This site will not be impacted (Figure 11)

Figure 9 Detail of stone work along the top of a ridge that was either a hunting hide or fortified ridge.

6.2.5 Graves and cemetery's

There is a formal cemetery (enclosure with graves stones) and nearby informal graves at Bakensklip that will not be affected by either phase 1 or phase 2 of the development proposal. There is a large informal cemetery at Driefontein that will not be affected by the proposed activities as well as one close to Swaelkrans in alluvial soils in a valley. The likelihood is that there are more in the project area, however the very shallow soils in many areas means that formal burials would have to have taken place in silty areas in river valleys. The possibility of pre-colonial burials under cairns and rock overhangs cannot be excluded.

6.3 The setting and landscape

The iconic landscape of the Eastern Karoo as epitomised by the Valley of Desolation at Graaff Reinet lies some 65 km to the east. There is also spectacular countryside and vistas all the way along the edge of the Great Escarpment (Cambeboo Mountains) above Aberdeen and extending westwards towards Beaufort West. The project area is located in the high Karoo 25 km north of the lip of the Escarpment at its closest point. Here the landscape is hilly, if not mountainous in places. Within the project area is a smaller escarpment where mudstone flats and incised canyons in the east give rise to a high sill of fragmented dolerite - very rough snow adapted country (altitude 14-1500 m asl) strewn with loose dolerite scree. Several river systems run off this plateaux flowing through deeply incised gullies and canyons converging just west of Murraysberg forming the Kareedo River which plunges over the Great Escarpment and flows over the Plains of Camdeboo just west of Aberdeen.

Figure 12 Many parts of the site have good natural/wilderness qualities.

The high dolerite strewn country is not hospitable – the extremely stony land surface makes walking anywhere tortuous, the few existing roads into the area being equally difficult to negotiate (Figure 13). The spatial patterning of both archaeological sites and historic farms reveal that people preferred to settle away from the high dolerite country close to more arable land in valley floors or the flats to the east. The inhospitable high country is exposed and has high wind speeds. This area and high ridges has been identified for the construction of phases I and 2 of the proposed Umsinde Emoyeni wind energy facility, which from a social and physical heritage point of view is optimal.

The stony nature of the dolerite scree means that within both phases (1 and 2) of Umsinde Emoyeni enormous quantities of stone and boulders will need to be shifted to make way for the road network system (Figure 13). Optimal rehabilitation will not only need to involve propagation of vegetation but also the return of millions of stones back onto the landscape or the scars of the operation will be indefinitely indelible.

Figure 13 The high areas are characterized by extensive tracts of dolerite scree. It is in these areas that turbines are planned.

6.4 Grading

The diverse character of the area gives rise to a variety of landscape forms rendering it difficult to offer a landscape grade that is appropriate to the entire study area. There are small enclaves deep in the canyons that have outstanding natural qualities and sense of wilderness (up to grade 3A). There are small cultural landscape settings around some of the historic farms where there is a palpable sense of history and abandonment (grade 3A-B) while the sense of desolation and wide open space on the high dolerite landscapes is almost equally intense (3B). In contrast the lower flat landscapes to the east are not as interesting, yet contain their share of canyons and historic enclaves (3C-3B). Overall, the landscape of the project area has a deep history, of which the colonial past forms a somewhat ephemeral layer. Aside from scattered farm houses, dirt tracks and fences the landscape is predominantly natural and relatively unaltered in the last 60 years. Its overall landscape grading is 3A-3B.

Although this landscape has been assigned a high grade in terms of its quality, the proponent has gone to some lengths to design both phases 1 and 2 to involve the most inhospitable and remote parts of the project area which means that much of the high scenic amenity value areas will be conserved albeit that elements of the proposed facilities will be visible. Farms situated on the valley floors will probably not be seriously impacted to changes in sense of place, although the overall natural qualities of the project areas and aesthetic qualities will be impacted. The implementation of generous buffer zones around rivers has mitigated this somewhat.

7 Assessments of impacts

The palaeontological, archaeological and built environment technical findings are separately presented in appendices 1-5 . The likely impacts on heritage resources are presented below.

7.1 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 (9m wide) that can be negotiated by a heavy lift crane(s) which means that in 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 3 m (or more) and over an area of 400 m^2 for the concrete base. The pre-fabricated steel 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 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. The impacts to palaeontological and archaeological heritage are very similar. Any form of landscape re-modeling has the potential to impact (destroy) any form of material on and close to the surface. Almond (2015 Appendix 4) has remarked on the amount of surface exposures of fossils in the study area and gives the area high significance.

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

During the construction phase the following physical impacts to the landscape and any heritage (including palaeontology) that lies on it can be expected:

- 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 kilometers of linear trenches for cables;
- Erection of a 132 kV power line;
- Construction of electrical infra-structure in the form of one or more sub-stations.

In terms of impacts to heritage, palaeontological and archaeological sites which are highly context sensitive are most vulnerable to the alteration of the land surface. The best way to manage impacts to such 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 provinces.

7.3 Impacts expected during operation of the wind energy facility

During the operational life of the wind farm, 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 wilderness 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 close to (for example) wilderness and heritage areas will destroy many 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 can be very disturbing and destructive to the sense of serenity of a place.

- 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 (personal observations), however indications are (PGWC, 2006) that they are perceived to aesthetically/artistically more acceptable in agricultural or manicured landscapes;
- The fact that the turbines are in continuous motion creates a visual impact more severe 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 will have a serious impact on the sense of place of a heritage site;
- 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. The large concrete turbine bases will remain buried in the ground unless provision has been made to remove them. Bankruptcy or neglect by a wind energy company can result in turbines standing derelict for years creating a long term eyesore.

The remote setting of phases 1 and 2 of the proposed facility will not have a high impact on any commemorated heritage or farm buildings. The closest turbines to structures are roughly 1km while most are 2-3 km from any historic structures. The setting of many farms on valley floors means that they will be recessed and shielded from direct visual impact in many instances by the topography. However the remote high dolerite scree plateaux’s and ridges where the turbines will be situated will lose all sense of wilderness and aesthetic qualities of the landscape will be severely compromised by the new and massive industrial presence.

7.4 Umsinde Emoyeni Phase 1 Impact Assessment

7.4.1 Impacts to palaeontological heritage

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 3 Impacts to Palaeontology

Impact	***Consequence***	***Probability***	***Significance***	***Status***	***Confidence***
Impact 1: Disturbance, damage or destruction of well-preserved fossils at or beneath the ground surface during the construction phase (especially due to bedrock excavations, ground clearance).	High	Possible	**MEDIUM**	–ve	Medium
Essential Mitigation measures: • Conduct a pre-disturbance inspection of any infrastructure that is to be positioned on sensitive geology. Sensitive specimens will need to be recorded and removed. **Best Practice mitigation:** • The employment of a palaeontologist during the construction phase, establishment of on-site curation facilities and identification of a repository for specimens.					

With Mitigation	Medium	Possible	**LOW**	-ve & +ve	Medium

7.4.2 Palaeontological mitigation

- Once the final layout of the WEF and associated transmission line is determined, a pre-construction palaeontological study be undertaken of those limited sectors of the footprint that overlie potentially-fossiliferous sediments (*i.e.* Lower Beaufort Group bedrocks, older consolidated alluvium). The study should be carried out by a suitably qualified palaeontologist and would involve (a) recording of near-surface fossil material, including relevant geological data (*e.g.* stratigraphy, sedimentology, taphonomy), (b) judicious sampling of scientifically-valuable fossils as well as (c) making recommendations regarding further mitigation or conservation of specific fossil sites for the construction phase of the WEF and transmission line.

- 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 the Umsinde Emoyeni 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.

7.4.3 Impacts to archaeological material and rock engravings

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 is likely to be the construction of access roads, lay-down areas and excavation of the footings the turbines.

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 archaeological material, similarly excavation of cable trenches and clearing of access roads could impact material that lies buried in the surface sand. 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 archaeological material is insignificant and dispersed, which means that the extent of impacts is likely to be highly localised (if at all), with no regional implications for heritage of this kind.

Significance of impacts: In terms of the information that has been collected, indications are that impacts to pre-colonial archaeological material will be limited. 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

<table>
<tr><th></th><th>Extent</th><th>Intensity</th><th>Duration</th><th>Consequence</th><th>Probability</th><th>Significance</th><th>Status</th><th>Confidence</th></tr>
<tr><td>Without mitigation</td><td>Local
1</td><td>Medium
2</td><td>Long-term</td><td>Medium
6</td><td>Probable</td><td>Medium</td><td>– ve</td><td>High</td></tr>
<tr><td colspan="9">Essential mitigation measures:
• Conduct a final walk down of roads and check turbines positions for archaeological material.
• In the improbable event of archaeological material being found, this will need to be subject to sampling and removal from site under a work plan (Heritage Western Cape) or a permit (Eastern Cape Heritage Authority)
• Check dolerite clusters and flat dolerite rafts for rock engravings. Rock engravings must be assigned co-ordinates, photographed (so as to record detail) and moved out of harm's way, or the road adjusted to avoid them.</td></tr>
<tr><td>With mitigation</td><td>Local
1</td><td>Low
1</td><td>Long-term</td><td>Low
5</td><td>Improbable</td><td>VERY LOW</td><td>Neut</td><td>High</td></tr>
</table>

7.4.4 Colonial period heritage

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.

Significance of impacts: Given that there are no structures or historical sites that will be affected by Phase 1 of Umsinde Emoyeni physical impacts will be low, but impacts to context at some sites will be medium significance..

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

Without mitigation	Local 1	Medium 2	Long-term 3	**Medium** **6**	Probable	**Medium**	**– ve**	High
Essential mitigation measures: • No essential mitigation measures are suggested. **Best practice mitigation measures** • Re-use and sensitive repair of abandoned farm houses would make a positive contribution to heritage conservation. Refurbishment should be done under the advice of a heritage architect/consultant.								
With mitigation	Local 1	Low 2	Long-term 3	**Low** **5**	Probable	**Medium**	**+ve**	High

7.4.5 Cultural landscape and setting

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. The remoteness of areas selected for especially phase 1 of Umsinde Emoyeni has mitigated somewhat this impact.

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

	Extent	***Intensity***	***Duration***	***Consequence***	***Probability***	***Significance***	***Status***	***Confidence***
Without mitigation	Local 1	Medium 2	Long-term 3	**Medium 6**	likely	**Medium**	**– ve**	High
Essential mitigation measures: • Mitigation not possible								
With mitigation	Local 1	Low 2	Long-term 3	**Medium 6**	Likely	**Medium**	**-ve**	High

7.5 Umsinde Emoyeni Phase 2 Impact Assessment

7.5.1 Impacts to palaeontological heritage

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 7 Impacts of palaeontology

Impact	***Consequence***	***Probability***	***Significance***	***Status***	***Confidence***
Impact 1: Disturbance, damage or destruction of well-preserved fossils at or beneath the ground surface during the construction phase (especially due to bedrock excavations, ground clearance).	High	Possible	**MEDIUM**	–ve	Medium
Essential Mitigation measures: • Conduct a pre-disturbance inspection of any infrastructure that is to be positioned on sensitive geology. Sensitive specimens will need to be recorded and removed. **Best Practice mitigation:** • The employment of a palaeontologist during the construction phase, establishment of on-site curation facilities and identification of a repository for specimens.					
With Mitigation	Medium	Possible	**LOW**	-ve & +ve	Medium

7.5.2 Mitigation

- Once the final layout of the WEF and associated transmission line is determined, a pre-construction palaeontological study be undertaken of those limited sectors of the footprint that overlie potentially-fossiliferous sediments (*i.e.* Lower Beaufort Group bedrocks, older consolidated alluvium). The study should be carried out by a suitably qualified palaeontologist and would involve (a) recording of near-surface fossil material, including relevant geological data (*e.g.* stratigraphy, sedimentology, taphonomy), (b) judicious sampling of scientifically-valuable fossils as well as (c) making recommendations regarding further mitigation or conservation of specific fossil sites for the construction phase of the WEF and transmission line.

- 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 the Umsinde Emoyeni 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.

7.5.3 Impacts to archaeological material and rock engravings

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 is likely to be the construction of access roads, lay-down areas and excavation of the footings the turbines.

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 archaeological material, similarly excavation of cable trenches and clearing of access roads could impact material that lies buried in the surface sand. 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 archaeological material is insignificant and dispersed, which means that the extent of impacts is likely to be highly localised (if at all), with no regional implications for heritage of this kind.

Significance of impacts: In terms of the information that has been collected, indications are that impacts to pre-colonial archaeological material will be limited. 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 8 Impacts to archaeology

	Extent	***Intensity***	***Duration***	***Consequence***	***Probability***	***Significance***	***Status***	***Confidence***
Without mitigation	Local 1	Medium 2	Long-term 3	**Medium 6**	Probable	**Medium**	**– ve**	High
Essential mitigation measures: • Conduct a final walk down of roads and check turbines positions for archaeological material. • In the improbable event of archaeological material being found, this will need to be subject to sampling and removal from site under a work plan (Heritage Western Cape) or a permit (Eastern Cape Heritage Authority) • Check dolerite clusters and flat dolerite rafts for rock engravings. Rock engravings must be assigned co-ordinates, photographed (so as to record detail) and moved out of harm's way, or the road adjusted to avoid them. • One rock painting site must be thoroughly recorded prior to development.								
With mitigation	Local 1	Low 1	Long-term 3	**Low 5**	Improbable	**VERY LOW**	**Neut**	High

7.5.4 Colonial period heritage

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.

Significance of impacts: Given that there are no structures or historical sites that will be affected by Phase 1 of Umsinde Emoyeni physical impacts will be low, but impacts to context at some sites will be medium significance..

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

	Extent	***Intensity***	***Duration***	***Consequence***	***Probability***	***Significance***	***Status***	***Confidence***
Without mitigation	Local 1	Medium 2	Long-term 3	**Medium 6**	Probable	**Medium**	**– ve**	High

Essential mitigation measures: • No essential mitigation measures are suggested. **Best practice mitigation measures** • Re-use and sensitive repair of abandoned farm houses would make a positive contribution to heritage conservation. Refurbishment should be done under the advice of a heritage architect/consultant.								
With mitigation	Local 1	Low 2	Long-term 3	**Low 5**	Probable	**Medium**	**+ve**	High

7.5.5 Cultural landscape and setting

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. Umsinde Emoyeni phase 2 is not as remote as phase 1 as there will be high visibility of turbines for a considerable distance along the road between Hartebeestfontein and Philipskraal. A tangible change to sense of place will be experienced by farmer and travellers along this road, albeit that it is not a popular tourist route. Oberholzer and Lawson agree with these findings with respect to phase 2 and comment that combined with the proposed adjacent WEF, Eswati Emoyeni the combined impact will be quite considerable.

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 high without mitigation.

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

Table 10 Impacts to cultural landscape and setting

	Extent	***Intensity***	***Duration***	***Consequence***	***Probability***	***Significance***	***Status***	***Confidence***
Without mitigation	Local 1	Medium 3	Long-term 3	**High 7**	likely	**High**	**– ve**	High
Essential mitigation measures: • Mitigation very difficult to achieve, however recommendations of the VIA apply.								

With mitigation	Local 1	Low 2	Long-term 3	**Medium 6**	Likely	**Medium**	**-ve**	High

7.6 The no-go alternative

The no-go alternative will result in retention of the status-quo in heritage terms.

7.7 Accumulative impacts

The cumulative impact will affect the landscape qualities of the Karoo which is generally considered to be significantly scenic. This area is well known for its wide open spaces, its exposed geology and semi-desert natural qualities. In terms of the larger picture the Karoo is destined to changes. Applications for wind and solar energy are numerous to the extent that if these are all authorised the likelihood are that there will be few regions where there will not be an industrial development on the horizon. The aesthetic qualities of the Karoo generally will irrevocably change. The sense of isolation and wilderness of this unique landscape will be affected and highly compromised in wind farm areas. Oberholzer and Lawson (2015) have indicated that the combination of both phases of the proposed activity will affect the quality of the environment within and around the project area, which combined with the proposed Eshwati Emoyeni will have a strong negative impact on the general character of the region. Although other proposed facilities are some 50 km away and given that turbines will be visible for up to 18 km the amount of landscape affected by the combined clusters of wind farms is 36 linear km out of a linear 50 km. This is a significant impact on the character of the Karoo.

7.8 Impacts of substations and transmission lines

7.8.1 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 will be surface only, however it must be noted that the grid connection traverses areas of fossiliferous mudstone as opposed to the non-fossiliferous dolerites with the result that the likelihood of an impact occurring is high.

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	***Consequence***	***Probability***	***Significance***	***Status***	***Confidence***
Impact 1: Disturbance, damage or destruction of well-preserved fossils at or beneath the ground surface during the construction phase (especially due to bedrock excavations, ground clearance).	High	Possible	**MEDIUM**	–ve	Medium
Essential Mitigation measures: • Conduct a pre-disturbance walk down of any distribution line that is to be positioned on sensitive geology. Sensitive specimens will need to be recorded and removed. **Best Practice mitigation:** • The employment of a palaeontologist during the construction phase, establishment of on-site curation facilities and identification of a repository for specimens.					
With Mitigation	Medium	Possible	**LOW**	-ve & +ve	Medium

7.8.2 Potential impacts to pre-colonial archaeology

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 states the following:

“Widening of the N1 national road took place during the survey, and we recorded the destruction of 11 surface sites (over a distance of 34 km)*. It is reasonable to estimate, therefore, that another dozen sites were lost during the original N1 construction, and another dozen or so during the railway construction. Powerlines have no marked impact on surface sites in this terrain* (with reference to the De Aar to Eastern Cape 400 kV lines over a 37 km stretch)*. Secondary roads fail to obliterate surface sites, except for very small lithic scatters of only a few dozen flakes. Hundreds of surface sites have been truncated by such roads, but their presence is still obvious on the graded edges, and they are almost all still identifiable to industry (phase). In many cases their surface areas can still be measured as well. Farm tracks have no serious impact on surface sites.*

Among the farming developments most threatening to surface sites are dams, weirs, and soil conservation programs involving mechanical levelling of eroded streambank silts – a relatively recent innovation. Any of these can totally obliterate surface sites. Ubiquitous small earthen weirs placed immediately upslope of most spring eyes invariably destroyed the configuration of a few sites, but their site identities are still mappable from the artefacts caught up in the dam walls. Surprisingly, farm buildings and stockpens also fail to completely obliterate sites, although shapes and sizes of sites are usually not recoverable once they are incorporated within a farm werf. However, any large, well-kept lawn in front of the farmhouse will obliterate a site. Beyond the farm yard, sheep camp fences, boundary fences, and telephone poles have virtually no impact at all. Many hundreds of sites have fences passing through them without any visible distortions. Dry-stone walled stock enclosures used before the advent of barbed wire fences to pen livestock at night were positioned in many of the same places used by the makers of the Lockshoek, Interior Wilton and Smithfield industries. Although they frequently disrupted the configurations of these sites, they do not submerge them completely. Lucerne lands are a minor disruptive feature, but they tend to be placed in areas not frequently used in the prehistoric past.” (Sampson 1985).

Given Sampson’s observations and our own experience it is argued that the impact of the construction of power lines is limited. 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.

Of perhaps greater concern are the service roads, laydown areas and construction camps and the substation site. If these are to be physically prepared or mechanically scraped, impacts may occur. If the power line service road (which runs through the servitude) is to be a simple 4x4 track, the amount of damage that will occur will be substantially less.

Impacts to heritage sites on the plains are likely to be very small, however the likelihood of impacts occurring increases in hilly areas, river valleys and on dolerite dykes and outcrops is higher as this is where many archaeological are typically situated. Given the general low frequency of open archaeological sites very few impacts are expected.

- Archaeological sites of the Early, Middle and Late Stone Age will be found in the corridor of the powerline with similar low frequency. Dolerite ridges, dykes and mazes and valleys are likely to be the most sensitive land forms in terms of the archaeology of Khoekhoen and San.
- Rock engravings are also likely to be found in the powerline corridor/substation site.
-

Table 12 Archaeological impacts – grid connection infrastructure

	Extent	***Intensity***	***Duration***	***Consequence***	***Probability***	***Significance***	***Status***	***Confidence***
Without mitigation	Local 1	Medium 2	Long-term	**Medium 6**	Probable	**Medium**	**– ve**	High
Essential mitigation measures: • Conduct a final walk down of corridor and substation site. • In the improbable event of archaeological material being found, this will need to be subject to sampling and removal from site under a work plan (Heritage Western Cape) or a permit (Eastern Cape Heritage Authority) • Check dolerite clusters and flat dolerite rafts for rock engravings. Rock engravings must be assigned co-ordinates, photographed (so as to record detail) and moved out of harm's way, or the road adjusted to avoid them.								
With mitigation	Local 1	Low 1	Long-term	**Low 5**	Improbable	**LOW**	**Neut**	High

7.9 Impacts to colonial period heritage and cultural landscape

Impacts to colonial period heritage are expected to be confined to changes to the quality of the setting of farm houses on the powerline route. Individual residences that lie within close proximity of the power lines will experience changes to their views, however how an individual interprets this aesthetic change is subjective. Certainly any residence within 500 m of the transmission line will experience a noticeable and negative change in the quality of the local environment.

Almost all the farms that were examined (as is typical of the Karoo) were found to have attributes that were historical and fell within the general protections of the National Heritage Resources Act. Such attributes include farm grave yards, old stone wall alignments barns and sheds and farm residences. Aside from unlikely event of total demolition, the main impact that will occur relate to changes to sense of place and setting, and not to physical fabric. The proposed power line from the onsite substation passes unacceptably close to farm buildings at Hartebeestfontein and Bakensklip, both of which have heritage qualities and sensitive landscape settings.

Table 13 Cultural landscape and setting - grid connection infrastructure

	Exte	***Intensit***	***Duratio***	***Consequen***	***Probabili***	***Significan***	***Statu***	***Confiden***
Without	Local 1	Medium	Long-term	**High 7**	likely	**High**	**– ve**	High
Essential mitigation measures: • Adjust corridor to avoid Bakensklip and Hartebeestfontein by at least 500m.								
With mitigati	Local	Low	Long-term	**Low 5**	Likely	**LOW**	**- ve**	High

8 Mitigation and conservation

8.1 Archaeological and palaeontological heritage

Given the size of the original project area and the fact that the level of coverage of the assessment survey was quite thin, a walk down survey is essential to check final road positions and infrastructures sites.

The presence of rock engravings on dolerite outcrops at unpredictable localities in the project areas are a concern. Road alignments and infrastructure sites will have to be walked, the rock engravings identified and recorded and where possible moved to the side of the road. The work should be done by an archaeologist (certainly at first) however an ECO which some heritage training may be able to assume this role.

A work plan to be submitted to Heritage Western Cape must detail how this is to be done, the level of sampling required and a dossier or catalogue of images and descriptions compiled.

8.1.1 General palaeontology mitigation

- Once the final layout of the WEF and associated transmission line is determined, a pre-construction palaeontological study be undertaken of those limited sectors of the footprint that overlie potentially-fossiliferous sediments (*i.e.* Lower Beaufort

Group bedrocks, older consolidated alluvium). The study should be carried out by a suitably qualified palaeontologist and would involve (a) recording of near-surface fossil material, including relevant geological data (*e.g.* stratigraphy, sedimentology, taphonomy), (b) judicious sampling of scientifically-valuable fossils as well as (c) making recommendations regarding further mitigation or conservation of specific fossil sites for the construction phase of the WEF and transmission line.

- 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 the Umsinde Emoyeni 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.

8.2 Built environment and colonial period sites

Turbines: While no historic structures are likely to be directly impacted and mitigation in these terms will not be required, a positive impact could be achieved if the more habitable of these structures could be re-used and subject to basic repairs to prolong their lives.

Several of the buildings are interesting examples of combinations of vernacular architecture and 19th century English influence.

Powerline: The proposed powerline must be adjusted to avoid Bakensklip and Hartebeestfontein by at least 500 m as these sits have heritage qualities.

8.3 Cultural landscape and setting

Pro-active planning has reduced the impact of the layouts for phases 1 and 2. Some recommendations of the VIA apply in terms of heritage (after Oberholzer and Lawson 2015)

8.3.1 Turbines

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

8.3.2 Grid connections (phase 1 and 2)

f) Powerlines to avoid visually sensitive peaks, major ridgelines, scarp edges and slopes steeper than 1:5 gradient.
g) Internal connecting powerlines to be below ground where possible, particularly on visually exposed ridges. (in areas of shallow bedrock, powerlines could be covered with overburden).
h) Substations to be sited in unobtrusive, low-lying areas, away from roads and habitations, and screened by berms and/or tree-planting where feasible.
i) 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.
j) Access roads to be in sympathy with the contours, avoid steep 1:5 slopes and drainage courses, and kept as narrow as possible.

8.4 Human remains

All identified grave yards were mapped and co-ordinates given to the proponent for planning purposes. 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.

9 Conclusion

- The palaeontological heritage of the project area is of high significance and sensitive to construction activities that involve any form of landscape change. Planning the proposed turbines on the dolerite heights has brought down the level of risk significantly to an acceptable level however there are areas of mud stone geology that will be impacted and will require mitigation action.

- In terms of archaeological heritage and built environment indications are that few impacts will occur. Proper mitigation will keep these to a minimum.

- The setting and landscape qualities of the site have been given a grade 3A field rating indicating high local significance. These qualities will be impacted negatively by the development proposal.

As is the case with renewable energy projects the 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 and physical heritage. Both phases on Umsinde Emoyeni are no exception being elements that contribute to a fast growing accumulative impact. The Karoo vast open landscape together with its layered cultural landscapes dating 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 something that should not be underestimated. Decisions to sacrifice this deeply layered cultural and natural landscape should be considered with care as in totality it is a heritage resource beyond comparison.

10 References

ACOCKS, A.P.H. 1953. Veld types of South Africa. Memoirs of the botanical survey of South Africa. 28: 1-128.

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

BARROW, J. 1806. Travels into the interior of South Africa. London: Cadell & Davis.

BOUSMAN, C.B. *et al.* 1988. Palaeoenvironmental implications of Late Pleistocene and Holocene valley fills in Blydefontein Basin, Noupoort, C.P., South Africa. Palaeoecology of Africa 19: 43-67.

BURCHELL, W.J. 1822-24. Travels in the interior of Southern Africa. V 1 & 2. Reprinted facimile 1967. Cape Town: struik.

BUTZER, K.W., HELGREN, D.M., FOCK, G. & STUCKENRATH, R. 1973. Alluvial terraces of the Lower Vaal River, South Africa: a re-appraisal and re-investigation. Journal of geololgy 81, 341-362.

CLUVER, M.A. 1978. Fossil reptiles of the South African Karoo. 54pp. South African Museum, Cape Town.

COWLING, R.M. , ROUX P.W. 1987. The Karoo biome: a preliminary synthesis. South African National Scientific Programmes Report 142. Pretoria: CSIR.

DOOLING, W. 2007. Slavery, Emancipation And Colonial Rule In South Africa. University of KwaZulu-Natal Press

DU TOIT, A. 1954. The geology of South Africa. xii + 611pp, 41 pls. Oliver & Boyd, Edinburgh.

FRANZEN, H. 2006 Old Towns and villages of the Cape Jeppestown, Jonathan Ball Publishers

HALKETT, D. 2009. An Archaeological Impact Assessment of Uranium prospecting on Portions 1, 3 and 4 of the Farm Eerste Water 349, and Remainder of the farm Ryst Kuil 351, Beaufort West.

HART, T 1989 Haaskraal and Volstruisfontein, Later Stone Age events at two rockshelters in the Zeekoe Valley, Great Karoo, South Africa. MA thesis, University of Cape Town.

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

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

MOODIE, D. 1838. The record. Cape Town: A.S. Robertson.

NEL, L. 1977. Die geologie van die gebied suid van Hopetown. Unpublished PhD thesis, University of the Free State, 171 pp.

PENN, N. 2005. The Forgotten Frontier: Colonist and Khoisan on the Cape's Northern Frontier in the 18th century. Ohio University Press: Athens.

PLUMSTEAD, E.P. 1969. Three thousand million years of plant life in Africa. Alex Du Toit Memorial Lectures No. 11. Transactions of the Geological Society of South Africa, Annexure to Volume 72, 72pp. 25 pls.

PROVINCIAL GOVERNMENT OF THE WESTERN CAPE., 2006. Strategic Initiative to Introduce Commercial Land Based Wind Energy Development in the Western Cape. Towards a Regional Methodology for wind energy site selection. Dated May 2006.

SAHRA 2013. Minimum standards: palaeontological component of heritage impact assessment reports, 15 pp. South African Heritage Resources Agency, Cape Town.

SAHRA. 2009. Archaeology, Palaeontology and Meteorite Unit: Report Mapping Project (SAHRIS).

SAMPSON, C HART, T WALLSMITH, D, AND BLAGG J.D. 1989. The ceramic sequence in the upper Seacow Valley: problems and implications. South African Archaeological Bulletin 44. 3-16.

SAMPSON, C.G. 1988. Stylistic Boundaries among Mobile Hunter-Foragers. Washington:

Smithsonian Institution Press.

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

SAMPSON, CG. 2010 Chronology and dynamics of Later Stone Age herders in the upper Seacow River valley, South Africa. Department of Anthropology, Texas State University, San

Marcos, Texas 78666-4616, USA . Journal of arid environments. Volume 74, Issue 7, July 2010, Pages 842–848

SAMPSON, CG., SAMPSON, B. AND NEVILLE, D. 1994 The Frontier Wagon Track System in the Seacow River Valley, North-Eastern Karoo. The South African Archaeological Bulletin, Vol. 49, No. 160 (Dec., 1994), pp. 65-72.

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

SMITH, A.B. 1999. Hunters and herders in the Karoo landscape. Chapter 15 in Dean, W.R.J. & Milton, S.J. (Eds.) The Karoo; ecological patterns and processes, pp. 243-256. Cambridge University Press, Cambridge.

TRUSWELL, J.F. 1977. The geological evolution of South Africa. Cape Town: Purnell.

TRUTER, F.C., WASSERSTEIN, B., BOTHA, P.R., VISSER, D.L.J., BOARDMAN, L.G. & PAVER, G.L. 1938. The geology and mineral deposits of the Olifants Hoek area, Cape Province. Explanation of 1: 125 000 geology sheet 173 Olifants Hoek, 144 pp. Council for Geoscience, Pretoria.

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

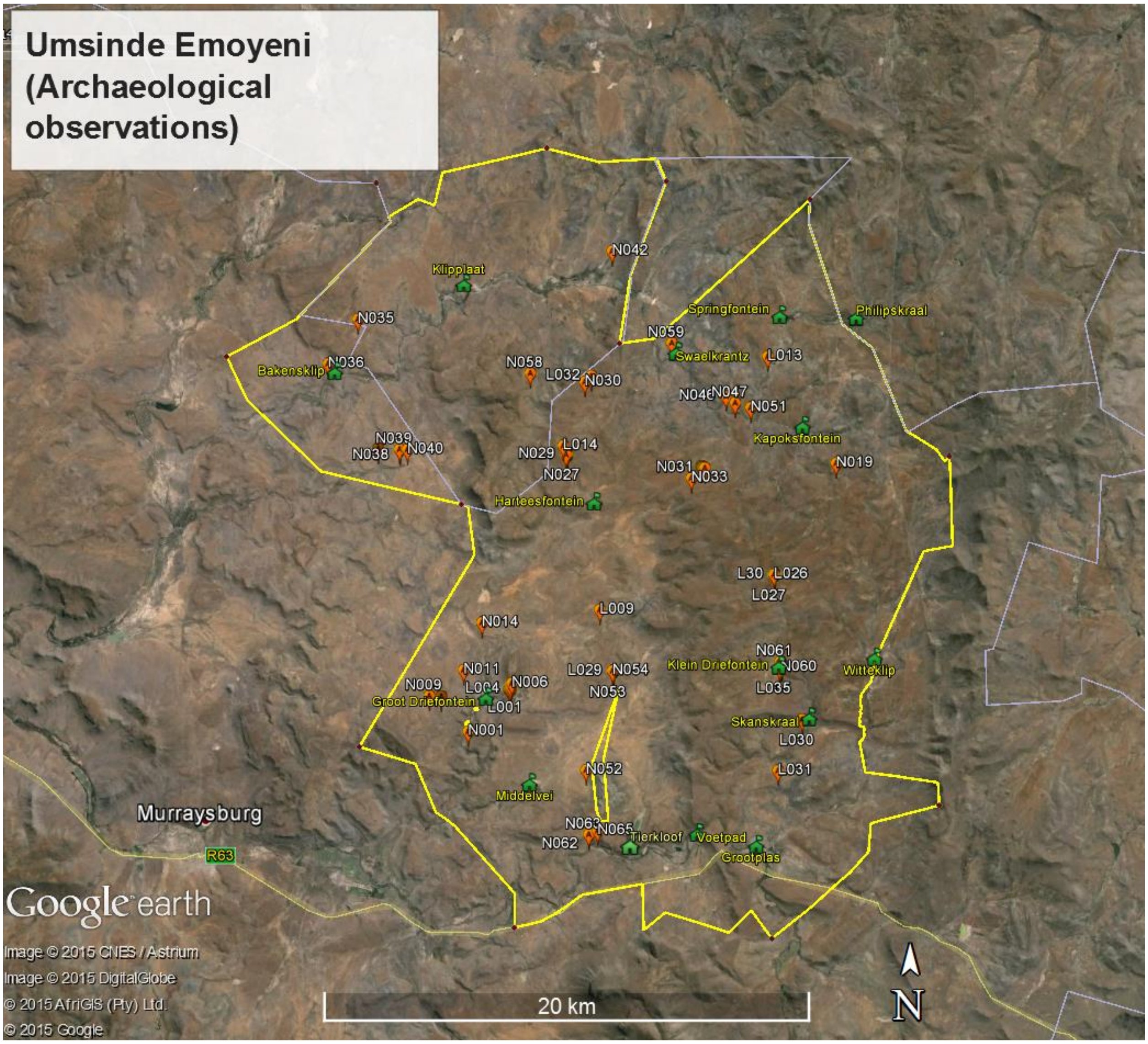
VENTER, J.M., MOCKE, C. , DE JAGER, J.M. 1986. Climate. In Cowling, R.M., Roux, P.W. & Pieterse, A.J.H. (eds). The Karoo Biome: a preliminary synthesis. Part 1 - physical environment. South African National Scientific Programmes Report No 124:39-52. Pretoria: CSIR.

WESTBURY, W., AND SAMPSON, CG. 1993. To Strike the Necessary Fire: Acquisition of Guns by the Seacow Valley Bushmen. Author(s): The South African Archaeological

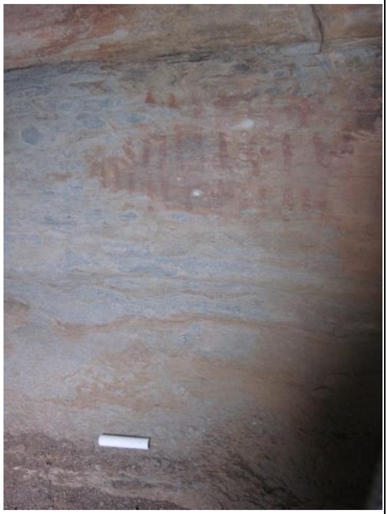
Bulletin, Vol. 48, No. 157 (Jun., 1993), pp. 26-31.

Appendix 1

Archaeology



Archaeological sites are relatively uncommon in the study area, of which the majority recorded consisted of rock engravings. Late Stone Age sites that were found were associated with the sides of and ridges above river valleys, taking the form of open artefact scatters (very few) and low stone alignments, curved or circular. Of interest is that almost all Late Stone Age ceramics located are of the grit tempered variety which contrasts greatly with observations from the ZVAP project between Hanover and the Sneeuberge where grass tempered ceramics dominate. Middle and Early Stone Age sites are extremely scarce being limited to a few occurrences and scatters. This is in contrast with the general archaeology of the Eastern Karoo which is generally well represented in all industries.

Field Number	Description	Significance
N001	Driefontein, in the valley near the house. A small rock shelter (3mx3m), sign-posted. The cave has a small wall in the front, some cemented stone steps and a small braai area in front used by visitors. The deposit is disturbed by placement of a toilet. There are about 11 vertical stripes in red paint on the back wall. On the roof, a further 4 red circles in red and three rows of red stripes. Cave appears to have shallow deposit with OES fragments observed. Disturbed by campers. 	3C
N014	On a lower plateau, below the walling, is a small shelter. There are at least 3 panels of finger paintings of small dashes. In red paint, very faded. One panel has about 15 faded stripes/daubs, the other has 4 and the third panel has 10. The floor of the cave is covered in OES (which is a mixture of un-weathered and fairly weathered, not giving a strong indication of age). The shelter is approx 1m high, 2m deep and 4m wide. There are stone artefacts on the talus below (cores blades and flakes). (There are two ridges on this side of the valley, this is situated on the lower one).	3C
L013	Level flat area in front of a small cave, overlooking the river. Bits of stone walling along the edge of the river bank. Two rock painting panels. One is very faded and consists of 14 red finger stripes. The second panel has a more complex arrangement of stripes and “chevrons”. All in red. The total length of the panel is 75 cm. There are at least 3 rows of chevrons. One the floor of the cave is a broken, incomplete bored stone, some hornfels flakes, fragment of aqua glass and two pieces of transfer ware.	3B

N036	Rock shelter/overhang. Not very deep, but quite long. Underneath the cap of a ridge, not very high from valley floor. Stone artefacts (Hornsfels waste) on the talus. Rock paintings. Finger stripes (approx 12) at my eye level. Above a red antelope and faded red patches.	3C
N046	Large series of rock art panels situated along a shallow shelter on the edge of a river bed. The growth of trees in front of panels are 'protecting' the site. It is on a cliff face above the river on Kapoksfontein. The panels cover a total of approx 50m.  There is extensive layering of paintings including modern graffiti. There are paintings of animals (including antelope, elephants, snakes and ostriches), finger daubs, 'circles' and human figures. There are also indistinguishable paintings. Overlaying some paintings are also engravings of antelope. In the Karoo context this is an exceptional site. There is likely to be archaeological deposit under dense leaf litter.	2 (Provincial heritage status)

N006	Rock engraving on a dolerite boulder at the start of a long dolerite ridge that overlooks a dam on Driefontein. It is close to the gate. The engravings are 'scratches' in a geometric pattern of parallel lines and cross hatches. It is very faint and patinated, likely to be extremely old. There was only one other rock engraving found along the ridge, however the entire length was not surveyed due to time constraints.   	3B
L001	Overlooking a dam is a large dolerite boulder with a few scratches. Below the dolerite boulders on the slopes of the hill is a spread of very weathered stone artefacts, perhaps ESA. But none diagnostic	Ungraded
L009	Horizontal scratches on black dolerite boulder on small koppie at Driefontein.	Ungraded
L014	On Hartebeesfontein – a distribution of dolerite boulders. There is at least one boulder with some parallel scratching. A single weathered MSA flake.	Ungraded
L015	Scratchings on a flat dolerite boulder.	Ungraded
L026	On Middelvlei farm, near the wind mast, a scatter of dolerite boulders with scratches	Ungraded
L027	Further scratches on boulders near the road. This collection of boulders will need to be examined properly if a road is built here.	Ungraded
L030	On Grootplaats, just beyond the Skanskraal house, is an outcrop of dolerite boulders . One large boulder has about 6 patches of incisions, and then 2 animals figures. There are at least a dozen boulders with scratch marks. Outcrop has been	3B

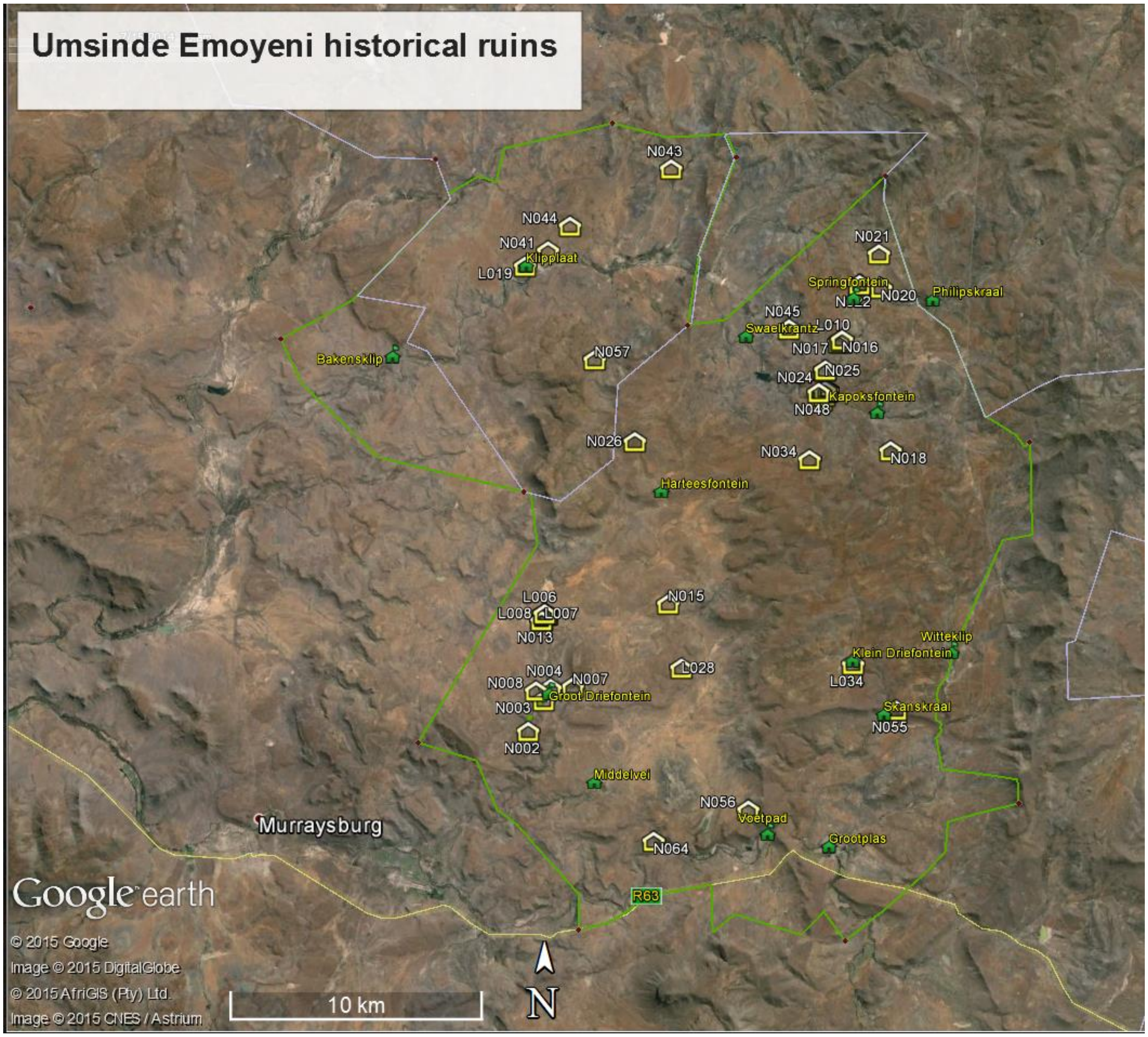
	used multiple times. Older engravings are patinated but complex patterns.	
L032	Scratches on a dolerite boulder on the road to the wind mast on the Swaelkrans road. A single boulder.	ungraded
L036	Some graffiti on a dolerite boulder: “21-1-1957. L.M. Petersen. Driefontein. Men TE JAAR”.	ungraded
L037	A large flat dolerite boulder (near the ruins of the old house on Klein Driefontein) with Dutch lettering, a prayer. The name Frans Johannes Olivier is written at the bottom	3B
N026 - N029	Rock engravings on large spread of dolerite boulders spread across a large flat area.	3C
N030	Rock engraving. On a small outcrop close that is close to the track, almost at the top of the ridge (very high). The scratches are in a bold v- shape and very weathered indicating significant age.	3C
N031	Rock engraving. Very old weathered scratches. Thin design difficult to make out. Quite large panel very detailed and abstract. Many designs overlaying. OES. 303 casing.	3B
N032	Rock engraving on a large dolerite boulder that is just below and to the right of large ridge outcropping. The engraving is a large bold arrow. It is very similar to 030, and may indicate that was also an arrow.	Ungraded
N033	Rock engravings. Many of the boulders have scratches of varying weathering. One is overlaid with a more modern engraving that is cursive text , done within a ‘page’. (Will need software to enhance enough to read).	Ungraded
N042	Large dolerite boulder a few scratches	Ungraded
N054	Large dolerite boulder on the flat, close to shallow water pans. A few with scratches. Some are in a sinuous line made up of short parallel ones.	3C
N060	Rock engravings on dolerite next to river and old fields. Modern (19-20c) engravings on old very weathered parallel line scratches. Also a prayer in Dutch. (Also see L035-L037)	3C
N061	More dolerite close to old ruins. Hatched parallel lines	3C

N011	Ephemeral MSA scatter of hornfels flakes and cores. These were seen on the floor beneath a low ridge that formed a semi-circle and is well protected from the wind (unfortunately there are no photos).	Ungraded
L003	A single adze on fresh hornfels	Ungraded
L004	A spread of grey stone artefacts on the edge of the pan, mainly flakes and cores. Not black hornfels, thus probably MSA? None diagnostic	Ungraded
N051	Very large selection of LSA material on hornfels in a small gulley leading to a large donga and small river. Numerous large circular hornfels scrapers, with cortex still evident. At least 1 artefact per m². 1 UG and one fragment of pottery from a lug. Grit-tempered.	3C
N058	Between the stone ruins and the river, is a swathe of historic material over-printing an earlier LSA site at least 50 m x 80 m in size. The historic material includes clear glass, older dark green bottle glass, 20th century ceramics with decal decorations, metal items and a sieve. The LSA material is quite densely distributed (1-3 artefacts per m²) and includes hornfels cores, flakes, end and side-scrapers and at least 1 UG and a grooved stone. There are at least 5 potsherds, about 5-7 mm in thickness with grit temper and red slip. There is one neck sherd which is highly burnished. Fragments of OES. Also some fragments of bone. It is possible that the sandy soils may include a high ashy content.	3B
N059	On banks of river at the Swaelkrans farm. A small scatter of LSA artefacts on hornfels. Three tiny fragments of pottery, 5-5mm in thickness, grit-tempered and with a red slip. One with a rounded rim but no decoration. At least 1 LSA blade. Some artefacts have retouch but no formal artefacts.	3C
L035	Between the boulders, which lie scattered near the river, are some very weathered MSA hornfels flakes, one with a facetted platform.	Ungraded
N063	Very large, freshly flaked hornfels cores and flakes on the banks of the river flowing through Tierkloof. This area is cleared of vegetation. The density of artefacts is low, but they are spread over an area of 20 m x 10 m. Possibly 20-30	3C

	artefacts in total. 1 large upper grindstone (UG) with hammerstone pitting.	
N065	Very ephemeral distribution of flakes and cores on hornfels on the edge of the river on the farm Tierkloof. The site is cut through by some large dongas. 6-8 pieces of pottery with a red slip, about 5 mm thick and with grit temper. Some large stone lying on top of the site, partly arranged in a circle, could be deliberate. Some rusty iron fragments nearby, and one broach. Possibly a contact period site overlying a pre-colonial site.  	3B
N019	The site is next to a large donga. There was a single decorated potsherd with two horizontal lines, it has both fibre and grit temper. Found in association with hornfels cores and flakes	3C
N035	Seen close to a klipbakkie (natural water hollow) were hornfels flakes. One of few sites found on the high dolerite plateaux. Artefacts were interesting because so few MSA artefacts have been seen in the general area, and a klipbakkie is where they would expect to be seen.	3C
N038	LSA site. High density stone artefacts and a piece of pottery. The site is above and close to the edge of a ravine.	3C
N039	Medium density MSA site, (all pieces are very weathered). The scatter does not continue down into the LSA site (N038). It is on top of escarpment and close to the track. It is slightly higher than N038.	3C

N040	Open air site, concentration of various stone artefacts associated with calcrete (indicating an old spring).	3C
N047	MSA artefacts (very light scatter, not in association with anything)	Ungraded
N059	Small concentration of LSA flakes, next to river on flood plain. Area has been extensively grazed and trampled by sheep	Ungraded
N062	3 weathered MSA cores. On bank on curve of river	Ungraded
N063	Large flakes. Not very many, down same bank as 062. Lots of cores	Ungraded
L029	Around the koppie from L028, is a small sheltered spot, with some overhanging rocks and some dry stone walling in front. Very small. Only has some OES lying on floor.	Ungraded

Kraals and ruins



Field Number	Description	Significance
N002	Two stone structures, on the lower slopes of the valley, below the cliffs and next to the fields. One is circular and the other rectangular with large opening. Each about 3mx4m in size.	ungraded
N003	Old ? pre-colonial kraal, (circular) low uneven wall, many of the stones have been piled in the middle. It is situated on a low slope on Driefontien in sight of Mr Reynolds Snr house. 1 x prepared core retouched blade (MSA).	ungraded

N004	Very large stone kraal complex opposite the main house (most likely 19C).	3C
N007	Small round pre-colonial kraal approx 10m diameter. It is situated on top of the dolerite ridge (re: N006), in a slight hollow bellow outcroppings. No artefacts were found in association (however see L001 for those found below). Typical of the herder period sites located in the Zeekoei valley and other parts of the Karoo.	3C
N008	Driefontein. The original house was situated opposite the river to the existing homesteads of Driefontein. Most of the house has been demolished and the stones reused. There is still a garage that has been bricked up (however there is no roof). There is a small dam and dipping pens by the river. Up against the ridge are a couple of small kraals. Mr Reynolds Snr stated that the original road to Murraysberg ran past the house.	ungraded
L005, L006 and L007	Right at top of ridge, stone walling along top of cliffs. Mainly placed in gaps in the rocks, and does not project above the ground. There is no back wall, so it is not a kraal. At least 500m in length. No historic or pre-colonial artefacts associated. (Hunting blinds or an attempt to fortify the road during the Boer War.)	3C
L008	A stone cairn (boundary marker) and further stone walling.	3C
L010	Small cave with large kraal (30m x 20m) packed in semi-circle around the front. The walling has two skins and inner rubble. It contains a tiny fragment of blue glass. This is likely to be a shepherds shelter.	3C
L011	Historic stone kraals, also with a small cliff face at the back of the kraal. The kraal is about 40 m long. Similar style of stone walling. Two pieces of ceramic with transfer ware, one is Asiatic Pheasant style	3C
L012	Across the river, on the banks next to a low cliff face (some overhang) a second kraal. Remnants of the wall reach 1 m in height. Also made with two outer skins and inner rubble. The kraal is about 16 m x 25 m in size. No sign of any paintings on the cliff face. No stone artefacts on the floor.	3C
N012	Valley on the Driefontein farm a small way off the Swartkrans Road to the west. N012 is opposite L05-L08 and N014. Is a low rough wall that runs down the ridge, it may have been part of a kraal however there are no other walls.	ungraded
N013	Is above N012 on top of the ridge (but close to the edge). It is a small circular kraal (approx 3m diameter).	3C

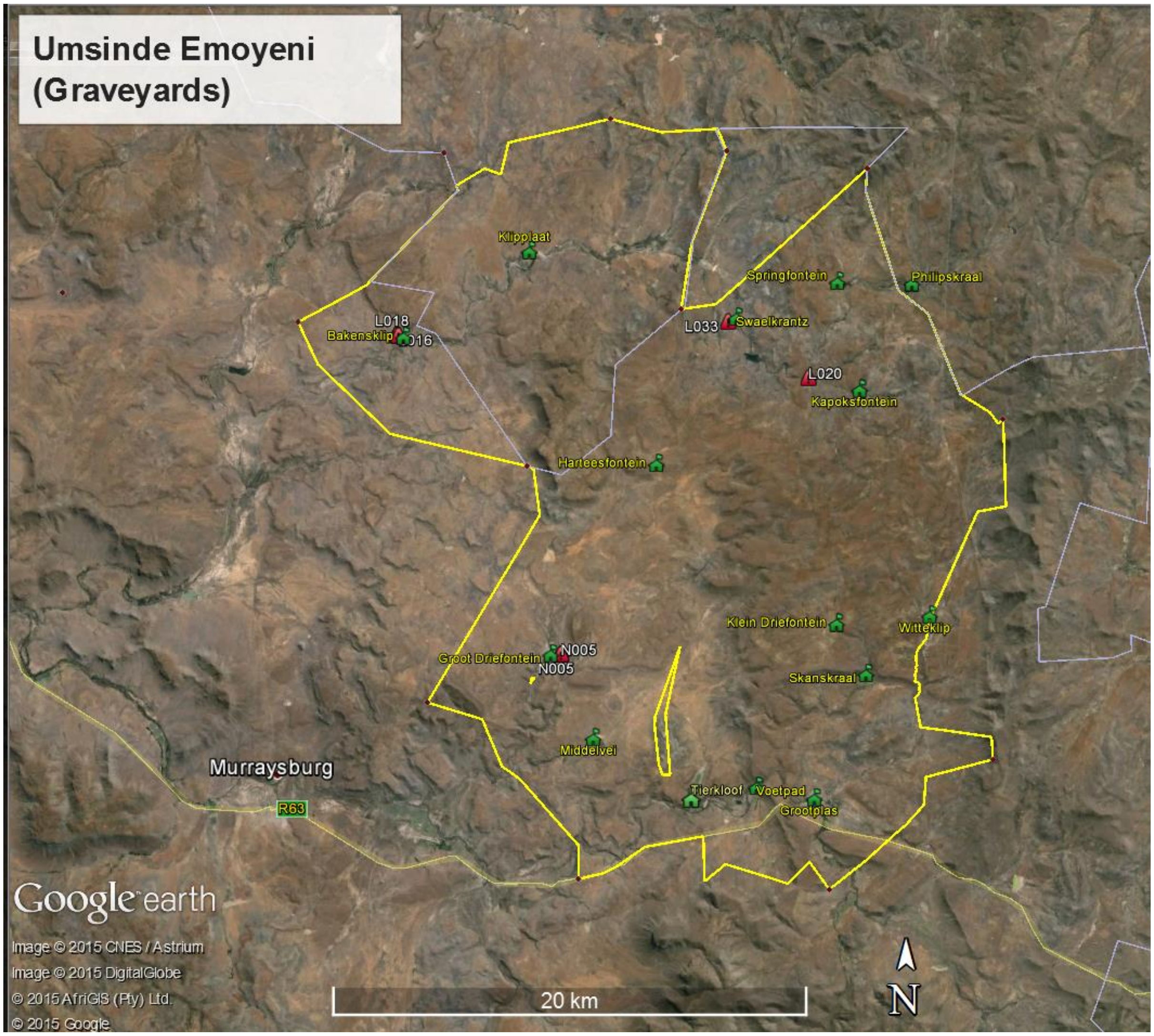
N015	Post 1860 small stone hut, possibly two rooms and a hearth. Found in association was glass, metal and two Martini Henry bullet cases. In the firepit were also the remains of a harmonica. Scattered about were also ceramics and OES. The hut is situated on the floor of a small cluster a dolerite outcrops that form a shelter semi-circle. It is also on top of an older LSA site, as there are freshly flaked hornfels. Close by the hut is a low wall forming two side of a square (against an outcrop) that was likely a kraal.	3C-B
N016	Is opposite L012 across the river and top of the ridge carved out by the river. It is a small ruin. The main part is two rooms (the larger is approx 3 x 4m, and the smaller is $3m^2$). To the river side are two kraals built against the house, the smaller is one straight wall while the other forms a long enclosure that is oval shaped at the ends. The walls are double and approx 50cm thick. There is much ceramic associated with the house including annular ware. The doors, or entrances, are on the north side.	3C
N017	Is a large kraal next to the river beneath a small ridge. It is associated with L013. The walls are thick and made double. It runs most of the length of the ridge. There are more kraals on the other side of the ridge, however the sun was setting and these were unable to be surveyed and recorded at the time.	3C
L019	A complex of stone buildings near the farm house of Klipplaat of Dr Marais. There are at least 2 buildings and 1 kraal on the top of the gorge. The buildings are large, one has a back wall verging on the kloof. One of the building has two “muurkasse”. There are a few fragments of older ceramic and a more recent ash heap.	3C
L021	Overlooking the river and graves, is the ruins of a substantial stone house. The house is about 40 m long and 15 m wide, and contains 2 rooms. There is only a single window overlooking the river, the door and other windows look to the back on the hill (probably more sheltered). The is a stone lintel over the door. The back garden in enclosed in a stone wall. Some pink glass scattered about.	3C
L022	A small workers cottage situated above the stone house. Single room about 10m x 8m.	3C
L023	A second stone workers cottage, 2 roomed.	3C
L024	A third stone worker’s cottage, also with 2 rooms.	3C
L025	An old “trapvloer” – circular are about 13 m in diameter surrounded by upstanding stones. The trapvloer overlooks a terrace area above the river which was probably cultivated in the past.	3C

L028	On top of a small hill, near a bat mast, on farm Middelvlei, is a small stone Kraal (unusual place for kraal?), about 3mx3m, using back of the koppie as the back wall. Almost square, rather than circular. No material associated.	3C
N057	Stone ruins on the farm Haartebeesfontein/Swaelkrans represent remains of the original farm yard. Main farm house was rebuilt in 1950's,	3C
L034	Klein Driefontein. Stone walling around a field on the edge of a river. Part of the walling runs over large black dolerite boulders, some with scratches.	3C
N018	Long stone wall. Very tumbled	ungraded
N020	Stone walling	ungraded
N021	Stone boundary walling; an extensive line. Oral history indicates the walls were built by migrant Xhosas who did the work in exchange for lodgings and food during the frontier wars	3C
N022 & N023	Small pre-colonial kraals below road above dam (Wallis property). Has been very disturbed by the road. Three different sizes, smallest approx 3md. Largest approx 5x5m. Some hornfels flakes. There is a little bit of glass and ceramic associated with the kraals.	ungraded
N024 & 025	Shepherds hut and very large kraal.	3C
N034	Small stone hut next to the road. Possible that it was a kraal but it has been highly disturbed by road which is on a significant slope.	ungraded
N041	Shed with associated ruins.	ungraded
N043	Small stone hut double walls, that were approx 9 x 5m	ungraded
N044	Place on track where a stone ruin and stone wall can be seen approx 200m to the south, we were unable at the time to reach the actual site.	ungraded
N045	Stone beacon (in a square shape, however there were no entrances.)	3C
N048	Small stone 'hut'	3C
N049	Large kraal complex of a least 4 historic stone kraals of various sizes (but all bigger than 8m across). Two of them have small kraals attached to the side.	3C
N050	Small stone ruin	ungraded
N055	Small stone hut that is one room. Small kraal attached to the side. Close to modern dam	3C
N056	Large early colonial stone kraal that uses a large ridge for backing	3C
N057	Small stone two room hut. No kraal. Some ceramics, iron oddments and glass. On top of an LSA site on sandy river banks.	3C

N064	This marks the point of a corner of a structure (kraal). It was on the wide river banks of a ravine beneath a rock cliff. There may be rock art along this river, however time and access restraints meant that we could not search them all.	ungraded

Appendix 3

Grave Yards



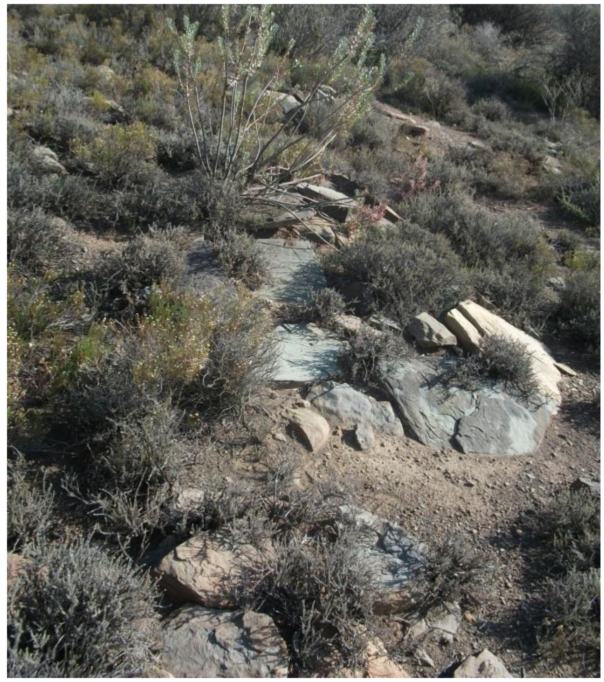
Almost all the graves found in the project area lie within proximity of farm houses. They were all located on the alluvial plains of rivers where the soil was deep enough to bury a body. Generally soil depth is very shallow in the study area. It was unusual to find formal graves with inscriptions – most of those located were very humble graves built from natural materials, often covered with a low mound decorated with pebbles and a simple head and foot stone. One formal graveyard was recorded at Bakensklip.

Field Number	Description	Significance
N005	Large informal graveyard east of Groot Driefontein near workers cottages and below the dam. Site is on alluvial silt of a river bed. Each grave has a headstone and footstone. The graves are covered in flat stones. None of the headstones have any	3A

	names/inscriptions. They probably all date pre-1945. Suggested that there are 80-90 graves. Many graves disturbed by aardvarks.	
L016	A cemetery near the farm house of Bakensklip on the farm Klipplaat in the silty bottom of a gulley. There is a stone wall around the cemetery – size around 12/15m x 15m. The wall which was once elaborate and quite formal is collapsing. There is one large slate headstone with the names of EJC van der Merwe and her 4 children. The oldest burial dates to 1878.	3A
L017-L018	Two rows of graves outside the formal cemetery but a little way down the gulley. The one row has 12 graves and the other has 11. The graves are all similar, with a headstone and footstone, and packed with stones. One had rows of stone which tried to emulate a vault with a large slab on top. None of the graves were marked. Some had been disturbed by aardvarks. Under a cliff face with a rockshelter containing paintings.	3A
L020	At least 3 graves on the sandy banks of the river on the farm Kapoksfontein. They have headstones and footstones and covered with stones but have no inscriptions.	3A
L033	9-10 graves on the farm Swaelkrans, opposite the farm house. They are located on the edge of a large dam. They had headstones and footstones and are covered in flat slabs of rock. They have no inscriptions.	3A

Left: formal grave at Bakensklip.
Above: informal grave close to Groot Driefontein.


TER GEDACHTENIS
VAN MYN
OUDERDOM VAN 40 JAREN
E.H. V.D. MERWE OVERLEDEN OP DEN
21 MEI 1881 IN DEN OUDERDOM
D.P. V.D. MERWE OVERLEDEN OP DEN
23 MEI 1883 IN DEN OUDERDOM
VAN 18 JAREN
C. V.D. MERWE OVERLEDEN OP DEN
IN DEN OUDERDOM
VAN 12 JAREN



Appendix 4 Palaeontology

Palaeontological specialist assessment: combined desktop and field-based reconnaissance study

UMSINDE EMOYENI WIND ENERGY FACILITY NEAR MURRAYSBURG, WESTERN AND NORTHERN CAPE

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EXECUTIVE SUMMARY

The proposed Umsinde Emoyeni WEF project area is largely underlain by Permian fluvial sediments of the Lower Beaufort Group (Karoo Supergroup) that have yielded a wealth of important fossil remains from the Murraysburg region over the past century or more. These include diverse vertebrate fossils of the Late Permian *Cistecephalus* and *Dicynodon* Assemblage Zones such as gorgonopsian, therocephalian and cynodont predators as well as small- to large-bodied herbivorous dicynodonts, among others. Recent palaeontological fieldwork confirms that well-preserved fossils belonging to a range of tetrapod groups are present at the surface in a high proportion of sites where Lower Beaufort Group bedrocks are well-exposed. Other fossil groups represented here include concentrations of medium to large vertebrate burrows, low-diversity invertebrate trace fossils and vascular plant remains (*e.g.* horsetail ferns). The palaeosensitivity of the Umsinde Emoyeni study area is therefore rated as high.

The proposed layouts of wind turbines, access roads and associated infrastructure for the various phases of the Umsinde Emoyeni WEF are mainly concentrated on higher-lying terrain in the central and eastern portions of the study area that are largely underlain by unfossiliferous Karoo dolerite. Only a small proportion of the development footprint will be underlain by potentially fossiliferous Lower Beaufort Group sedimentary bedrocks and older, consolidated alluvium. Substantial impacts on local fossil heritage – conservatively rated as of *medium* (*negative*) significance - may be expected in these more sensitive sectors during the construction phase of the WEF, notably as a result of surface clearance and

excavations for wind turbine footings, hard standing areas and laydown areas, access roads and underground cables. To a large extent, these impacts can be mitigated through pre-construction recording and collection of scientifically valuable fossil material as well as through the application of a chance-finds procedure during development itself. Impact significance following mitigation is rated as *low* (*negative*), and would be partially offset by *positive* impacts as a result of improved understanding of local fossil heritage resources (*i.e.* new palaeontological data and specimens). This assessment applies to all proposed phases and alternative layouts of the WEF as well as the associated transmission line. Obviously, the anticipated impacts will broadly increase in step with the number of wind turbines and length of new access roads and other infrastructure involved. Levels of confidence for the assessment are *medium*, given the unpredictable occurrence of well-preserved fossils as well as uncertainties regarding the levels of sedimentary bedrock exposure within the final development footprint. These uncertainties can be largely resolved through further specialist fieldwork during the pre-construction phase.

The grid application site to the west of the main Umsinde Emoyeni WEF study area is largely underlain by potentially fossiliferous sediments of the Lower Beaufort Group, locally intruded by Karoo dolerite, as well as by substantial areas of Late Caenozoic superficial sediments. Fossil vertebrates of the *Tropidostoma* and *Cistecephalus* Assemblage Zones have been previously recorded here. Surface fossil sites are likely to be less dense than within the main WEF study area because of the more subdued topography - and hence lower bedrock exposure levels - within the western half of the grid application area.

In terms of palaeontological heritage within the Umsinde Emoyeni project area it is recommended that:

- Once the final layout of the WEF and associated transmission line is determined, a pre-construction palaeontological study be undertaken of those limited sectors of the footprint that overlie potentially-fossiliferous sediments (*i.e.* Lower Beaufort Group bedrocks, older consolidated alluvium). The study should be carried out by a suitably qualified palaeontologist and would involve (a) recording of near-surface fossil material, including relevant geological data (*e.g.* stratigraphy, sedimentology, taphonomy), (b) judicious sampling of scientifically-valuable fossils as well as (c) making recommendations regarding further mitigation or conservation of specific fossil sites for the construction phase of the WEF and transmission line.

- 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 the Umsinde Emoyeni 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.

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).

Summary of palaeontological impact significance ratings for the Umsinde Emoyeni WEF

Impact	*Consequence*	*Probability*	*Significance*	*Status*	*Confidence*
Impact 1: Disturbance, damage or destruction of well-preserved fossils at or beneath the ground surface during the construction phase (especially due to bedrock excavations, ground clearance)	High	Possible	**MEDIUM**	–ve	Medium
With Mitigation	Medium	Possible	**LOW**	-ve & +ve	Medium

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 mitigation required before or during the construction phase of the development.

On the basis of the desktop and Phase 1 field assessment studies, the likely impact of the proposed development on local fossil heritage and any need for specialist mitigation are then determined. Adverse palaeontological impacts normally occur during the construction rather than the operational or decommissioning phase. Phase 2 mitigation by a professional palaeontologist – normally involving the recording and sampling of fossil material and associated geological information (*e.g.* sedimentological data) may be required (a) in the pre-construction phase where important fossils are already exposed at or near the land surface and / or (b) during the construction phase when fresh fossiliferous bedrock has been exposed by excavations. To carry out mitigation, the palaeontologist involved will need to apply for 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 desktop study was based on the following:

1. A draft heritage scoping report kindly provided by ACO Associates, Cape Town;
2. A review of the relevant satellite images, scientific literature, including published geological maps and accompanying sheet explanations as well a limited number of desktop and field-based palaeontological assessment studies in the broader study region (*e.g.* Almond 2012, Almond 2014, Rossouw undated desktop report);
3. The author's previous field experience with the formations concerned and their palaeontological heritage;
4. A six-day palaeontological reconnaissance field assessment of the Umsinde Emoyeni WEF project area on 16 – 21 August 2014 by the author and one assistant.

2. GEOLOGICAL CONTEXT

The Umsinde Emoyeni WEF study area to the northeast of Murraysburg comprises scenic hilly and mountainous terrain spanning the Western and Northern Cape boundary (Figs. 1 to 5). The climate is semi-arid and the vegetation is typical karroid *bossieveld* with grasses well represented in doleritic upland areas and trees mainly confined to water courses. Geographically the study area is situated to the north of the R63 Murraysburg to Graafff-Reinet tar road and lies largely between two north-south minor dust roads to Richmond on the west and eastern sides. The Great Escarpment is situated further to the south, at the latitude of Graafff-Reinet, while the more subdued Winterhoekberge escarpment (elevations up to 2070 m amsl) lies just outside the eastern boundary of the study area. Higher mountains within the WEF project area include Trouberg (1654 m amsl) in the west, Vaalkop (1781 m amsl) in the north and Perdekop (1918 m amsl) in the northeast. The area is drained by the Buffelsrivier and its tributaries (*e.g.* Snyderskraalrivier, Bakenskliprivier) in the south and west; these river systems tend to be well-incised as a result of Late Caenozoic crustal uplift. Steeper mountain slopes and plateaux areas are mantled with rocky colluvium (predominantly sandstone, dolerite), with only limited exposure of less resistant mudrocks, while coarse, gravelly as well as fine-grained alluvium is associated with non-perennial water courses.

Fig. 1. View of Trouberg from the south showing several closely-spaced sandstone packages of the Oudeberg Member (Balfour Formation) generating stepped slopes. The uppermost mudrocks probably belong to the succeeding Daggaboersnek Member.

Fig. 2. Good exposure of potentially fossiliferous overbank mudrocks on hillslopes to the south of Swaelkrantz.

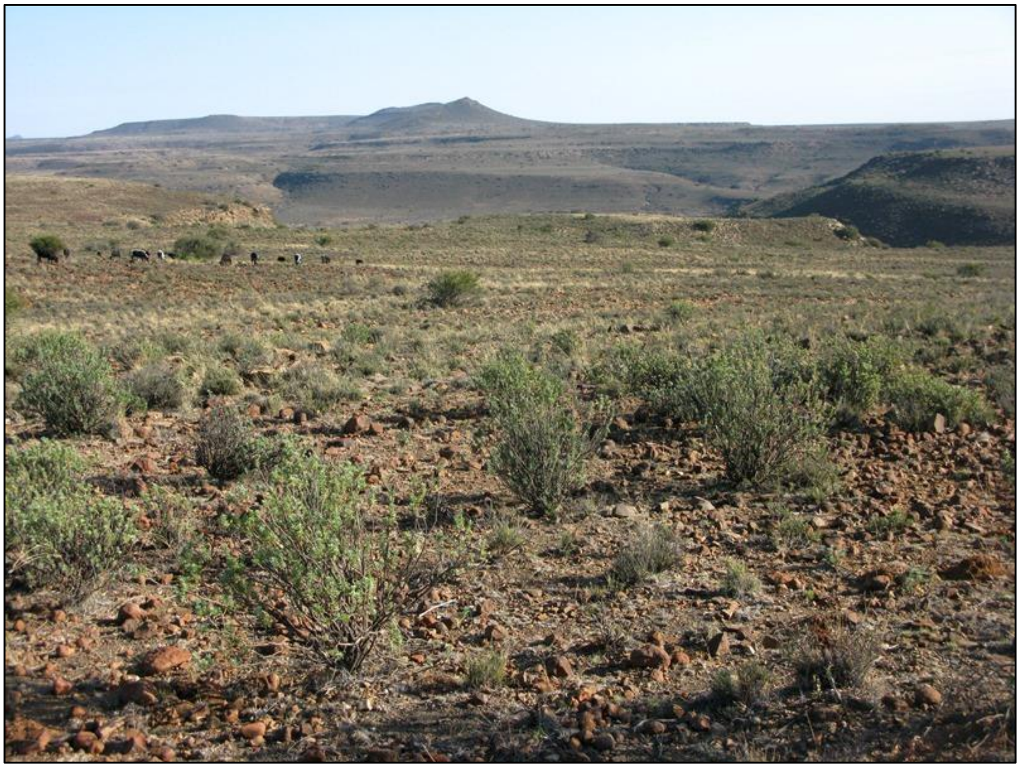


Fig. 3. Rusty-brown surface gravels overlying dolerite bedrocks on Driefontein 26.

Fig. 4. Gentle hillslope exposures of purple-brown overbank mudrocks – ideal for fossil recording and collection, Farm 50 Renosterfontein (Loc. 579).

Fig. 5. Extensive stream bed exposure of Balfour Formation grey-green overbank mudrocks, Farm Portion 7/26 (Loc. 531). This was a key fossil collection locality of the well-known amateur palaeontologist Lex Bremner, while numerous skulls and postcrania still exposed in the stream bed.

The geology of the Umsinde Emoyeni WEF study area near Murraysburg is outlined on the adjoining 1: 250 000 geology sheets 3122 Victoria West and 3124 Middelburg (Le Roux & Keyser 1988, Cole *et al.* 2004) (Fig. 7). The area is largely underlain by Late Permian continental sediments within the upper part of the **Lower Beaufort Group** (**Adelaide Subgroup**, Karoo Supergroup). A useful overview of this internationally famous rock succession has been given by Johnson *et al.* (2006). The study area spans the arbitrary boundary between the **Teekloof Formation** in the west and **Balfour Formation** in the east along longitude 24º E (Fig. 6). The stratigraphically lower-lying, sandstone-rich succession in the study area is assigned to the **Oukoof Member** of the Teekloof Formation in the west and to the **Oudeberg Member** of the Balfour Formation in the east (= "Richmond Sandstone" of Le Roux and Keyser 1988) (Note that the Adelaide Subgroup succession is not differentiated on the Middelburg 1: 250 000 geology sheet). These laterally equivalent members are characterised by several closely-spaced, pale yellow to greyish, medium-grained multi-storey channel sandstones, often with basal channel lag breccio-conglomerates, that are interbedded with grey-green to purple-brown overbank mudrocks (Fig. 1). The sandstone component decreases in importance towards the north, grading laterally into thinly-interbedded mudrock and sandstone horizons. According to Cole *et al.* (2004) the Oudeberg Member to the south of Richmond is 40 m thick and thins towards the east; it is 50 m thick in the Oudeberg Pass, just south of the Middelburg sheet area and NW of Graafff-Reinet.

The upper parts of the Lower Beaufort Group succession consist mainly of mudrocks with few major intercalated sandstone units, generating comparatively smooth hillslopes (Fig. 13). These mudrocks are assigned to the **Steenkampsvlakte Member** and **Daggaboersnek Member** in the west and east respectively (Fig. 6). The latter attains a thickness of 440 m in the southwestern portion of the Middelburg sheet area (Cole *et al.* 2004). A small outlier of the Early Triassic Upper Beaufort Group (Tarkastad Subgroup, TRk) is mapped just outside the eastern boundary of the present study area. Balfour Formation subunits extending across the palaeontologically critical Permo-Triassic boundary can therefore be expected within the study area itself but were not indentified during the present field assessment.

Bedding dips are not indicated on the relevant portions of the Victoria West and Middelburg sheets, indicating that the Beaufort Group succession here is largely flat-lying and undeformed. These Permian sediments are extensively intruded and thermally metamorphosed (baked) by sills and dykes of the Early Jurassic **Karoo Dolerite Suite** (**Jd**) that may be responsible for local disturbance of the original bedding. Dolerite bedrocks predominate in a high proportion of upland sites that have been earmarked for wind turbines.

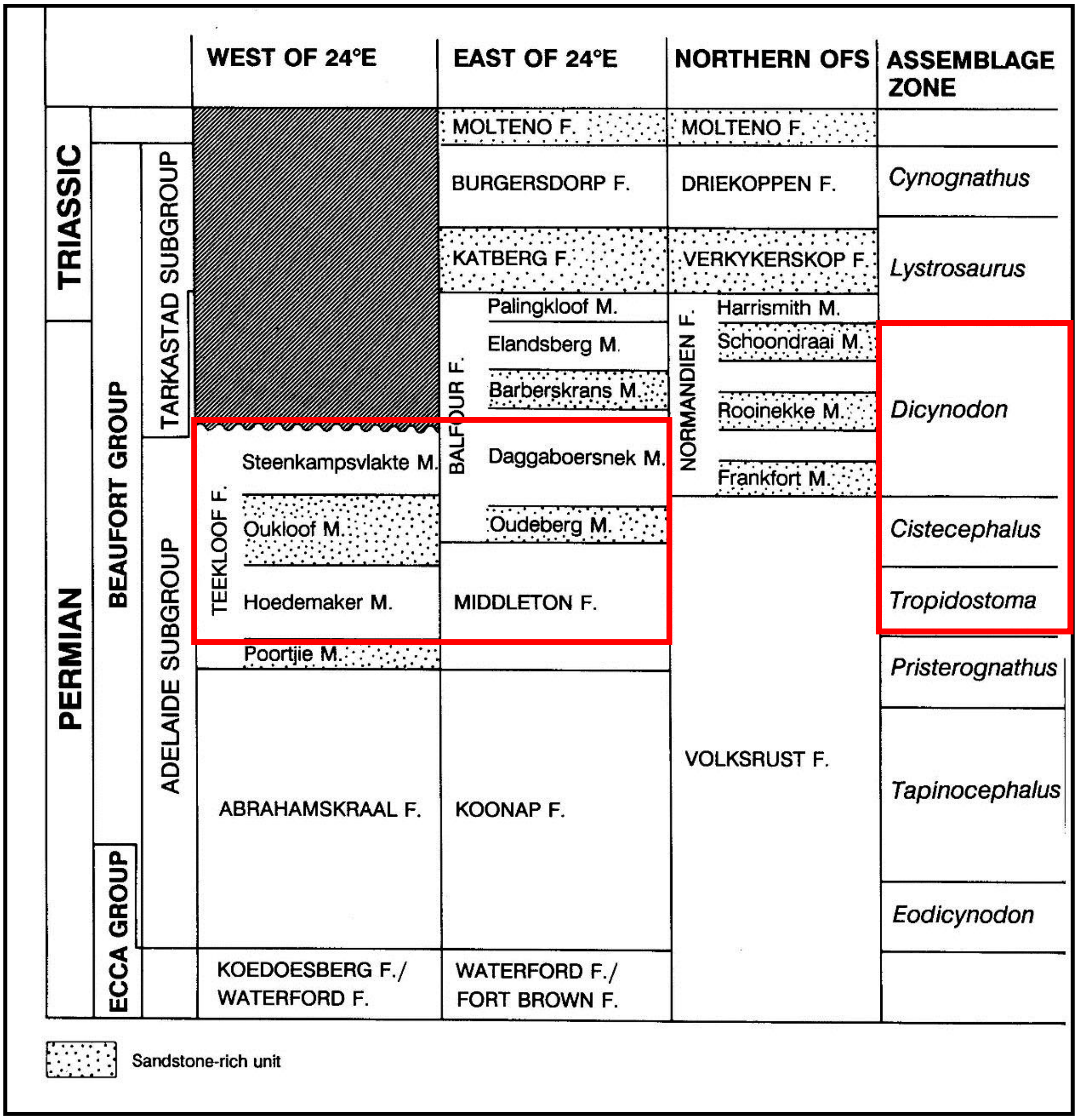


Fig. 6. Chart showing the lithostratigraphic (rock-based) and biostratigraphic (fossil-based) subdivisions of the Beaufort Group with rock units and fossil assemblage zones relevant to the present study outlined in red (Modified from Rubidge 1995). Note that these include subdivisions of the Teekloof and Balfour Formations of the Adelaide Subgroup and range in age from Late Permian to earliest Triassic. Due to insufficient field data, the precise subunits of the Balfour Formation represented in the study area have not yet been determined (See text for discussion). It is quite possible that subunits of the Balfour Formation overlying the Daggaboersnek Member may also be present towards the eastern edge of the study area, for example. Note that the Hoedemaker Member and its associated *Tropidostoma* Assemblage Zone fossils is only represented within the grid application site study area to the west of the main WEF study area.

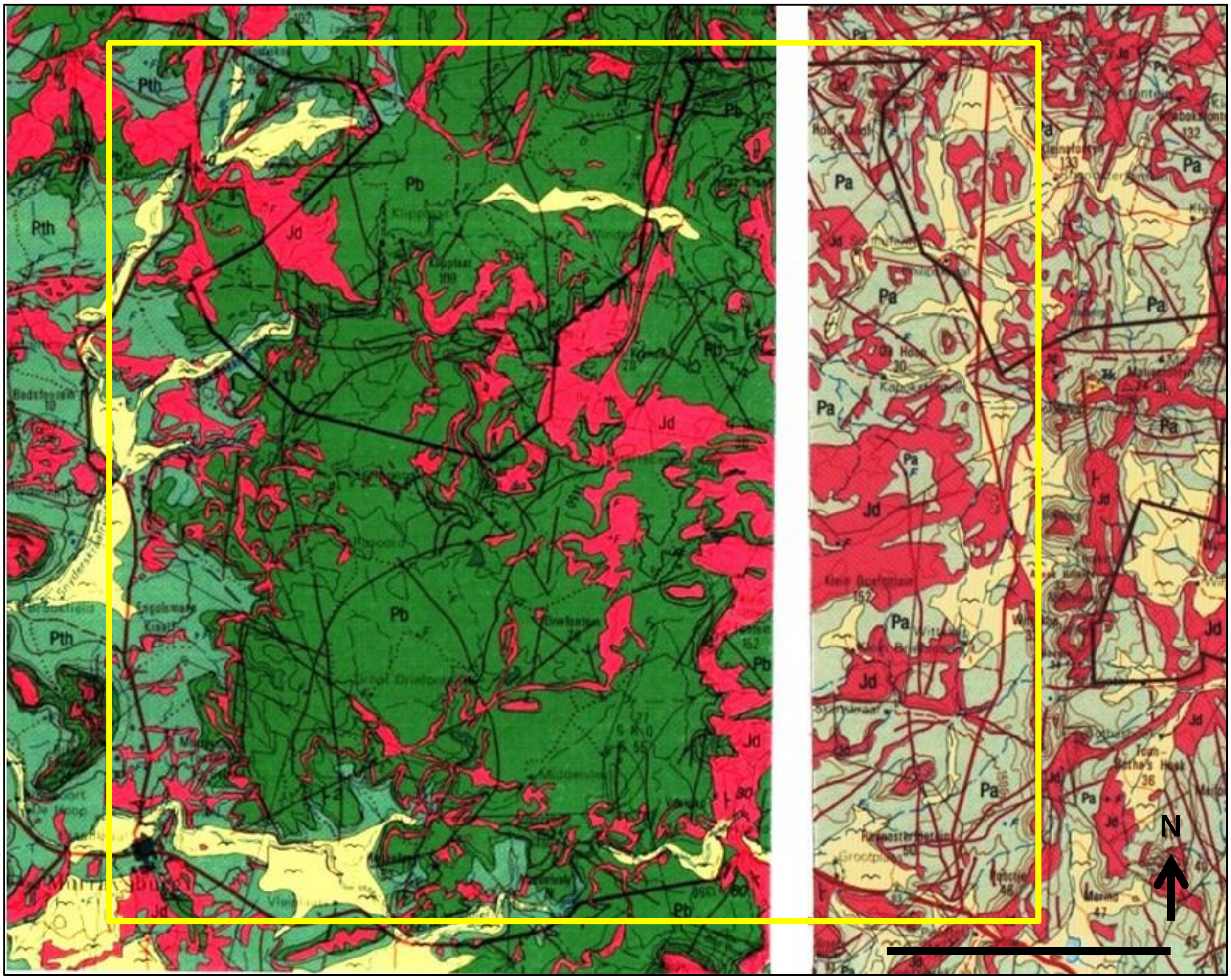


Fig.7. Extracts from adjoining 1: 250 000 geology sheets 3122 Victoria West and 3124 Middelburg (Council for Geoscience, Pretoria) showing the main rock units represented within the Umsinde WEF study area - broadly indicated by the yellow rectangle - to the northeast of Murraysburg, Western and Northern Cape. The black scale bar represents *c*. 10 km.

LOWER BEAUFORT GROUP
Teekloof Formation: Hoedemaker Member (Pth, blue-green)
Balfour Formation (Pb, green)
Adelaide Subgroup (undifferentiated) (Pa, pale blue)
UPPER BEAUFORT GROUP
Tarkastad Subgroup (TRk, yellow)
KAROO DOLERITE SUITE
Jd(pink)
LATE CAENOZOIC ALLUVIUM
Pale yellow with "flying bird" symbol

2.1. Lower Beaufort Group

Geological and palaeoenvironmental analyses of the Lower Beaufort Group sediments in the 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, 1987, 1988, 1989, 1990, 1993a, 1993b) and Stear (1978, 1980), as well as several informative field guides (*e.g.* Smith *et al.* 1998, Cole & Smith 2008). In brief, these thick 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 within the Late Permian Period (*c*. 265-252 Ma). Sinuous sandstone bodies of lenticular cross-section represent ancient channel infills, while thin (< 1.5 m), laterally-extensive sandstone beds were deposited by crevasse splays during occasional overbank floods. The bulk of the Beaufort sediments are greyish-green to reddish-brown or purplish mudrocks ("mudstones" = fine-grained claystones and slightly coarser siltstones) that were deposited over the floodplains during major floods. Thin-bedded, fine-grained playa lake deposits also accumulated locally where water ponded-up in floodplain depressions and are associated with distinctive fossil assemblages (*e.g.* fish, amphibians, coprolites or fossil droppings, arthropod, vertebrate and other trace fossils).

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

Due to the absence of unambiguous sandstone marker horizons, the Adelaide Subgroup is not subdivided into individual formations or members on the 3124 Middelburg sheet but these subdivisions are discussed in the accompanying sheet explanation by Cole *et al.* (2004). It is apparent from lithostratigraphic (*i.e.* rock-based) as well as biostratigraphic (*i.e.* fossil-based) mapping, however, that Late Permian to Early Triassic portions of the Adelaide Subgroup are present within the present study area, corresponding to the *Cistecephalus* and *Dicynodon* Assemblage Zones (Kitching 1977, Keyser & Smith 1979, Rubidge 2005, Van der Walt *et al.* 2010, Smith *et al.* 2012) (Figs. 20 & 21). The succession here is therefore broadly equivalent to most of or perhaps the entire **Balfour Formation** that is recognised at the top of the Adelaide Subgroup succession within the Main Karoo Basin to the east of 24º East (Rubidge 1995) (Fig. 6). The Balfour Formation has been subdivided into five successive lithostratigraphic subunits or members. These members are not separately mapped on the 1: 250 000 scale geological maps, however (Fig. 7), but they are briefly described for the Middelburg sheet area by Cole *et al.* (2004). Members within the Balfour Formation that are recognised within the main body of the Umsinde Emoyeni WEF study area have been discussed above.

The fluvial Balfour Formation comprises recessive weathering, grey to greenish-grey or purple-brown overbank mudrocks with subordinate resistant-weathering, grey, fine-grained channel sandstones deposited by large meandering river systems in the Late Permian to Earliest Triassic Period (Hill 1993, Cole *et al.* 2004) (Figs. 8 to 13). The formation reaches a maximum thickness of over 2000 m in the Fort Beaufort area but is only 650 m near Graafff-Reinet (Johnson 1976, Visser & Dukas 1979). Thin wave-rippled siltstones and sandstones were laid down in transient playa lakes on the flood plain (Fig. 11). Reddish mudrocks are comparatively rare, but increase in abundance towards the top of the Adelaide Subgroup succession near the upper contact with the Katberg Formation (Fig. 13). Key recent reviews of the Balfour Formation fluvial succession have been given by Visser and Dukas (1979), Catuneanu and Elango (2001), Katemaunzanga (2009) and Oghenekome (2012). Catuneanu and Elango (2001) identified six upward-fining depositional sequences within the Balfour succession that are separated by subaerial unconformities and lasted on average about 0.7 Ma (million years). The sequences were generated by tectonic processes within the Cape Fold Belt. Fluvial deposition by sandy braided rivers in the early part of each sequence was followed by more mixed channel sandstones and overbank mudrocks laid down by meandering rivers higher in the sequence. Sedimentological data, such as the comparative rarity of palaeosols (fossil soils, desiccation cracks, red beds), suggest that palaeoclimates during this period were predominantly temperate to humid and water tables were generally high, at least in the more eastern outcrop areas. In more western outcrop areas, including the present study area, pedogenic calcretes are commonly well-developed.

Fig. 8. Stream bank exposure of purple-brown and grey-green overbank mudrocks of the Lower Beaufort Group showing thin crevasse-splay sandstones and ferruginous pedocrete horizons (Loc. 510) (Hammer = 30 cm).

Fig. 9. Section through a lenticular, multi-storey channel sandstone exposed in a stream bank on Farm 50 Renosterfontein (Loc. 577)

Fig. 10. Horizontally-laminated channel sandstone with a thin, pebbly channel lag breccio-conglomerate at the base (Loc. 578) (Hammer = 30 cm).

Fig. 11. Stream bank section through thinly-bedded, markedly tabular, purple-brown siltstones deposited on the distal floodplain, possibly in a playa lake (Loc. 568) (Hammer = 30 cm).

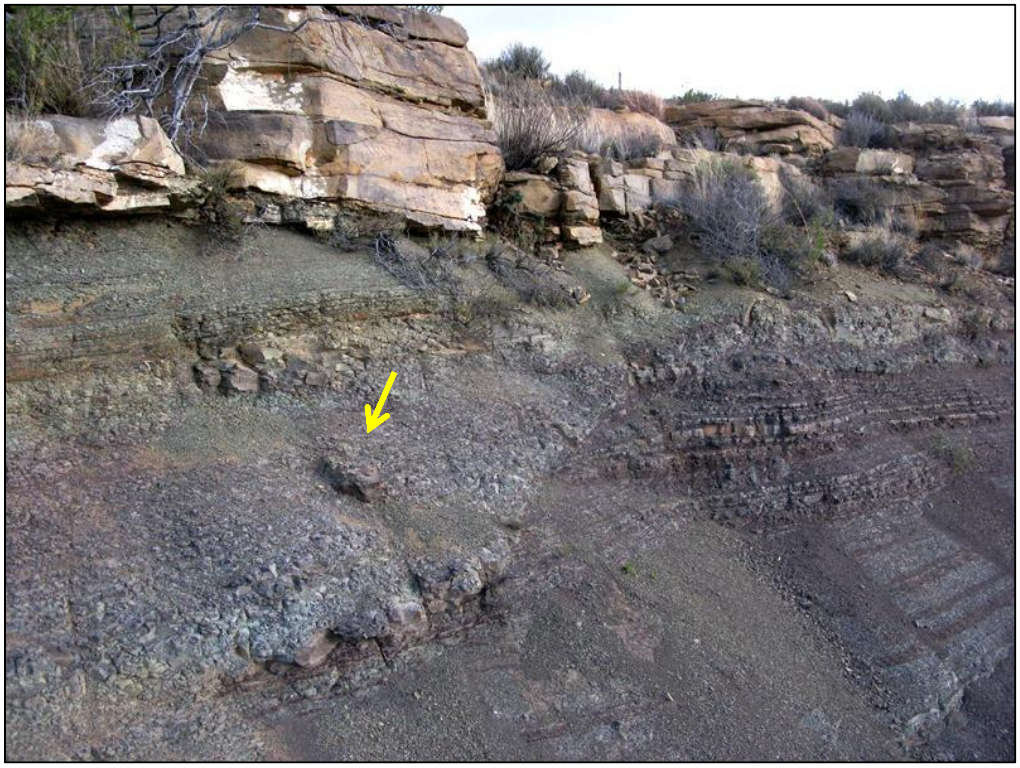


Fig. 12. Road cutting on the Rooikranshoogte Pass where thin-bedded floodplain mudrocks show evidence of deep erosional incision and are capped by a channel sandstone (Loc. 584). The arrowed structure is a probable vertebrate burrow cast.

Fig. 13. Excellent hillslope exposures of purplish overbank mudrocks of the *Dicynodon* Assemblage Zone (Loc. 560). Several tetrapod fossils are exposed on these slopes.

2.2. Karoo Dolerite Suite

Numerous sills and dykes of Karoo dolerite intruding the continental sediments of the Adelaide Subgroup are mapped in the Umsinde Emoyeni WEF study area (Cole *et al.* 2004, Duncan & Marsh 2006) (Fig. 7 & 14). These igneous rocks were not examined extensively during fieldwork because because they are unfossiliferous. Excellent exposures of the contact between intrusive, columnar-jointed dolerite and baked country rocks of the Balfour Formation can be seen in river banks on De Hoop 30 (Loc. 520; Fig. 15) as well as in road cuttings along the Richmond dust road to the east of the study area (Loc. 582).

2.3. Late Caenozoic superficial deposits

A wide range of superficial sediments overlie the Palaeozoic and Mesozoic bedrocks in the present study area. They include coarse, gravelly alluvium as well as finer-grained alluvial deposits associated with water courses and low-lying areas, pan sediments, pedocretes (*e.g.* calcrete) and colluvial deposits on hillslopes (*e.g.* scree, hillwash, debrites) (Figs. 16 to 19). These younger superficial sediments were only briefly examined for fossil remains since their palaeosensitivity (with the exception of older consolidated alluvium) is generally low.

Fig. 14. Major NNW-SSE trending dolerite dyke eroding out as a prominent ridge crossing the Richmond dust road on the eastern side of the study area (Loc. 582a). Note also theflat-topped Karoo *koppie* capped by a dolerite sill in the background.

Fig. 15. Contact between rusty brown intrusive dolerite and paler baked country rocks of the Balfour Formation, De Hoop 30 (Loc. 520).

Fig. 16. Mantle of blocky sandstone scree wasting down from a channel sandstone of the Lower Beaufort group, Farm 109 Klipplaat.

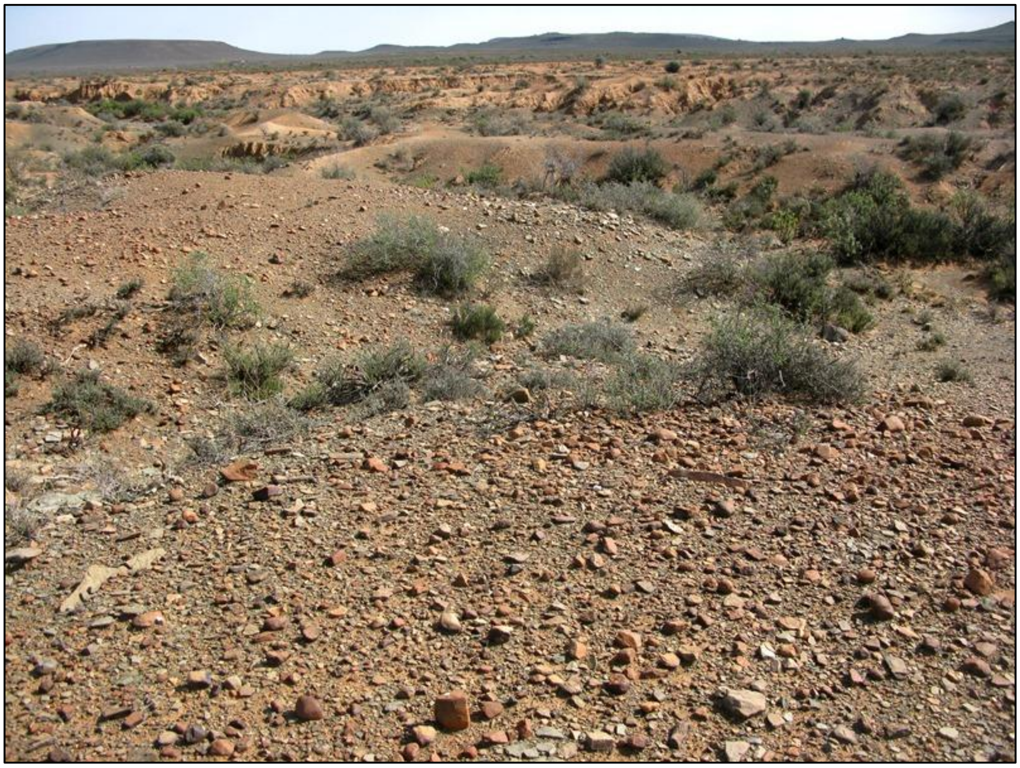


Fig. 17. Extensive orange- or brown-hued older alluvial deposits (possibly Late Pleistocene) exposed by donga erosion and mantled by surface gravels, Farm Portion 7/26.

Fig. 18. Stream bank section through coarse older alluvial gravels (locally calcretised and with probable Acheulian stone artefacts) beneath finer-grained younger alluvial deposits, Farm Portion 7/26 (Loc. 542) (Hammer = 30 cm).

Fig. 19. River bank section through pale brown, calcretised older alluvium with gravel lenses (locally containing reworked bone) overlain by unconsolidated, fine-grained younger alluvium, Driefontein 26 (Loc.508).

3. PALAEONTOLOGICAL HERITAGE

In this section of the report the previously known, as well as recently recorded, fossil heritage resources within the main rock units that are represented within the Umsinde Emoyeni WEF study area are outlined.

3.1. Fossils within the Lower Beaufort Group

The overall palaeontological sensitivity of the Beaufort Group sediments in the Main Karoo Basin of South Africa is high (Rubidge 1995, Rubidge 2005, Almond *et al*. 2008, Smith *et al.* 2012). 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. A chronological series of mappable fossil biozones or assemblage zones (AZ), defined mainly on their characteristic tetrapod faunas, has been established for the Main Karoo Basin of South Africa (Rubidge 1995, 2005). Maps showing the distribution of the Beaufort Group assemblage zones within the Main Karoo Basin have been provided by Kitching (1977), Keyser and Smith (1977-78), Rubidge (1995) and Van der Walt *et al* (2010) (Figs. 20 & 21). The 1: 250 000 geological maps as well as a recently updated biozone map based on a comprehensive GIS fossil database (Van der Walt *et al.* 2010) suggest that two Permo-Triassic vertebrate-based biozones are represented within the Umsinde Emoyeni WEF study region near Murraysburg, *viz.* the *Cistecephalus* Assemblage Zone at lower elevations and following *Dicynodon* Assemblage at higher elevations (Fig. 6). A number of known *Cistecephalus* and *Dicynodon* AZ vertebrate fossil sites in the Murraysburg region are shown on the map presented by Kitching (1977) (Fig. 20). A recent compilation map of known fossil vertebrate sites from the Beaufort Group of the Main Karoo Basin by Nicolas (2007) also indicates a concentration of fossil sites to the northwest of Middelburg (Fig. 24) (See also recent field-based palaeontological assessment studies in the Murraysburg region by Almond 2012, 2014).

As a consequence of their proximity to large dolerite intrusions, the Beaufort Group sediments in parts of the study area have been thermally metamorphosed or “baked” (*i.e*. recrystallised, impregnated with secondary minerals). Calcrete concretions within the thermal aureole are secondarily ferruginised. Embedded fossil material of phosphatic composition, such as bones and teeth, is frequently altered by baking – bones may become blackened or whitened and porcellanous, for example - and can be very difficult to extract from the hard matrix by mechanical preparation (Smith & Keyser *in* Rubidge 1995). Thermal metamorphism by dolerite intrusions therefore tends to reduce the palaeontological heritage potential of Beaufort Group sediments.

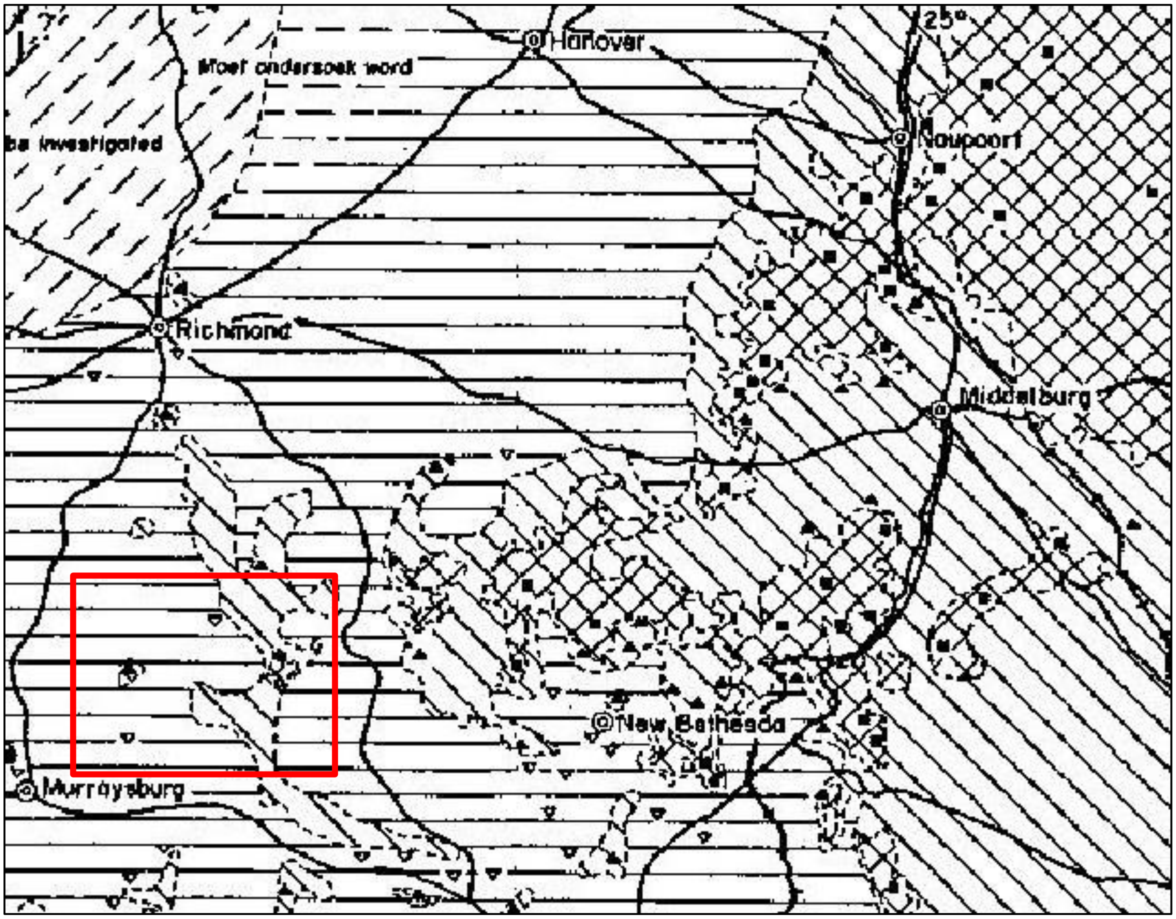


Fig. 20. Early fossil zonation map of the Middelburg – Richmond region showing the occurrence of several fossil localities in the broader Umsinde Emoyeni WEF study area area to the northeast of Murraysburg (red rectangle). Horizontally-lined areas with open triangles are referred to the Late Permian *Cistecephalus* Assemblage Zone, covering the majority of the WEF study area, especially at lower elevations. Obliquely-hatched areas with black triangles belong to the succeeding *Dicynodon* Assemblage Zone of Latest Permian to earliest Triassic age. They include the higher-lying N-S region in the eastern half of the study area as well as some elevated outliers, such as the summit of Trouberg. The Winterhoekberge escarpment to the east of the study area is capped by sediments of the Early Triassic *Lystrosaurus* AZ (Katberg Formation; cross-hatched with black squares) (Figure modified from Karoo biozonation map of Kitching 1977).

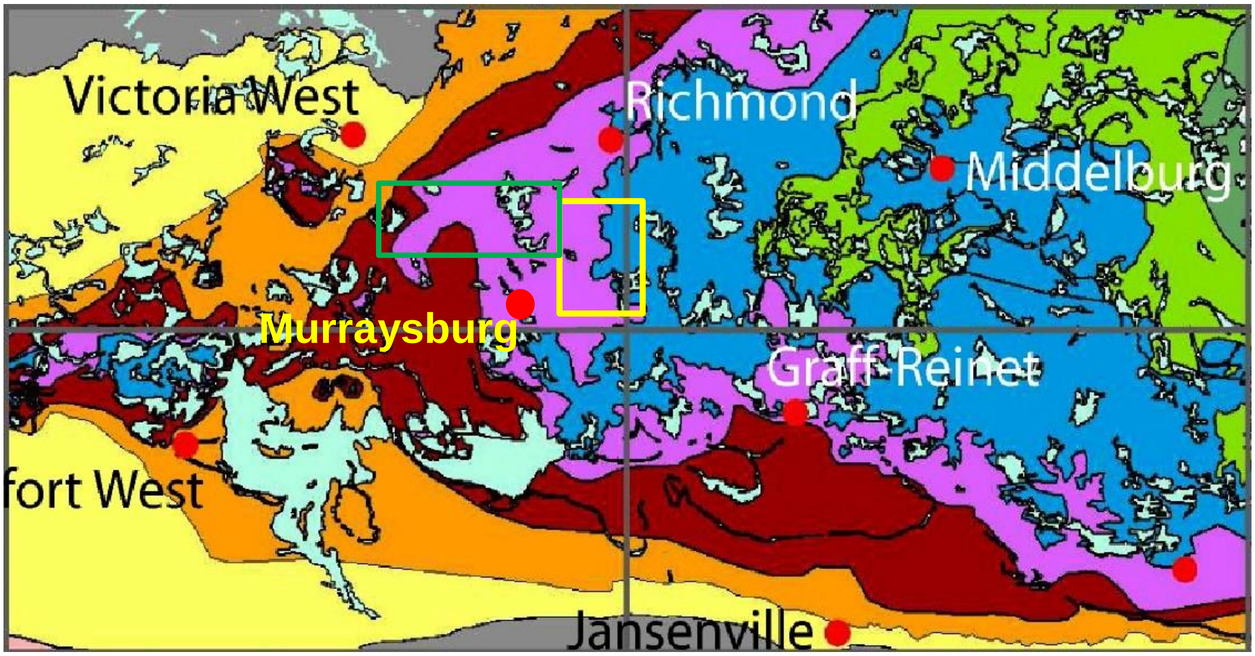


Fig. 21. Extract from the latest fossil biozonation map for the Main Karoo Basin (Van der Walt *et al.* 2010) showing the approximate location of the Umsinde Emoyeni WEF study area NE of Murraysburg (yellow rectangle). The biozones represented here include the Late Permian *Cistecephalus* AZ (purple) in the west and the *Dicynodon* AZ (blue) towards the east, with the Early Triassic *Lystrosaurus* (pale green) AZ occurring outside and to the east of the study area. The green rectangle indicates fossil assemblages of the *Tropidostoma* AZ (dark brown) and *Cistecephalus* AZ (purple) within the grid connection application area to the west of the WEF.

3.1.1. Cistecephalus Assemblage Zone

The sandstone-rich Oudeberg Member at the base of the Balfour Formation is characterised by fossil tetrapods of the *Cistecephalus* Assemblage Zone (= upper *Cistecephalus* Biozone or *Aulacephalodon-Cistecephalus* Assemblage Zone of earlier authors) (Fig. 6). These rich fossil vertebrate assemblages are assigned to the Late Permian (Wuchiapingian). The following major categories of fossils might be expected within *Cistecephalus* AZ sediments in the study area (Kitching 1977, Keyser & Smith 1977-78, Anderson & Anderson 1985, Smith & Keyser 1995, MacRae 1999, Cole *et al*., 2004, Rubidge *et. al.* 1995, 2005, Smith *et al.* 2012):

• isolated petrified bones as well as rare articulated skeletons of terrestrial vertebrates (tetrapods) such as true reptiles (*e.g.* large herbivorous pareiasaurs like *Pareiasaurus*, small insectivorous owenettids) and therapsids or "mammal-like reptiles" (*e.g.* diverse herbivorous dicynodonts, notably

Cistecephalus, *Oudenodon* and *Aulacephalodon*, a wide range of flesh-eating gorgonopsians such as *Lycaenops*, and insectivorous therocephalians like *Ictidosuchoides*) (Fig. 22).

- aquatic vertebrates such as large temnospondyl amphibians (*Rhinesuchus*, usually disarticulated), and palaeoniscoid bony fish (*Atherstonia*, *Namaichthys*) - these are often represented by scattered scales rather than intact fish.
- freshwater bivalves (*Palaeomutela*).
- trace fossils such as worm, arthropod and tetrapod burrows and trackways (*e.g.* of the large dicynodont *Aulacephalodon*), coprolites (fossil droppings), plant roots.
- vascular plant remains including leaves, twigs, roots and silicified woods ("*Dadoxylon*") of the *Glossopteris* Flora, especially glossopterid trees and arthrophytes (horsetails). Plant remains are usually sparse and fragmentary.

Authoritative lists of vertebrate genera and species recorded so far from the *Cistecephalus* Assemblage Zone are given by Smith and Keyser (1995) as well as Smith *et al.* (2012). Faunal lists for fossil sites in the Victoria West and Murraysburg map areas are given by Kitching (1977). The marked increase in fossils of the small dicynodont *Cistecephalus* at the top of the AZ in the Victoria West area and elsewhere is noted by these authors. Vertebrate fossils recorded in the Oudeberg Member in particular include the dicynodont genera *Cistecephalus* (the commonest form), *Aulacephalodon* and *Oudenodon* (Le Roux & Keyser 1988).

As far as the biostratigraphically important tetrapod remains are concerned, the best fossil material is generally found within overbank mudrocks. In contrast, fossils preserved within channel sandstones (*e.g.* channel lag breccio-conglomerates of reworked mudflakes and calcrete nodules) tend to be fragmentary and water-worn (Smith & Keyser 1995, Smith 1993). Many fossils are found in association with ancient soils (palaeosol horizons) that can usually be recognised by bedding-parallel concentrations of calcrete nodules. The fossil bones are isolated and disarticulated for the most part, and are typically permineralised and encrusted in a mantle of calcrete (often brown-weathering). Fossil bone embedded in mudrocks adjacent to major dolerite intrusions may be modified by thermal metamorphism; for example, bones in the Graafff-Reinet District may acquire a smooth, white "porcellanite" pallor, while bones recorded near Bedford may be black (Smith & Keyser 1995).

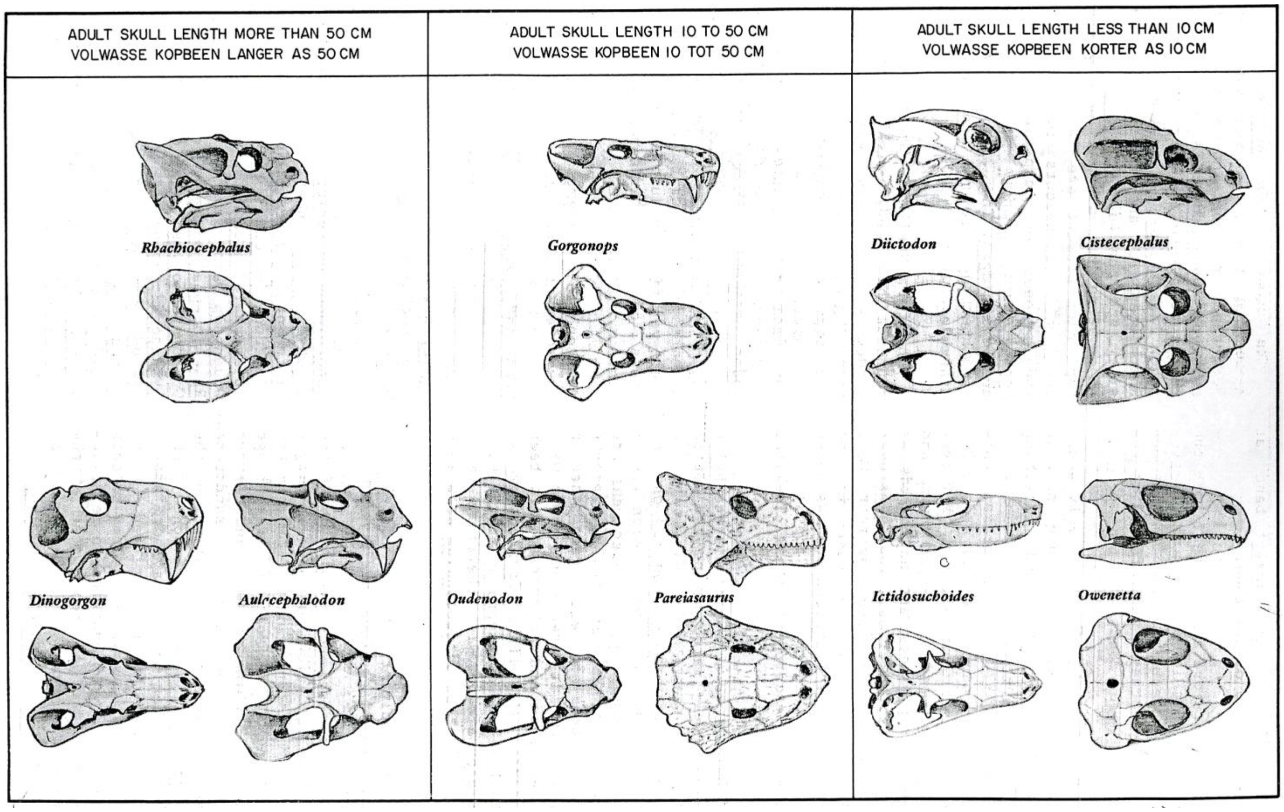


Fig. 22. Skulls of characteristic fossil vertebrates from the *Cistecephalus* Assemblage Zone (From Keyser & Smith 1979). *Pareiasaurus,* a large herbivore, and *Owenetta*, a small insectivore, are true reptiles. The remainder are therapsids or "mammal-like reptiles". Of these, *Gorgonops* and *Dinogorgon* are large flesh-eating gorgonopsians, *Ictidosuchoides* is an insectivorous therocephalian, while the remainder are small- to large-bodied herbivorous dicynodonts.

3.1.2. Dicynodon Assemblage Zone

The upper portion of Balfour Formation sediments directly overlying the Oudeberg Member is characterised by Late Permian fossil biotas of the ***Dicynodon* Assemblage Zone** (Fig. **). This biozone has been assigned to the Changhsingian Stage (= Late Tartarian) right at the end of the Permian Period, with an approximate age range of 253.8-251.4 million years (Rubidge 1995, 2005; *N.B.* Smith *et al.* 2012 refer the biozone to the Wuchiapingian and Changhsingian Stages). Good accounts, with detailed faunal lists, of the fossil biotas of the *Dicynodon* Assemblage Zone have been given by Kitching (*in* Rubidge 1995), Cole *et al*. (2004) and Smith *et al.* (2012). See also the reviews by Cluver (1978), MacRae (1999) and McCarthy & Rubidge (2005) as well as recent papers on Permo-Triassic boundary tetrapod faunas of the Main Karoo Basin by Smith and Botha (2005) as well as Botha and Smith (2006, 2007). In general, the following broad categories of fossils might be expected within the Balfour Formation near Murraysburg:

- isolated petrified bones as well as articulated skeletons of terrestrial vertebrates such as true **reptiles** (notably large pareiasaurs, small millerettids) and **therapsids** (diverse dicynodonts such as *Aulacephalodon*, *Oudenodon*, *Dicynodon* and the much smaller *Diictodon*, gorgonopsians, therocephalians such as *Theriognathus*, primitive cynodonts like *Procynosuchus*, and biarmosuchians) (Fig. 23).
- aquatic vertebrates such as large temnospondyl **amphibians** like *Rhinesuchus* (usually disarticulated), and palaeoniscoid **bony fish** (*Atherstonia*, *Namaichthys*).
- freshwater **bivalves**.
- **trace fossils** such as worm, arthropod and tetrapod burrows and trackways, coprolites.
- **vascular plant remains** including leaves, twigs, roots and petrified woods ("*Dadoxylon*") of the *Glossopteris* Flora (usually sparse, fragmentary), especially glossopterids and arthrophytes (horsetails).

From a palaeontological viewpoint, these diverse *Dicynodon* Assemblage Zone biotas are of extraordinary interest in that they provide some of the best available evidence for the last flowering of ecologically-complex terrestrial ecosystems immediately preceding the catastrophic end-Permian mass extinction (*e.g.* Smith & Ward, 2001, Rubidge 2005, Retallack *et al*., 2006, Smith & Botha 2005, Botha & Smith 2006, 2007). The faunal turnover at the Permian – Triassic boundary, which has been identified within the Palingkloof Member of the Balfour Formation, is discussed in some detail by Smith and Botha (2005), Botha and Smith (2007) as well as more recently by Smith *et al.* (2012).

As far as the biostratigraphically important tetrapod remains are concerned, the best fossil material is generally found within overbank mudrocks, whereas fossils preserved within channel sandstones tend to be fragmentary and water-worn (Rubidge 1995, Smith 1993). Many fossils are found in association with ancient soils (palaeosol horizons) that can usually be recognised by bedding-parallel concentrations of calcrete nodules. The abundance and variety of fossils within the *Dicynodon* Assemblage Zone decreases towards the top of the succession (Cole *et al*., 2004).

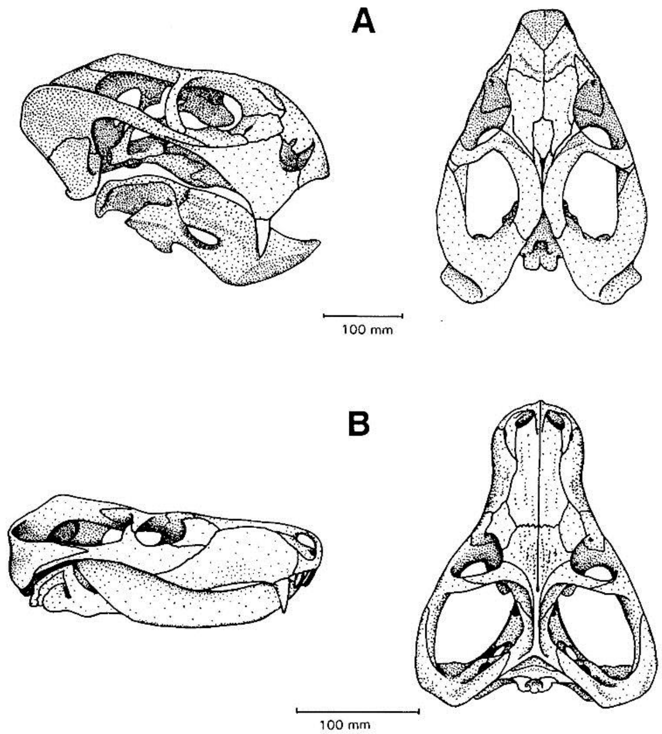


Fig. 23. Skulls of key therapsids ("mammal-like reptiles") from the Late Permian *Dicynodon* Assemblage Zone: the medium-sized dicynodont *Dicynodon* and the therocephalian *Theriognathus* (From Kitching *in* Rubidge 1995).

As is clear from the map of Beaufort Group fossil vertebrate sites produced by Nicolas (2007), the Murraysburg area is unusally rich in fossil remains (Fig. 24). Smith & Keyser (1995, p. 27) suggested that the Murraysburg Townlands and the area to the southeast of Murraysburg could be regarded as reference localities for the *Cistecephalus* Assemblage Zone. The present study area includes important collection sites of the well-known C20 amateur palaeontologist Lex Bremner whose fossil collection is now housed in Graafff-Reinet and Iziko Museums, Cape Town. Numerous other academic palaeontologists have collected fossils in the area. Farms on which fossil collections of the *Cistecephalus* (=*Daptocephalus*) and *Dicynodon* AZ were made are also listed by Kitching (1977); several of these have been listed in the recent historical account of Murraysburg by Malherbe *et al.* (2011). Recent borrow pit PIAs by Almond (2012, 2014) have reported high concentrations of well-preserved vertebrate remains within the present study area. Interested local people are well aware of, and value, the numerous vertebrate fossils found at surface in the area (See Acknowledgments) and some of these have already been informally collected and are currently in private hands (*e.g.* the complete gorgonopsian skull shown in Fig. 32).

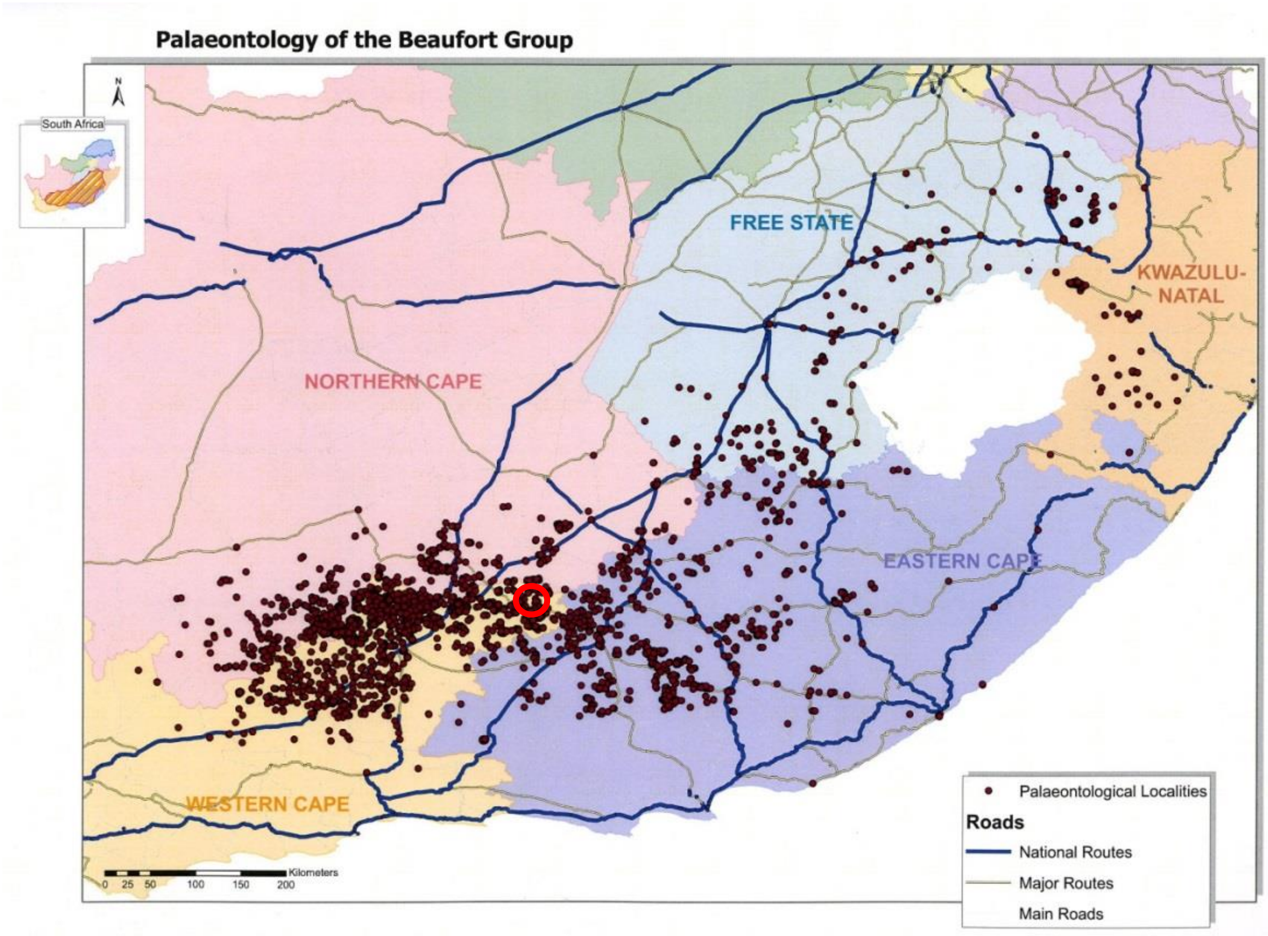


Fig. 24. Distribution of recorded fossil vertebrate localities within the Beaufort Group (Main Karoo Basin) showing the concentration of sites around Murraysburg (red circle) and to the west (Map abstracted from Nicolas 2007).

3.1.3. Lower Beaufort Group fossils in the Umsinde Emoyeni WEF study area

A brief, illustrated account of new fossil material recorded within the study area during our recent palaeontological reconnaissance survey is given here. GPS locality data for all fossil sites is provided separately in the Appendix to this report (*Not* for publication).

Palaeontological fieldwork during the six-day field assessment of the Umsinde Emoyeni WEF study area focussed mainly on the examination of selected overbank mudrock exposures of the Lower Beaufort Group since this where the majority of the fossil vertebrate material is generally preserved and found. These sites include natural exposures on hillslopes, in erosion gullies and along stream and riverbanks as well as artificial exposures in road cuttings, borrow pits and farm dams. Given the considerable size of the study area, it was only feasible to examine some of the numerous land parcels involved and a very small sample of the potentially fossiliferous sites within them. The principal localities visited and fossils observed are listed in the Appendix. Please note that fossil sites are *not* explicitly mapped in this report. This is for conservation reasons and also because mapping might give the very misleading impression that areas between known sites are fossil-free, which is *far from being the case*. In general, recent fieldwork has reinforced the impression gained from the preceding palaeontological heritage desktop analysis that the study area near Murraysburg area is indeed unusually rich in Late Permian fossil vertebrate remains, as well as associated trace fossils such as vertebrate burrows. Where extensive mudrock exposures are available, fossils can generally be found, occasionally in comparatively high concentrations (*e.g.* sites shown in Figs. 5 & 13). Due to low levels of tectonic deformation (*e.g.* cleavage development) and weathering, the preservation of the fossils is often good, so many specimens are identifiable and may well be of research value. Nevertheless, well-preserved and well-articulated vertebrate fossil remains are always rare, while their distribution is largely unpredictable on the scale of this project.

Vertebrate fossils of the *Cistecephalus* Assemblage Zone were recorded during this study within the sandstone-rich package of the Balfour Formation known as the Oudeberg Member, while slightly younger *Dicynodon* Assemblage Zone fossils were also recorded from the overlying mudrock-rich package of the Daggaboersnek Member (Fig. 6). The detailed mapping of the various members of the Balfour Formation in the study area and their fossils would require considerable additional fieldwork that lies outside the scope of the present palaeontological heritage assessment.

Late Permian vertebrate fossil remains were recorded from two main preservational settings:

- Transported, usually fragmentary and disarticulated, bones and teeth within channel or crevasse splay sandstones (Fig. 25) as well as – more commonly – within basal channel lag breccio-conglomerates in association with reworked calcrete glaebules and mudrock intraclasts) (Fig. 26).

- Disarticulated to semi- or well-articulated skeletal remains embedded within overbank mudrocks. Specimens include several well-preserved skulls of small to large-bodied therapsids (“mammal-like reptiles”) such as cynodonts, therocephalians, gorgonopsians and dicynodonts (Figs. 27 to 37). These fossils often occur in association with, and partially encased by, pedogenic calcrete concretions representing ancient soils on the semi-arid Late Permian floodplain. The fossils are variously found partially enclosed by the mudrock or calcrete matrix, fully-exposed by natural weathering, or as downwasted or transported material at the land surface. Secondary baking within the thermal aureole of dolerite intrusions has imparted a white, porcellanous appearance to some fossil remains (Figs. 30).

In addition to the vertebrate skeletal remains, other fossil groups of note from the study area include:

- Sparse to locally-concentrated moulds of vascular plants, principally the stems of sphenophytes (horsetails) and other reedy plants (Fig. 43). Transported woody stems and twigs within channel sandstones may show preferential current orientation (Loc. 553). No petrified wood material was recorded during this study, although it may well be present here, for example in association with basal channel sandstones or reworked into alluvial or surface gravels (*cf* Almond 2014b).

- Low diversity invertebrate trace fossil assemblages, such as the horizontal burrows preserved on the sole surfaces of some sandstone beds (Fig. 41). The serially-repeated, paired ridge-like casts shown on a sandstone sole in Fig. 42 are of unknown origin (they are possibly tool marks).

- Horizons with several to numerous vertebrate burrows (10-30 cm diameter), preserved as sandstone-infilled casts embedded within overbank mudrocks (Fig. 40), as washed-out casts on sandstone sole surfaces (Fig. 39), as secondarily-calcretised helical casts (Fig. 38). Rarely the casts may contain bone fragments (possible washed-in) (*e.g.* Loc. 526).

Fig. 25. Skull of a small dicynodont embedded within a baked quartzitic channel sandstone, Farm 6/109 (Loc. 567) (Scale in mm and cm). Such fossils are very difficult to prepare out from the matrix.

Fig. 26. Reworked limb bone embedded within a ferruginised, baked channel lag conglomerate (Loc. 556) (Scale in cm).

Fig. 27. Concentration of reworked, weathered bone fragments within a ferruginised pedogenic calcrete lens intercalated within grey-green overbank mudrocks (Loc. 550) (Scale in cm).

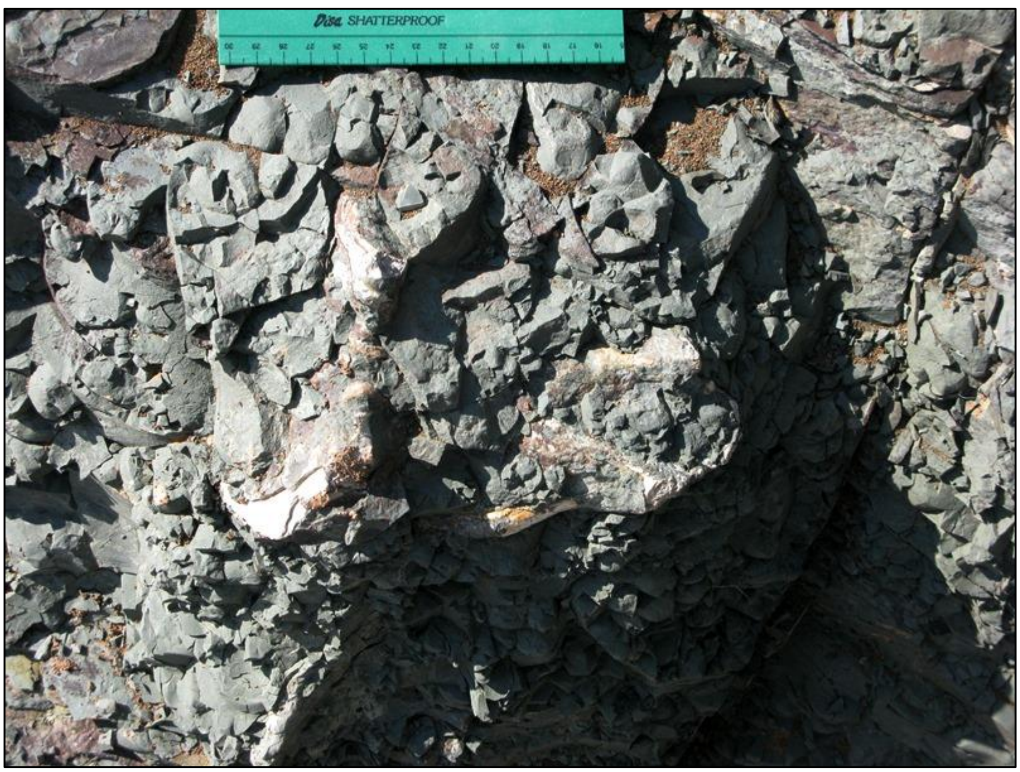


Fig. 28. Inverted skull of a medium-sized dicynodont embedded within hackly-weathering mudrocks, stream section on Farm Portion 7/26 (Loc. 535) (Scale in cm).

Fig. 29. Delicate skull of a small-bodied therocephalian carnivore embedded in siltstone, Driefontein 26 (Loc. 512). Skull is *c*. 9 cm long.

Fig. 30. Dark hornfels containing numerous disarticulated tetrapod postcrania with a white, porcellanous appearance due to thermal metamorphism during dolerite intrusion (Loc. 523) (Scale in cm).

Fig. 31. Postcrania of a medium-sized tetrapod emerging from overbank mudrocks on Driefontein 26 (Loc. 513) (Scale = *c*. 15 cm).

Fig. 32. Complete skull of a gorgonopsian therapsid enclosed in a calcrete concretion. The specimen was previously collected on Farm Driefontein 26 (precise locality unknown) and is now in private hands) (Scale in cm).

Fig. 33. Articulated vertebrae of a small tetrapod lying as float on De Hoop 30 (Loc. 514) (Scale in cm).

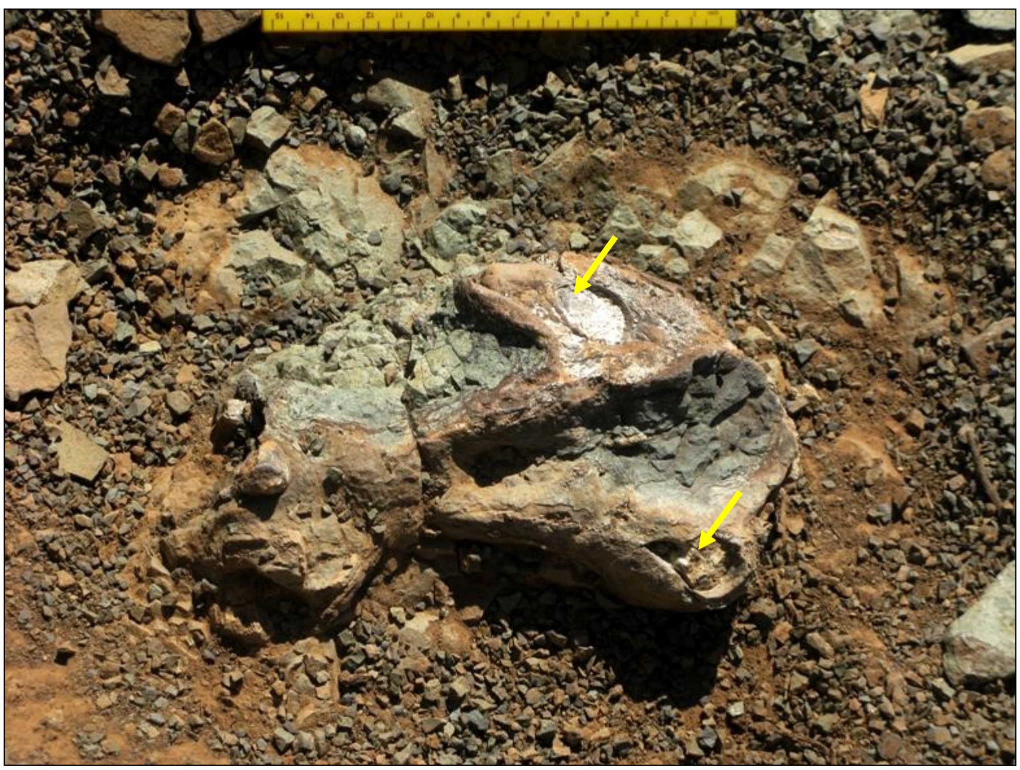


Fig. 34. Skull of a medium-sized, large-tusked dicynodont therapsid (possibly *Aulacephalodon*) seen in ventral view (tusks arrowed); the snout of the animal is facing to the right (Loc. 585) (Scale in cm).

Fig. 35. Partially-exposed, inverted skull of a large dicynodont (probably *Dicynodon*) eroding out of overbank mudrocks on Houtkloof 29 (563). See next figure for approximate scale.

Fig. 36. Skull of a large dicynodont (probably *Dicynodon*) exposed in ventral view, Houtkloof 29 (Loc. 562) (Scale in cm).

Fig 37. Skull of a small, lizard-sized cynodont (possibly a procynosuchid) exposed as float on Farm 27 (Loc. 551) (Skull is *c*. 4.5 cm long).

Fig. 38. Large ferruginised calcrete structure *c.* 30 cm deep (arrowed) – possibly a modified helical vertebrate burrow (Loc. 570).

Fig. 39. Washed-out horizontal vertebrate burrow (*c*. 12 cm in diameter) preserved on the sole of a thin sandstone bed (Loc. 572).

Fig. 40. Horizontal sandstone infill of a subcylindrical small vertebrate burrow, Driefontein 26 (Loc. 526) (Hammer = 30 cm).

Fig. 41. Washed-out cylindrical invertebrate burrows on the sole surface of a channel sandstone, fallen block in stream channel, Rhenosterfontein (Loc. 577) (Scale in cm).

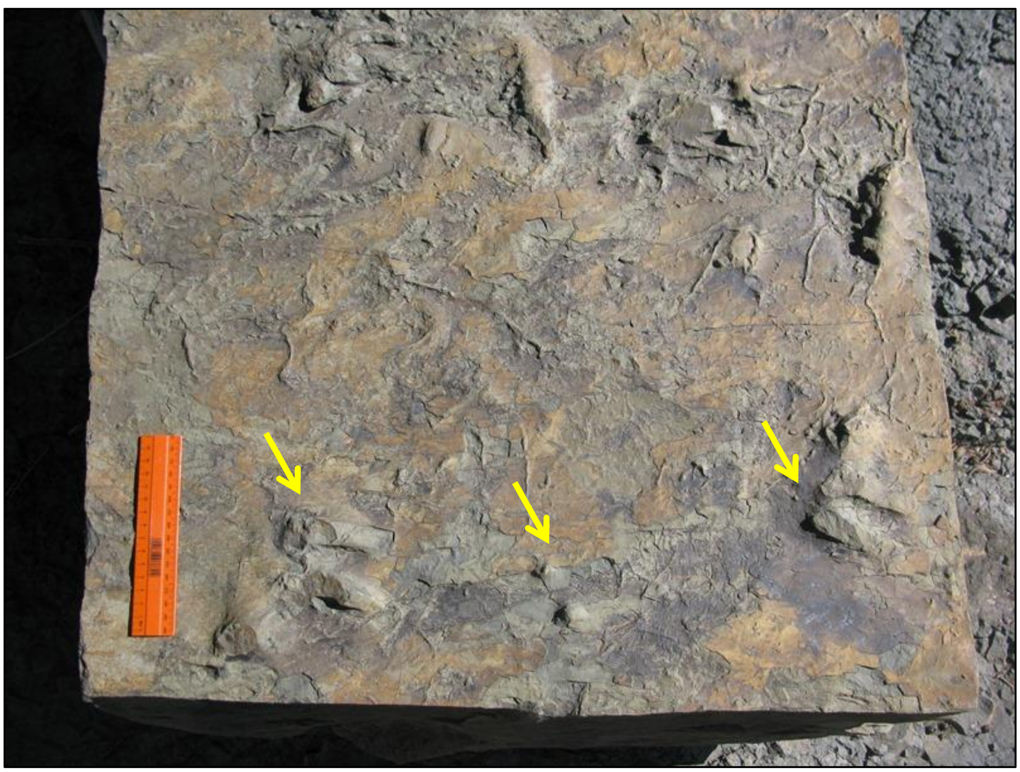


Fig. 42. Sole of erosional-based sandstone showing fine, sinuous washed-out invertebrate burrows as well as serially repeated casts of enigmatic larger paired structures (arrowed) (Loc. 577) (Scale *c*. 15 cm).

Fig. 43. Mould of a finely-striated plant stem (*c.* 2 cm wide) within sandstone, float block on Houtkloof 29 (Loc. 557).

3.2. Fossils within Late Caenozoic superficial deposits

The central Karoo superficial or "drift" deposits have been comparatively neglected in palaeontological terms. However, they may occasionally contain important fossil biotas, notably the bones, teeth and horn cores of mammals as well as remains of reptiles like tortoises. Good examples are the Pleistocene mammal faunas at Florisbad, Cornelia and Erfkroon in the Free State and elsewhere (Wells & Cooke 1942, Cooke 1974, Skead 1980, Klein 1984, Brink, J.S. 1987, Bousman *et al.* 1988, Bender & Brink 1992, Brink *et al*. 1999, MacRae 1999, Meadows & Watkeys 1999, Churchill *et al*. 2000, Partridge & Scott 2000, Brink & Rossouw 2000, Rossouw 2006). Other late Caenozoic fossil biotas from these superficial deposits include non-marine molluscs (bivalves, gastropods), ostrich egg shells, tortoise remains, trace fossils (*e.g.* calcretised termitaria, coprolites, invertebrate burrows), 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.

The only fossil remains recorded from the various Late Caenozoic superficial deposits examined during the present field assessment include:

- Calcretised rhizoliths (root casts) preserved within well-consolidated, older sandy alluvium of probable Late Quaternary age (Fig. 44);
- Sparse, poorly-preserved, fragmentary bones from consolidated older alluvium (Fig. 45).

There are unsubstantiated reports of fossil *skulpe* (shells) from alluvial deposits on Dreifontein 26 (Mev. Sarie Reynolds, pers. comm., 2014) that might refer to subfossil unionids (swan mussels).

Fig. 44. Well-consolidated older sandy alluvial deposits on De Hoop 30 containing dense assemblages of calcretised root casts (rhizoliths) extending below a well-developed calcrete hardpan (Loc. 524) (Hammer = 30 cm).

Fig. 45. Poorly-preserved, fragmentary bones eroding out from older calcretised alluvium on De Hoop 30 (Loc. 524) (Scale in cm).

4. IMPLICATIONS OF THE PROPOSED WEF LAYOUTS FOR FOSSIL HERITAGE

The proposed layouts of wind turbines, access roads and associated infrastructure for the various phases of the Umsinde Emoyeni WEF are mainly concentrated on higher-lying terrain in the central and, especially, eastern portions of the study area. To a considerable extent the development footprint will be largely confined to sectors of the study area that are underlain by Karoo dolerite or doleritic colluvium (scree, surface gravels). This is indicated by comparing the proposed layouts with the geological map (Fig. 7; red areas, Jd, are dolerite) and satellite images (*cf* Figs.46 & 47; dolerite in rusty-brown areas). Impacts on fossil heritage in doleritic areas will be very limited since dolerite is itself an unfossiliferous igneous rock, while fossils embedded in adjacent country rocks are often compromised by thermal metamorphism during dolerite intrusion.

In a minority of cases, proposed access roads and turbine positions clearly overlie the outcrop areas of potentially-fossiliferous sediments of the Lower Beaufort Group which often appear pale grey on satellite images. Examples include the north-eastern portion of the study area near Perdekop (Fig. 46) or proposed infrastructure towards the summit of Trouberg (Fig. 47). However, it is often not possible on the basis of satellite images alone to distinguish between dolerite and sandstone, or between exposed mudrock bedrocks and younger overlying surface deposits rich in reworked mudrock fragments. Potentially fossiliferous older alluvial deposits (*e.g.* calcretised alluvium, older terrace gravels) are also difficult to map from satellite images. Further fieldwork is therefore necessary to assess potential impacts of proposed WEF infrastructure on the ground in these sectors and, where necessary, to carry out appropriate mitigation.

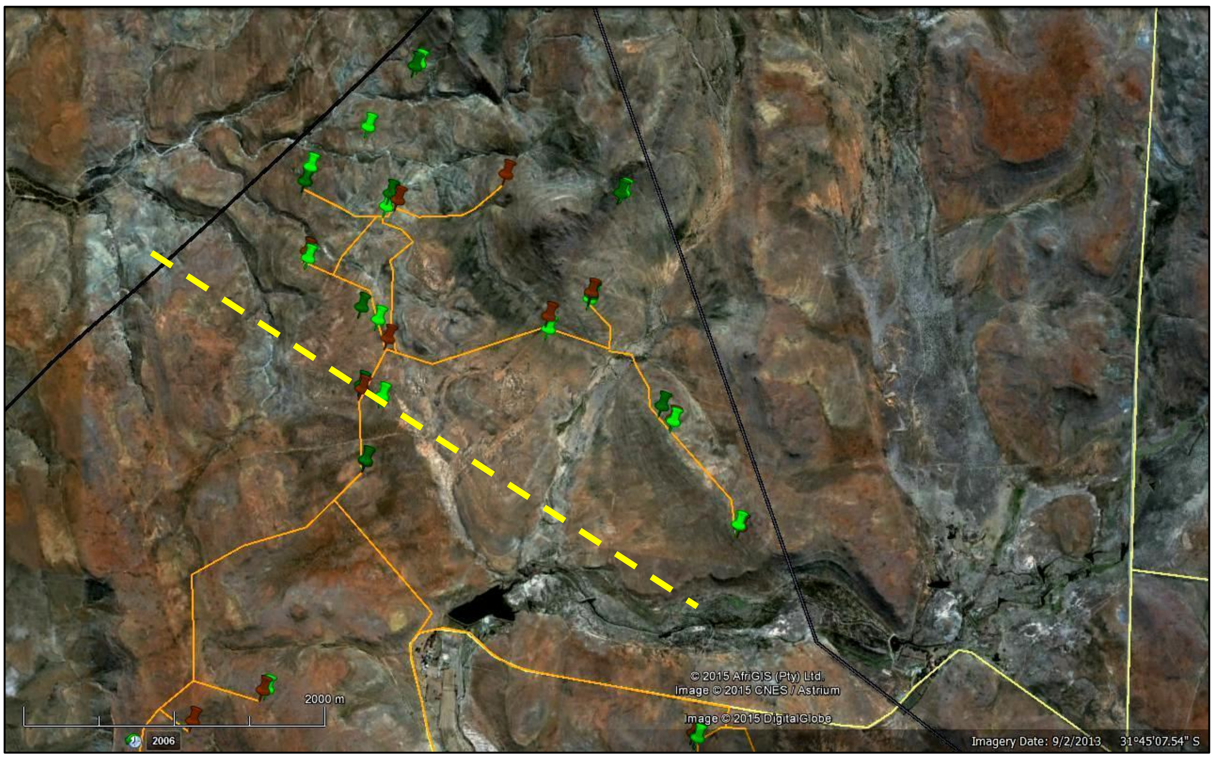


Fig. 46. Google earth© satellite image of the north-easternmost sector of the Umsinde Emoyeni study area near Perdekop showing proposed wind turbine positions (green, brown tack symbols) and access roads (orange). Infrastructure to the SW of the yellow dashed line is largely underlain by unfossiliferous dolerite (rusty-brown) and will not have significant impacts on fossil heritage. To the NE of the line many of the turbine positions and access roads overlie potentially fossiliferous Lower Beaufort Group mudrocks (greyish) and / or sandstones (pale brown). Impacts on these more sensitive sectors of the study area require detailed palaeontological field assessment and, possibly, professional mitigation (*i.e.* recording and judicious sampling of near-surface fossil remains) *before* construction commences.

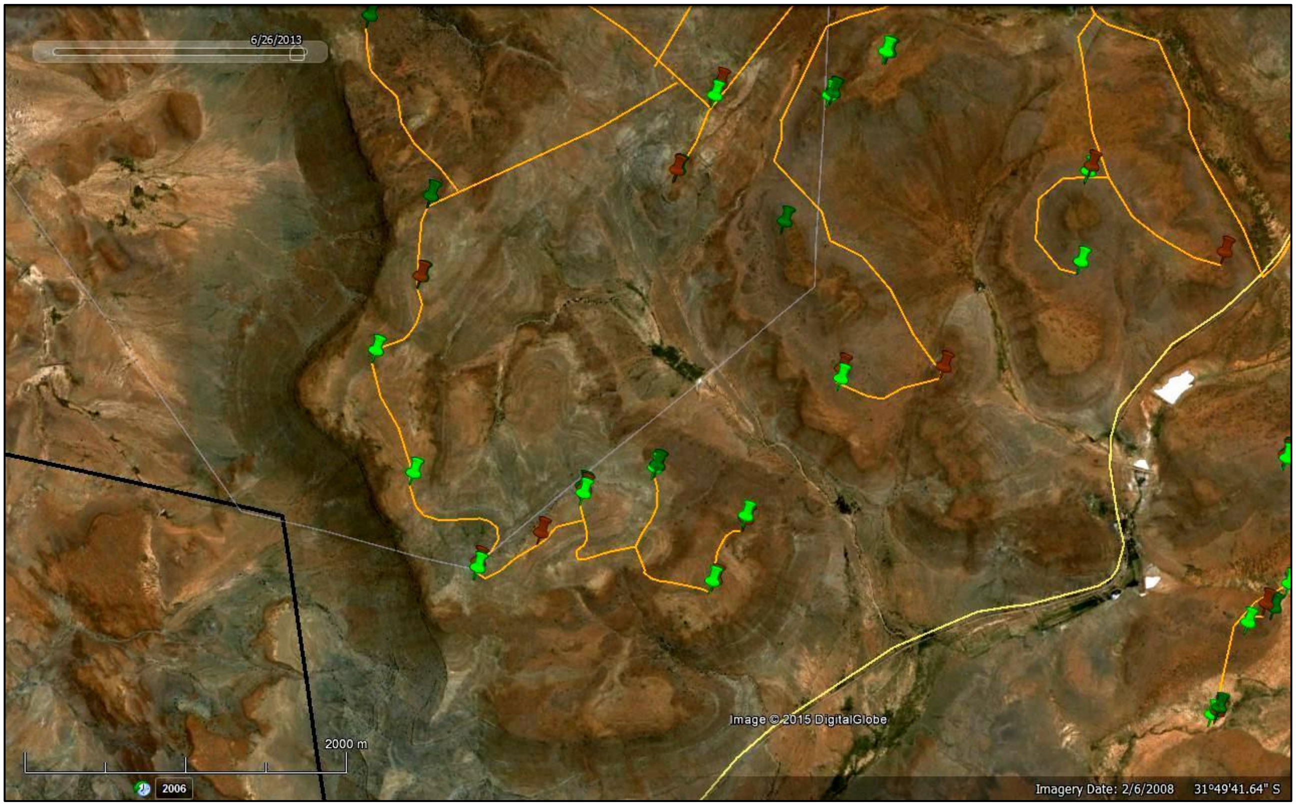


Fig. 47 . Google earth© satellite image of Trouberg in the west-central portion of the Umsinde Emoyeni study area showing proposed wind turbine positions (green, brown tack symbols) and access roads (orange). Most of the proposed infrastructure overlies dolerite (rusty-brown areas) and has little or no significance for palaeontological heritage. However, Lower Beaufort Group sediments (grey areas) are potentially fossiliferous. Vertebrate fossils of the *Cistecephalus* and *Dicynodon* Assemblage Zones have been recorded from the lower slopes and summit of Trouberg respectively.

5. PALAEONTOLOGICAL IMPACT ASSESSMENT OF THE UMSINDE EMOYENI WEF

The inferred impact of the proposed Umsinde Emoyeni WEF on local fossil heritage resources is analysed in Table 1 below, based on the system used by ARCUS. This assessment applies only to the construction phase of the development since further 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*). Such impacts can usually be mitigated but cannot be fully rectified or reversed (*i.e. long-term, irreversible*). Since loss of irreplaceable, well-preserved and scientifically valuable fossil remains may well be involved (the precautionary principle applies here), the impact intensity is rated as *high*. The consequence rating of the development without mitigation is therefore assessed as *high* as far as fossil heritage is concerned. 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. The probability of serious impacts on irreplaceable fossil heritage resources is conservatively rated as *possible*. This is because of (a) the generally scattered, unpredictable distribution of exceptional, well-preserved fossils within the bedrocks as well as within the overlying superficial sediments (*e.g.* older alluvium), (b) the mantling of the bedrocks with thick superficial sediments in many areas, so that major impacts on potentially-fossiliferous fresh (*i.e.* unweathered) bedrock are limited, and (c) the comparatively small proportion of the proposed footprint that overlies sedimentary rocks rather than unfossiliferous dolerite. The possibility of high consequence impacts gives a *medium* significance rating for the WEF development (*negative* status) 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. These uncertainties can be largely resolved through further specialist fieldwork during the pre-construction phase.

Recommended mitigation measures to limit the impact of the proposed WEF development on local fossil heritage resources are outlined in the Section 7 of the report and are outlined in Table 1. Given the internationally recognised value of Karoo fossil heritage (*e.g.* Macrae 1999, McCarthy & Rubidge 2005), the demonstrably rich palaeontological record in the Murraysburg area, 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*.

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 be reduced from *medium* to *low* (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 rich region would constitute a useful addition to our scientific understanding of Karoo Basin fossil heritage.

Table 1: Palaeontological heritage impact assessment table for the Umsinde Emoyeni WEF and associated transmission line (construction phase)

	Extent	***Intensity***	***Duration***	***Consequence***	***Probability***	***Significance***	***Status***	***Confidence***
Without mitigation	Local 1	High 3	Long-term 3	**High 7**	Possible	**MEDIUM**	**– ve**	Medium
Essential mitigation measures: • Recording and judicious sampling of well-preserved fossil remains within the final development footprint by a professional palaeontologist during the pre-construction phase. Fossils collected to be curated in an approved depository (*e.g.* museum, university). Phase 2 report to be submitted to responsible heritage management authority (Heritage Western Cape / SAHRA). • Application of a chance-finds procedure by the ECO during the construction phase (*i.e* safeguarding of significant new fossil finds and reporting to the relevant heritage management authority for appropriate professional recording and mitigation)								
With mitigation	Local 1	Medium 2	Long-term 3	**Medium 6**	Possible	**LOW**	**– ve & +ve**	Medium

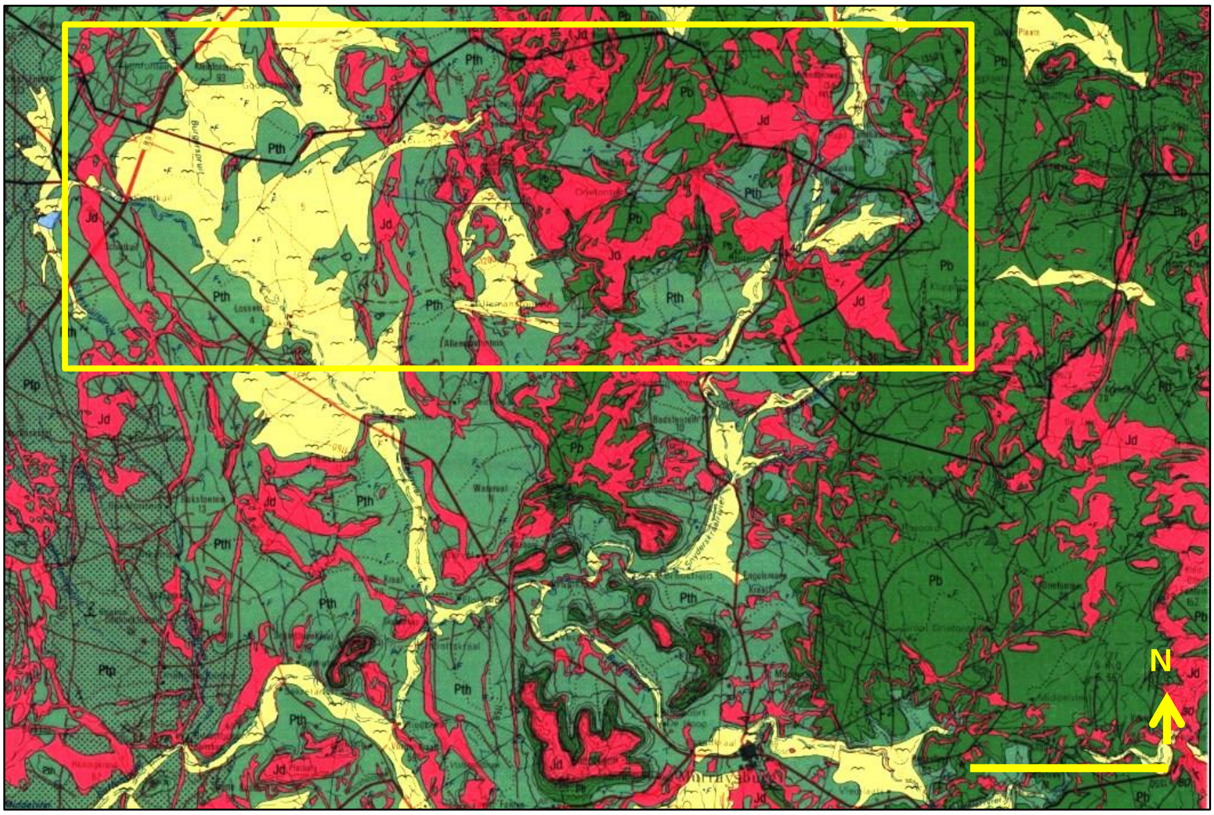
6. PALAEONTOLOGY OF THE UMSINDE EMOYENI GRID APPLICATION AREA

The geology of the study area for the proposed 132 kV transmission line connection between the Umsinde Emoyeni WEF and the Eskom grid is shown in Fig. 48 (based on the 1: 250 000 Victoria West sheet 3122). The eastern half of the area is largely underlain by Late Permian sediments of the **Balfour Formation** (Pb, dark green) or equivalent units of the Teekloof Formation. The Lower Beaufot Group bedrocks are extensively intruded by the Early Jurassic **Karoo Dolerite Suite** (Jd, red). The geology and palaeontology of these rock units have already been covered in Sections 2 and 3 of this report. The western half of the tranmission line study area traverses the outcrop area of the **Hoedemaker Member** (Pth, blue-green), a slightly older, mudrock-dominated succession within the Teekloof Formation (Fig. 6) as well as large areas of **Late Caenozoic alluvial sediments** (pale yellow).

The mudrock-dominated Hoedemaker Member is considered to be of Late Permian (Wuchiapingian) age (*c.* 260 Ma) (Smith & Keyser 1995a, Rubidge 2005, Rubidge *et al.* 2013, Smith *et al.* 2012). The geology of the Hoedemaker Member, which is up to 240 m thick, has been outlined by Smith (1980, 1993a, b) and later by Smith and Keyser (1995a) as well as Cole and Smith (2008). The Hoedemaker succession is dominated by greenish-grey to purple-brown overbank mudrocks, with occasional single-storey sheet sandstones. Palaeosol (ancient soil) horizons characterized by calcrete nodules and rhizocretions (root casts) are common, as are also lacustrine (transient to long-lived playa lake) sediments deposited in depressions on the Late Permian floodplain. These last are associated with limestone crusts, gypsum crystals ("desert roses") as well as a range of fine-scale sedimentary features such as wave rippled sandstones, falling water marks, mudcracks, and trace fossils (Stear 1978, Smith 1980, 1986, 1993a).

The Hoedemaker Member is characterised by fossil assemblages of the *Tropidostoma* Assemblage Zone (Rubidge 1995, Smith & Keyser 1995a) whereas overlying Lower Beaufort Group sediments in the eastern sector of the grid application area feature fossils of the *Cistecephalus* and *Dicynodon* Assemblage Zones, as discussed earlier in this report (See Fig. 21). The following major categories of fossils might be expected within *Tropidostoma* AZ sediments in the grid application study area (Kitching 1977, Keyser & Smith 1979, Anderson & Anderson 1985, Smith & Keyser 1995a, MacRae 1999, Cole *et al*., 2004 and Smith *et al.* 2012):

- isolated petrified bones as well as rare articulated skeletons of terrestrial vertebrates (tetrapods) such as true reptiles (notably large herbivorous pareiasaurs, lizard-like archosauromorphs) and therapsids or "mammal-like reptiles" (*e.g.* diverse, small- to large-bodied herbivorous dicynodonts, flesh-eating gorgonopsians, carnivorous and insectivorous therocephalians, cynodonts) (Fig. 49).



Fig, 48. Extract from 1: 250 000 geology sheet 3122 Victoria West (Council for Geoscience, Pretoria) showing the geology of the Umsinde Emoyeni WEF grid application site area that extends to the west of the WEF study area broadly indicated in Fig. 7. The yellow scale bar represents *c*. 10 km.

LOWER BEAUFORT GROUP
Teekloof Formation: Hoedemaker Member (Pth, blue-green)
Balfour Formation (Pb, green)
Adelaide Subgroup (undifferentiated) (Pa, pale blue)
UPPER BEAUFORT GROUP
Tarkastad Subgroup (TRk, yellow)
KAROO DOLERITE SUITE
Jd(pink)
LATE CAENOZOIC ALLUVIUM
Pale yellow with "flying bird" symbol

- aquatic vertebrates such as large temnospondyl amphibians (*Rhinesuchus* spp., usually disarticulated), and palaeoniscoid bony fish (*Atherstonia*, *Namaichthys*, often represented by scattered scales rather than intact fish).
- freshwater bivalves (*e.g. Palaeomutela*).
- trace fossils such as worm, arthropod and tetrapod burrows and trackways, coprolites (fossil droppings), fish swimming trails.

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

According to Smith and Keyser (1995a) the tetrapod fauna of the *Tropidostoma* Assemblage Zone is dominated by the small burrowing dicynodont *Diictodon* that constitutes some 40% of the fossil remains recorded here. There are several genera of toothed dicynodonts (*e.g. Emydops, Pristerodon*) as well as medium-sized forms like *Rachiocephalus* and *Endothiodon*. Carnivores are represented by medium-sized gorgonopsians (*e.g. Lycaenops, Gorgonops*) as well as smaller, insectivorous therocephalians such as *Ictidosuchoides*. Among the large (2.3-3 m long), lumbering pareiasaur reptiles the genus *Pareiasaurus* replaces the more primitive *Bradysaurus* seen in older Beaufort Group assemblages. The *Tropidostoma* AZ biota inhabited extensive, very low-relief alluvial plains traversed by several perennially flowing, meandering rivers bordered by levees in Late Permian times. Climates were highly seasonal (Smith *et al.* 2012 and refs. therein). As far as the biostratigraphically important tetrapod remains are concerned, the best fossil material within the Hoedemaker Member succession is generally found within overbank mudrocks, whereas fossils preserved within channel sandstones tend to be fragmentary and water-worn (Rubidge 1995, Smith 1993b). Many vertebrate fossils are found in association with ancient soils (palaeosol horizons) that can usually be recognised by bedding-parallel concentrations of calcrete nodules. Smith and Keyser (1995a) report that in the *Tropidostoma* Assemblage Zone / Hoedemaker Member most tetrapod fossils comprise isolated disarticulated skulls and post-cranial bones, although well-articulated skeletons of the small dicynodont *Diictodon* are locally common, associated with burrows (See also Smith 1993b for a benchmark study of the taphonomy of vertebrate remains in the Hoedemaker Member).

As a consequence of their proximity to large dolerite intrusions, some of the Beaufort Group sediments in the study region have been thermally metamorphosed or "baked" (*i.e*. recrystallised, impregnated with secondary minerals). Embedded fossil material of phosphatic composition, such as bones and teeth, is frequently altered by baking – bones may become blackened or become porcellanous, for example - and can be very difficult to extract from the hard matrix by mechanical preparation (Smith & Keyser 1995b). Thermal metamorphism by dolerite intrusions therefore tends to reduce the palaeontological heritage potential of Beaufort Group sediments. The readily-weathered mudrocks of the Hoedemaker Member often generate subdued topographic relief, with extensive cover by superficial sediments (*e.g.* alluvium, soils), so good exposures of fresh bedrock are often rare. Resistant-weathering fossil material – notably silicified wood – that has eroded out of the Beaufort Group bedrocks may be concentrated in surface gravels by downwasting, stream action and sheet floods (*cf.* Almond 2014b).

Fossil vertebrate localities are indicated within the Umsinde Emoyeni grid application site study area to the northwest of Murraysburg in the Karoo fossil distribution map of Nicolas (2007) (Fig. 24) and a few localities are also shown here in the earlier map of Kitching (1977). Surface fossil finds are likely to be less dense than within the main WEF study area because of the more subdued topography - and hence lower bedrock exposure levels - within the western half of the grid application area. Once the footprint of the proposed 132 kV transmission line is finalised, a pre-construction palaeontological field assessment is recommended focussing on those sectors of the power line corridor that traverse exposures of (a) Lower Beaufort Group sediments or (b) consolidated older alluvial deposits.

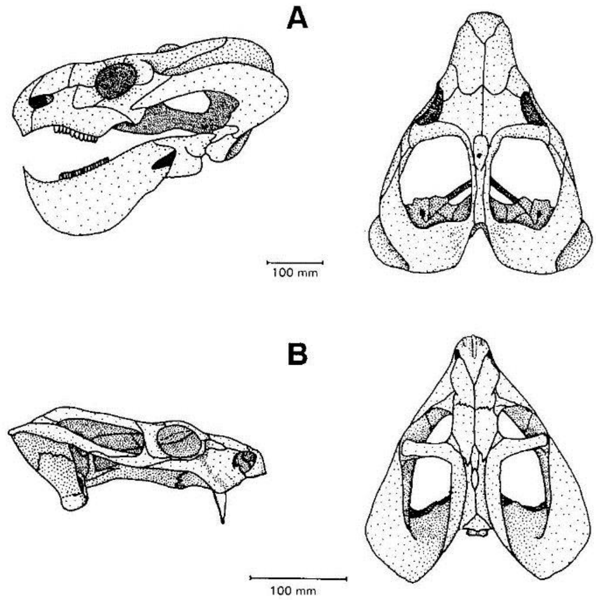


Fig. 49. Skulls of characteristic dicynodont taxa from the *Tropidostoma* Assemblage Zone: *Endothiodon* (A) and *Tropidostoma* (B) (From Smith & Keyser 1995a).

7. CONCLUSIONS AND RECOMMENDATIONS

The proposed Umsinde Emoyeni WEF project area is largely underlain by Permian fluvial sediments of the Lower Beaufort Group (Karoo Supergroup) that have yielded a wealth of important fossil remains from the Murraysburg region over the past century or more. These include diverse vertebrate fossils of the Late Permian *Cistecephalus* and *Dicynodon* Assemblage Zones such as gorgonopsian, therocephalian and cynodont predators as well as small- to large-bodied herbivorous dicynodonts, among others. Recent palaeontological fieldwork confirms that well-preserved fossils belonging to a range of tetrapod groups are present at the surface in a high proportion of sites where Lower Beaufort Group bedrocks are well-exposed. Other fossil groups represented here include concentrations of medium to large vertebrate burrows, low-diversity invertebrate trace fossils and vascular plant remains (*e.g.* horsetail ferns). The palaeosensitivity of the Umsinde Emoyeni study area is therefore rated as high.

The proposed layouts of wind turbines, access roads and associated infrastructure for the various phases of the Umsinde Emoyeni WEF are mainly concentrated on higher-lying terrain in the central and eastern portions of the study area that are largely underlain by unfossiliferous Karoo dolerite. Only a small proportion of the development footprint will be underlain by potentially fossiliferous Lower Beaufort Group sedimentary bedrocks and older, consolidated alluvium. Substantial impacts on local fossil heritage – conservatively rated as of *medium* (*negative*) significance - may be expected in these more sensitive sectors during the construction phase of the WEF, notably as a result of surface clearance and excavations for wind turbine footings, hard standing areas and laydown areas, access roads and underground cables. To a large extent, these impacts can be mitigated through pre-construction recording and collection of scientifically valuable fossil material as well as through the application of a chance-finds procedure during development itself. Impact significance following mitigation is rated as *low* (*negative*), and would be partially offset by *positive* impacts as a result of improved understanding of local fossil heritage resources (*i.e.* new palaeontological data and specimens). This assessment applies to all proposed phases and alternative layouts of the WEF as well as the associated transmission line. Obviously, the anticipated impacts will broadly increase in step with the number of wind turbines and length of new access roads and other infrastructure involved. Levels of confidence for the assessment are *medium*, given the unpredictable occurrence of well-preserved fossils as well as uncertainties regarding the levels of sedimentary bedrock exposure within the final development footprint. These uncertainties can be largely resolved through further specialist fieldwork during the pre-construction phase.

The grid application site to the west of the main Umsinde Emoyeni WEF study area is largely underlain by potentially fossiliferous sediments of the Lower Beaufort Group, locally intruded by Karoo dolerite, as well as by substantial areas of Late Caenozoic superficial sediments. Fossil vertebrates of the *Tropidostoma* and *Cistecephalus* Assemblage Zones have been previously recorded here. Surface fossil sites are likely to be less dense than within the main WEF study area because of the more subdued topography - and hence lower bedrock exposure levels - within the western half of the grid application area.

In terms of palaeontological heritage within the Umsinde Emoyeni project areait is recommended that:

- Once the final layout of the WEF and associated transmission line is determined, a pre-construction palaeontological study be undertaken of those limited sectors of the footprint that overlie potentially-fossiliferous sediments (*i.e.* Lower Beaufort Group bedrocks, older consolidated alluvium). The study should be carried out by a suitably qualified palaeontologist and would involve (a) recording of near-surface fossil material, including relevant geological data (*e.g.* stratigraphy, sedimentology, taphonomy), (b) judicious sampling of scientifically-valuable fossils as well as (c) making recommendations regarding further mitigation or conservation of specific fossil sites for the construction phase of the WEF and transmission line.

- 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 the Umsinde Emoyeni 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.

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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9. KEY REFERENCES

ALMOND, J.E. 2012. Two borrow pit sites near Murraysburg, Central Karoo District Municipality, Western Cape. Palaeontological specialist study: field assessment, 16 pp. Natura Viva cc, Cape Town.

ALMOND, J.E. 2014a. Proposed extension of a borrow pit on the Farm Driefontein 26 near Murraysburg, Central Karoo District Municipality, Western Cape: revised footprint. Palaeontological specialist study: field assessment, 19 pp. Natura Viva cc, Cape Town.

ALMOND, J.E. 2014b. Proposed Aberdeen 200MW wind farm, Camdeboo Local Municipality, Eastern Cape. Palaeontological impact assessment: desktop study, 46 pp. Natura Viva cc, Cape Town.

ALMOND, J.E. & PETHER, J. 2008. Palaeontological heritage of the Northern Cape. Interim SAHRA technical report, 124 pp. Natura Viva cc., Cape Town.

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

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

BAMFORD, M.K. 2004. Diversity of woody vegetation of Gondwanan southern Africa. Gondwana Research 7, 153-164.

BENDER, P.A. & BRINK, J.S. 1992. A preliminary report on new large mammal fossil finds from the Cornelia. South African Journal of Science 88, 512-515.

BENTON, M.J. 2003. When life nearly died. The greatest mass extinction of them all, 336 pp. Thames & Hudson, London.

BOTHA, J. & SMITH, R.M.H. 2006. Rapid vertebrate recuperation in the Karoo Basin of South Africa following the End-Permian extinction. Journal of African Earth Sciences 45, 502–514.

BOTHA, J. & SMITH, R.M.H. 2007. *Lystrosaurus* species composition across the Permo-Triassic boundary in the Karoo Basin of South Africa. Lethaia 40, 125-137.

BOUSMAN, C.B. *et al.* 1988. Palaeoenvironmental implications of Late Pleistocene and Holocene valley fills in Blydefontein Basin, Noupoort, C.P., South Africa. Palaeoecology of Africa 19: 43-67.

BRINK, J.S. 1987. The archaeozoology of Florisbad, Orange Free State. Memoirs van die Nasionale Museum 24, 151 pp.

BRINK, J.S. et al. 1995. A new find of *Megalotragus priscus* (Alcephalini, Bovidae) from the Central Karoo, South Africa. Palaeontologia africana 32: 17-22.

BRINK, J.S. & ROSSOUW, L. 2000. New trial excavations at the Cornelia-Uitzoek type locality. Navorsinge van die Nasionale Museum Bloemfontein 16, 141-156.

BRINK, J.S., BERGER, L.R. & CHURCHILL, S.E. 1999. Mammalian fossils from erosional gullies (dongas) in the Doring River drainage. Central Free State Province, South Africa. *In*: C. Becker, H. Manhart, J. Peters & J. Schibler (eds.), Historium animalium ex ossibus. Beiträge zur Paläoanatomie, Archäologie, Ägyptologie, Ethnologie und Geschichte der Tiermedizin: Festschrift für Angela von den Driesch. Rahden/Westf : Verlag Marie Leidorf GmbH, 79-90.

CATUNEANU, O. AND ELANGO, H.N. 2001. Tectonic control on fluvial styles: the Balfour Formation of the Karoo Basin, South Africa. Sedimentary Geology 140, 291-313.

CHURCHILL, S.E. et al. 2000. Erfkroon: a new Florisian fossil locality from fluvial contexts in the western Free State, South Africa. South African Journal of Science 96: 161-163.

CLUVER, M.A. 1978. Fossil reptiles of the South African Karoo. 54pp. South African Museum, Cape Town.

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

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

COOKE, H.B.S. 1974. The fossil mammals of Cornelia, O.F.S., South Africa. In: Butzer, K.W., Clark, J.D. & Cooke, H.B.S. (Eds.) The geology, archaeology and fossil mammals of the Cornelia Beds.

DUNCAN, A.R. & MARSH, J.S. 2006. The Karoo Igneous Province. In: Johnson, M.R., Anhaeusser, C.R. & Thomas, R.J. (Eds.) The geology of South Africa, pp. 501-520. Geological Society of South Africa, Marshalltown.

GASTALDO, R.A., ADENDORFF, R., BAMFORD, M., LABANDEIRA, C.C., NEVELING, J. & SIMS, H. 2005. Taphonomic trends of macrofloral assemblages across the Permian – Triassic boundary, Karoo Basin, South Africa. Palaios 20, 479-497.

GASTALDO, R.A. & ROLERSON, M.W. 2008. *Katbergia* Gen. Nov., a new trace fossil from the Upper Permian and Lower Triassic rocks of the Karoo Basin: implications for palaeoenvironmental conditions at the P/TR extinction event. Palaeontology 51, 215-229.

HILL, R.S. 1993. The geology of the Graafff-Reinet area. Explanation of Sheet 3224, scale 1: 250 000. 31pp. Geological Survey / Council for Geoscience, Pretoria.

HILLER, N. & STAVRAKIS, N. 1984. Permo-Triassic fluvial systems in the southeastern Karoo Basin, South Africa. Palaeogeography, Palaeoclimatology, Palaeoecology 34, 1-21.

JOHNSON, M.R. 1966. The stratigraphy of the Cape and Karoo Systems in the Eastern Cape Province. Unpublished MSc Thesis, Rhodes University, Grahamstown.

JOHNSON, M.R. 1976. Stratigraphy and sedimentology of the Cape and Karoo sequences in the Eastern Cape Province. Unpublished PhD thesis, Rhodes University, Grahamstown, xiv + 335 pp, 1pl.

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

KATEMAUNZANGA, D. 2009. Lithostratigraphy, sedimentology and provenance of the Balfour Formation (Beaufort Group) in the Fort Beaufort-Alice, Eastern Cape Province, South Africa. Unpublished M.Sc. Thesis, University of Fort Hare, 1-140.

KEYSER, A.W. & SMITH, R.M.H. 1979. Vertebrate biozonation of the Beaufort Group with special reference to the Western Karoo Basin. Annals of the Geological Survey of South Africa 12: 1-36.

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

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

LE ROUX, F.G. & KEYSER, A.W. 1988. Die geologie van die gebied Victoria-Wes. Explanation to 1: 250 000 geology Sheet 3122, 31 pp. Council for Geoscience, Pretoria.

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

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

MALHERBE, I.J., CONRADIE, C. & PIENAAR, A. 2011. Murraysburg 150 jaar, 207 pp. Privately published.

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

MEADOWS, M.E. & WATKEYS, M.K. 1999. Palaeoenvironments. In: Dean, W.R.J. & Milton, S.J. (Eds.) The karoo. Ecological patterns and processes, pp. 27-41. Cambridge University Press, Cambridge.

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

OGHENEKOME, M.E. 2012. Sedimentary environments and provenance of the Balfour Formation (Beaufort Group) in the area between Bedford and Adelaide, Eastern Cape Province, South Africa. Unpublished MSc thesis, University of Fort Hare, 132 pp.

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

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

RETALLACK, G.J., SMITH, R.M.H. & WARD, P.D. 2003. Vertebrate extinction across the Permian-Triassic boundary in the Karoo Basin, South Africa. Geological Society of America Bulletin 115, 1133-1152.

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

ROSSOUW, L. 2006. Florisian mammal fossils from erosional gullies along the Modder River at Mitasrust Farm, Central Free State, South Africa. Navorsinge van die Nasionale Museum Bloemfontein 22, 145-162.

ROSSOUW, L. Undated. Palaeontological desktop assessment of the proposed Ishwati Emoyeni Wind Farm Facility near Murraysburg, WC Province, 9 pp. Palaeo Field Services, Langenhoven Park

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

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

RUBIDGE, B.S., ERWIN, D.H., RAMEZANI, J., BOWRING, S.A. & DE KLERK, W.J. 2013. High-precision temporal calibration of Late Permian vertebrate biostratigraphy: U-Pb zircon constraints from the Karoo Supergroup, South Africa. Geology published online 4 January 2013. doi: 10.1130/G33622.1.

SAHRA 2013. Minimum standards: palaeontological component of heritage impact assessment reports, 15 pp. South African Heritage Resources Agency, Cape Town.

SCOTT, L. 2000. Pollen. In: Partridge, T.C. & Maud, R.R. (Eds.) The Cenozoic of southern Africa, pp.339-35. Oxford University Press, Oxford.

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

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

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

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

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

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

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

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

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

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

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

SMITH, R.M.H. & KEYSER, A.W. 1995a. Biostratigraphy of the Tropidostoma Assemblage Zone. Pp. 18-22 in Rubidge, B.S. (ed.) Biostratigraphy of the Beaufort Group (Karoo Supergroup). South African Committee for Stratigraphy, Biostratigraphic Series No. 1. Council for Geoscience, Pretoria.

SMITH, R.M.H. & KEYSER, A.W. 1995b. Biostratigraphy of the Cistecephalus Assemblage Zone. In: Rubidge, B.S. (ed.) Biostratigraphy of the Beaufort Group (Karoo Supergroup). South African Committee for Stratigraphy, Biostratigraphic Series No. 1, pp. 23-28. Council for Geoscience, Pretoria.

SMITH, R. M.H.., TURNER, B.R., HANCOX, P.J., RUBDIGE, B.R. & CATUNEANU, O. 1998. Trans-Karoo II: 100 million years of changing terrestrial environments in the main Karoo Basin. Guidebook Gondwana-10 International Conference, University of Cape Town, South Africa, 117 pp.

SMITH, R.H.M. & WARD, P.D. 2001. Pattern of vertebrate extinction across an event bed at the Permian-Triassic boundary in the Karoo Basin of South Africa. Geology 29, 1147-1150.

SMITH, R. & BOTHA, J. 2005. The recovery of terrestrial vertebrate diversity in the South African Karoo Basin after the end-Permian extinction. Comptes Rendus Palevol 4, 555-568.

SMITH, R., RUBIDGE, B. & VAN DER WALT, M. 2012. Therapsid biodiversity patterns and paleoenvironments of the Karoo Basin, South Africa. Chapter 2 pp. 30-62 in Chinsamy-Turan, A. (Ed.) Forerunners of mammals. Radiation, histology, biology. xv + 330 pp. Indiana University Press, Bloomington & Indianapolis.

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

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

VAN DER WALT, M., DAY, M., RUBIDGE, B., COOPER, A.K. & NETTERBERG, I. 2010. A new GIS-based biozone map of the Beaufort Group (Karoo Supergroup), South Africa. Palaeontologia Africana 45, 1-5.

VISSER, J.N.J. & DUKAS, B.A. 1979. Upward-fining fluviatile megacycles within the Beaufort Group, north of Graafff-Reinet, Cape Province. Transactions of the Geological Society of South Africa 82, 149-154.

WARD, P.D., BOTHA, J., BUICK, R., DE KOCK, M.O., ERWIN, D.H., GARRISON, G.H., KIRSCHVINK, J.L. & SMITH, R.M.H. 2005. Abrupt and gradual extinction among Late Permian land vertebrates in the Karoo Basin, South Africa. Science 307, 709-714.

WELLS, L.H. & COOKE, H.B.S. 1942. The associated fauna and culture of Vlakkraal thermal springs, O.F.S.; III, the faunal remains. Transactions of the Royal Society of South Africa 29: 214-232.

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

Declaration of Independence

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

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