HERITAGE IMPACT ASSESSMENT FOR THE PROPOSED SANKRAAL WIND ENERGY FACILITY TO BE SITUATED IN THE NORTHERN CAPE.

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

Prepared for
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November 2017

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CONTENTS OF THE SPECIALIST REPORT – CHECKLIST

Regulation GNR 326 of 4 December 2014, as amended 7 April 2017, Appendix 6	Section of Report
(a) details of the specialist who prepared the report; and the expertise of that specialist to compile a specialist report including a *curriculum vitae*;	Preface pages
(b) a declaration that the specialist is independent in a form as may be specified by the competent authority;	Preface pages
(c) an indication of the scope of, and the purpose for which, the report was prepared;	1. Introduction
(cA) an indication of the quality and age of base data used for the specialist report;	2. Methodology and 8.4 Accumulative Impacts.
(cB) a description of existing impacts on the site, cumulative impacts of the proposed development and levels of acceptable change;	8.4 Accumulative impacts
(d) the duration, date and season of the site investigation and the relevance of the season to the outcome of the assessment;	1.1 Introduction
(e) a description of the methodology adopted in preparing the report or carrying out the specialised process inclusive of equipment and modelling used;	2. Methodology
(f) details of an assessment of the specific identified sensitivity of the site related to the proposed activity or activities and its associated structures and infrastructure, inclusive of a site plan identifying site alternatives;	6. Archaeological and Palaeontological sensitivities
(g) an identification of any areas to be avoided, including buffers;	Appendix A, & 6. Archaeological and Palaeontological sensitivities
(h) a map superimposing the activity including the associated structures and infrastructure on the environmental sensitivities of the site including areas to be avoided, including buffers;	6. Archaeological and Palaeontological sensitivities
(i) a description of any assumptions made and any uncertainties or gaps in knowledge;	2. Methodology
(j) a description of the findings and potential implications of such findings on the impact of the proposed activity, including identified alternatives on the environment, or activities;	9. Impact assessment.
(k) any mitigation measures for inclusion in the EMPr;	13.1 Mitigation
(l) any conditions for inclusion in the environmental authorisation;	13.1 Mitigation
(m) any monitoring requirements for inclusion in the EMPr or environmental authorisation;	13.1 Mitigation
(n) a reasoned opinion— i. as to whether the proposed activity, activities or portions thereof should be authorised; iA. Regarding the acceptability of the proposed activity or activities; and ii. if the opinion is that the proposed activity, activities or portions thereof should be authorised, any avoidance, management and mitigation measures that should be included in the EMPr or Environmental Authorization, and where applicable, the closure plan;	13. Conclusion
(o) a summary and copies of any comments received during any consultation process	n/a

and where applicable all responses thereto; and	
(p) any other information requested by the competent authority	
Where a government notice gazetted by thye Minister provides for any protocol or minimum information requirement to be applied to a specialist report, the requirements as indicated in such notice will apply.	

Summary

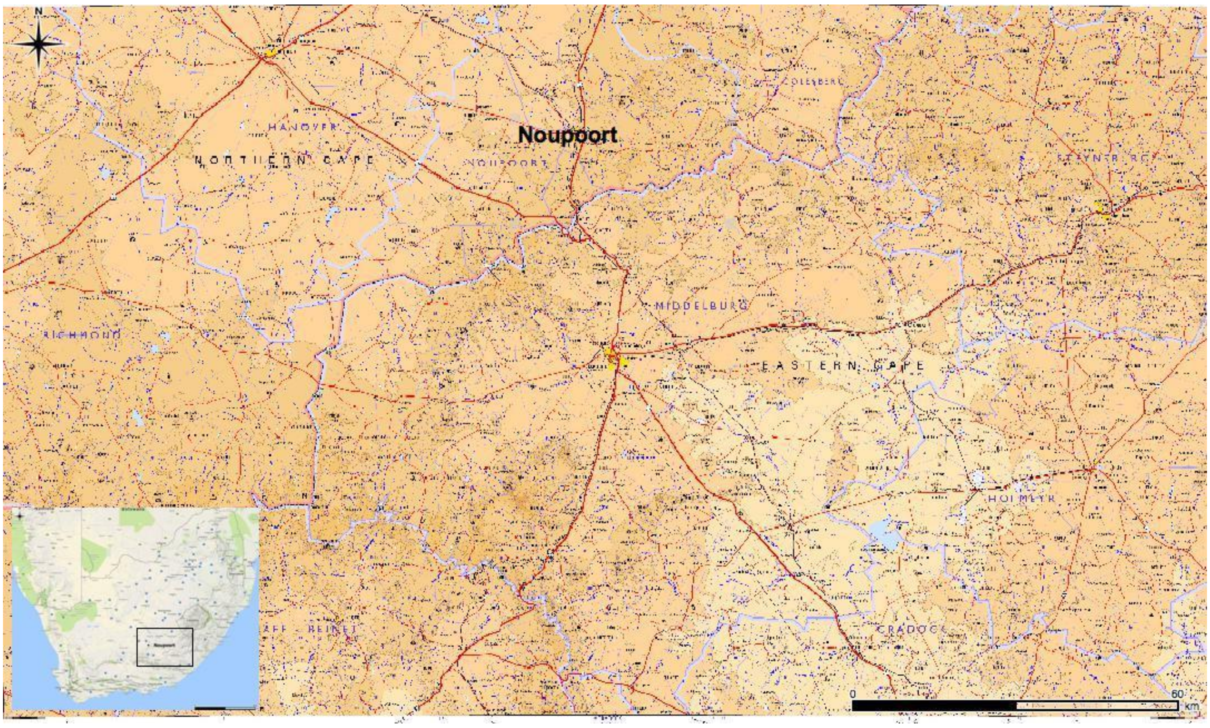
ACO Associates CC has been appointed by Arcus Consulting Pty Ltd to contribute a specialist heritage report into the Impact Assessment phase of an EIA process for the proposed San Kraal Wind Energy Facility. The project area lies in the Great Karoo mainly in the Northern Cape Province just 6 km south east of Noupoort. A very small portion of the site lies in the Eastern Cape. This is an arid area situated on the escarpment of the Kikvorsberge. The area is quite sparsely populated and rural in nature. This report explores issues with respect to the broad discipline of heritage which includes palaeontology, archaeology, historic structures, history, places and landscape quality. Previous work in the area has revealed a long history of human occupation, several periods of conflict and numbers of archaeological sites. The palaeontology of the Karoo and escarpment is internationally significant.

The impact assessment phase of the project has addressed the following issues:

- Archaeology. The physical remnants of human activity were identified and assessed through physical site inspection, mapped and assigned field grades. The comprehensive survey of the project area, associated intrastructure and power lines has revealed that Stone Age archaeological sites are sparse in the high *suurveld* areas and that not very many sites will be physically impacted. Mitigation of 1 archaeological site (Stone Age) close to grid connection option 2 requires that the site be avoided or mitigated through systematic collection.
- Palaeontology. The palaeontological assessment by Dr John Almond has revealed that while the geology is potentially sensitive, fossil finds on site are confined to mostly fragmented river-washed bone fragments. He noted the presence of a number of fossilised vertebrate burrows in a river bed close to the convergence of the grid connection alternatives and has suggested that care must be taken to ensure that infrastructure is kept clear of the river bed.
- Landscape and setting. The landscape is largely rural, and apart from being used for small stock keeping is quite wild and un-altered. The slopes of the Kikvorsberge support *suurveld* grazing which is not optimal for domestic stock. Hence the area which has good scenic qualities, is very isolated and seldom visited.
- Accumulative impacts. The types of heritage material found on San Kraal, are very similar to those found in other projects within a 35 km radius. Almost all of this is grade 3 or ungraded – historic kraals and stock posts and Stone Age open scatters of moderate heritage significance. This material is all well represented in the eastern Karoo region therefore the accumulative impact is expected to be low. There is a concern that the compounded effect of renewable energy facilities will result in an aesthetic impact and change of character of the landscape, however this is difficult to quantify.
- The Northern Cape Heritage authority is responsible for the heritage issues in the Northern Cape while the Eastern Cape Heritage Authority is responsible for that province. All reports will be uploaded to SAHRIS for their attention.

Conclusion

Indications are that the proposed activity is acceptable. Mitigation is un-onerous with only two archaeological sites in the project area needing to be avoided, or systematically collected by an archaeologist if this is not possible. One fossil buffer zone will need to be observed.



Location of Noupoort.

Details of the specialist

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

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CURRICULUM VITAE

Name: Timothy James Graham Hart

Profession: Archaeologist

Date of Birth: 20/07/60

Parent Firm: ACO Associates

Position in Firm: Director

Years with Firm: 9

Years experience: 30 years

Nationality: South African

HDI Status: n/a

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

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

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

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

KEY QUALIFICATIONS

- Bachelor of Arts in Archaeology and Psychology
- BA Honours in archaeology
- MA in Archaeology
- Recipient of Frank Schwietzer Memorial Prize (UCT) for student excellence
- Professional member (no 50) Association of Southern African Professional Archaeologists (ASAPA)
- Principal Investigator, cultural resources management section (ASAPA)
- Professional member in specialist and generalist categories Association of Heritage Professionals (APHP)
- Committee Member Heritage Western Cape, Committee Member SAHRA
- Awarded Department of Arts and Culture and Sport award for best heritage study in 2014,

Relevant recent Project Experience with respect to large projects:

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

Experience

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

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

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

Academic Publications

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

Sampson, C.G., Hart, T.J.G., Wallsmith, D.L. & Blagg, J.D. 1988. The Ceramic sequence in the upper Sea Cow Valley: Problems and implications. South African Archaeological Bulletin 149: 3-16.

Plug, I. Bollong, C.A., Hart, T.J.G. & Sampson, C.G. 1994. Context and direct dating of pre-European livestock in the Upper Seacow River Valley. Annals of the South African Museum, Cape Town.

Hart, T. & Halkett, D. 1994. Reports compiled by the Archaeology Contracts Office, University of Cape Town. Crossmend, HARG. University of Cape Town.

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Hine, P, Sealy, J, Halkett, D and Hart, T. 2010. Antiquity of stone walled fish traps on the Cape Coast of South Africa. The South African Archaeological Bulletin. Vol. 65, No. 191 (JUNE 2010), pp. 35-44

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

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

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

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

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

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

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

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

Declaration of independence

I,Tim JG Hart declare that -- General declaration:

I act as the independent specialist in this application;
I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant;
I declare that there are no circumstances that may compromise my objectivity in performing such work;
I have expertise in conducting the specialist report relevant to this application, including knowledge of the Act, Regulations and any guidelines that have relevance to the proposed activity;
I will comply with the Act, Regulations and all other applicable legislation;
I have no, and will not engage in, conflicting interests in the undertaking of the activity;
I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing - any decision to be taken with respect to the application by the competent authority; and - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
all the particulars furnished by me in this form are true and correct; and
I realise that a false declaration is an offence in terms of regulation 48 and is punishable in terms of section 24F of the Act.

TJG Hart.

Signature of the specialist:

ACO Associates CC

Name of company (if applicable):

30 September 2017

Date:

GLOSSARY

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

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

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

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

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

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

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

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

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

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

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

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

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

Palaeosole: *An ancient land surface.*

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

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

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

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

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

Acronyms

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

Contents

1 Introduction

The proposed San Kraal wind energy facility is situated just 6 km south east of the town of Noupoort on the edge of the escarpment of a high lying area known locally as the Kikvorsberge. The area is characterised by a high plateaux with snow adapted vegetation and *suurveld* grasses. Several degraded dolerite dykes pass through this mainly shale area. It is sparsely populated and generally rural, with razing of sheep and cattle being the primary occupation of local famers. In the winter months the Kikvorsberge can be exceptionally cold and is also windy and exposed year round. ACO Associates has been appointed by Arcus Consulting to carry out the heritage impact assessment for the EIA process. The scoping report was completed in 2016-17 and the field work for the current study was completed between 15 – 23 September 2017.

The proposed 390 MW San Kraal WEF would consist of the following infrastructural components:

- Up to 78 turbines with a generation capacity between 3 – 5 MW and a rotor diameter of up to 150 m, a hub height of up to 150 m and blade length of up to 75 m;
- Foundations (up to 25 x 25 m) and hardstands associated with the wind turbines;
- Internal access roads of between 8 m (during operation) and 14 m (during construction) wide to each turbine;
- Medium voltage underground electrical cables will be laid to transmit electricity generated by the wind turbines to the on-site switching station or substation;
- Overhead medium voltage cables between turbine rows where necessary;
- An on-site switching station (10 000 m^2);
- An 4 km medium voltage overhead line connecting the on-site switching station with the on-site medium voltage/132 kV substation;
- An on-site substation and OMS complex (180 000 m^2) to facilitate stepping up the voltage from medium to high voltage (132 kV) to enable the connection of the WEF to the proposed Umsobomvu WEF 132/400 kV Substation, and the generated power will be fed into the national grid;
- A 23 km 132 kV high voltage overhead power line from the on-site substation to the proposed 400 kV Umsobomvu substation to the national grid;
- 3 turn-in options of 45 000 m^2 – 450 000m^2 at Eskom MTS SS
- Two 90 000 m^2 alternative areas for batching plants, temporary laydown area and construction compound
- Temporary infrastructure including a site camp; and
- A laydown area approximately 7500 m^2 in extent, per turbine.

  The total size of the land portions within which the proposed development will be located is 10 511.51 hectares. The footprint of the proposed development is estimated to be less than 1% of this area

Description	Dimensions		
	Length (m)	Breadth (m)	Area (sqm)
Eskom 132/400 kV Umsobomvu substation	600	600	360000
San Kraal WEF medium voltage/132 substation and OMS area	600	300	180000
Construction compound, temporary laydown area and batching plant	300	300	90000

1.1 Time and season

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

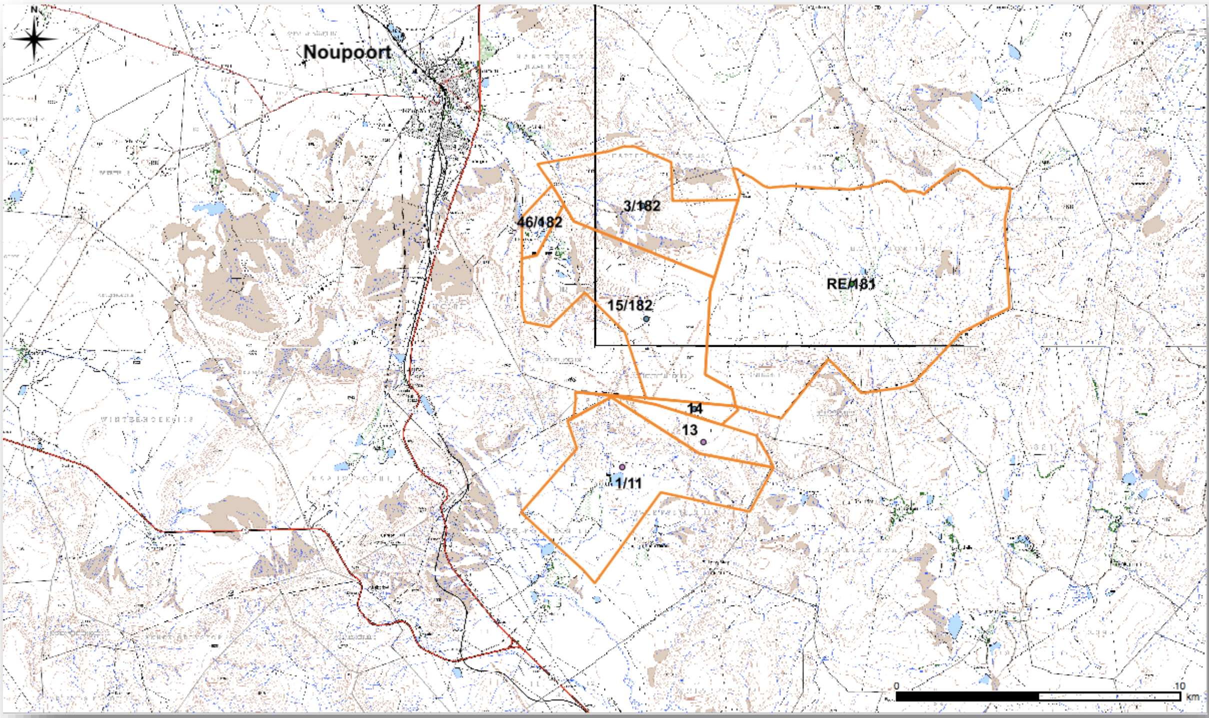

Figure 1 Location of the proposed San Kraal WEF.

2 Methodology

The study area is known to the author of this report as he has completed a number other studies nearby including being a staff member of the Zeekoe Valley Archaeological project and a co-excavator with Prof Brit Bousman (Bousman 1988) at Blydefontein in the nearby Kikvorsberge.

In term of written sources, a number of heritage studies have taken place in the region as well as the Zeekoei Valley Archaeological Survey which has generated numerous scientific publications on Karoo archaeology. The heritage of the eastern Great Karoo is therefore quite well understood, well published and available.

2.1 Assessing heritage in the context of wind energy developments

Wind energy facilities have increased exponentially throughout the world in response to the international energy crisis and climate change. Initially communities enthusiastically accepted the presence of wind energy facilities, however web-based research of international experience has indicated that they are not without controversy. The impacts of clusters of massive wind turbines on cultural landscape can be severe, 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 recognised that severe impacts can occur, however the heritage authorities generally recognise the desirability of clean energy and the need to build clean energy facilities in landscape that can tolerate them. Heritage sites are contextually sensitive to any form of development – this is particularly the case with a heritage site or place that is well known, well used and publically celebrated.

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

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

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

2.2 Landscape and setting

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

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

a. The **clearly defined landscape** designed and created intentionally. This embraces garden and parkland landscapes constructed for aesthetic reasons
b. The **organically evolved landscape.** This results from an initial social, economic, administrative, and/or religious imperative and has developed its

present form by association with and in response to its natural environment. Such landscapes reflect that process of evolution in their form and component features. They fall into two sub-categories:

c. A **relict (or fossil) landscape** is one in which an evolutionary process came to an end at some time in the past, either abruptly or over a period. Its significant distinguishing features are, however, still visible in material form.
d. A **continuing landscape** is one which retains an active social role in contemporary society closely associated with the traditional way of life, and in which the evolutionary process is still in progress. At the same time it exhibits significant material evidence of its evolution over time.
e. The **associative cultural landscape** included by virtue of the powerful religious, artistic or cultural associations of the natural element rather than material cultural evidence which may be insignificant or even absent (Extract from paragraph 39 of the Landscape *Operational Guidelines for the Implementation of the World Heritage Convention)*

Also criteria that have been considered (Baumann *et al.* 2005) locally are:

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

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

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

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

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

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

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

The study area lies within a rural context. In terms of the UNESCO guidelines it is a natural evolving landscape. In terms of the assessment checklist published by Baumann *et al.* (2005) the landscape is largely intact as a natural landscape and intrusions within the last 60 years are moderate. The landscape may, therefore- be considered reasonably authentic.

2.3 Survey method and impact assessment

The site was comprehensive searched, mainly on foot in that all but 19 of 78 proposed turbine location were located in the field. The team was unable to reach some turbines due to distance and impassable roads, even for an off-road vehicle. Large tracks of land between turbines and farm roads were walked on foot. The team members were equipped with a GPs unit each, field kit and UHF radios. Any heritage site that was located, was mapped, recorded and graded as per the SAHRA grading system. No trial holes were dug and all observations were based on surface material. The palaeontological assessment involved identifying geological exposures in the project area that would provide suitable opportunities for identifying fossil remains giving an indication of what could be expected sub-surface.. Sites sites were mapped, photographed and described.

The assessment of impacts was carried out as per the instructions furnished by Arcus Consulting Pty Ltd.

2.4 Assumptions and uncertainties

Access to the site was mostly good (apart from one area) and the survey team was able to check to majority of turbine positions and infrastructure alignment in the project area. While it was not possible to cover the entire landscape of the project area, overall coverage was good and there is reasonable confidence in the findings. There is an underlying assumption in all the work and findings that the regional archaeological sequence as determined by the nearby Zeekoei Valley Archaeological Project applies.

3 Legislation and policies

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

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

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

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

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

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

i) exceeding 5 000 m2 in extent; or

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

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

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

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

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

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

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

3.1 Scenic Routes

While not specifically mentioned in the NHRA, No 25 of 1999, Scenic Routes are recognised as a category of heritage resources which requires grading as the Act protects area of aesthetic significance (see clause "e" above). Baumann & Winter (2005) comment that the visual intrusion of development on a scenic route should be considered a heritage issue.

3.2 Heritage Grading

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

1) Decide what kind of landscape is involved (rural, natural wilderness, historical townscape or historical agricultural area) – establish its dominant characteristics taking cognisance of UNESCO guidelines and previous work.
2) Establish the value of the landscape in terms of its history, its aesthetic value and its value to a given community (in this case its tourism value).

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

3) Consider the intactness of the landscape – has it been recently intruded on by new development (we have taken 60 years as a marker as this is generally used as a historic cut-off), and using the grading system as a guide suggest a field grading.

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

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

Grade	Level of significance	Description
1	National	Of high intrinsic, associational and contextual heritage value within a national context, i.e. formally declared or potential Grade 1 heritage resources.
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. It must be noted that the subdivision of grades 3A-3C is merely a guidance tool and not legally applicable.

4 Need and desirability of the project

The need for renewable energy is essentially two-fold. Firstly the planet is facing an unprecedented environmental crisis brought on historical dependence on fossil fuels which have contributed to global warming and climate change. Wind turbines represent renewable energy that is not dependent on the use of fossil fuels (apart from during construction). During operation they produce no emissions. Secondly, South Africa which is heavily reliant on fossil fuels is having its own energy crisis as there is not enough generating capacity to sustain base-load supply. A diversity of supplementary sources is needed to contribute to the national grid.

The negative side of renewable energy facilities is that they are large industrial developments that are more often than not situated outside of the urban edge. Hence the impacts on the aesthetic and heritage qualities of large tracts of the South African Landscape can be high.

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 central Karoo landscape.

5.1 The Karoo as a cultural landscape

The central Karoo is almost entirely given over to sheep, some cattle and game farming. Overgrazing since the advent of formal farming in the 19th 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* and uranium mining taking place, as well as the construction of the Square Kilometer Array, will accumulatively add a significant 21st century development layer that will significantly impact the status-quo and probably irreversibly.

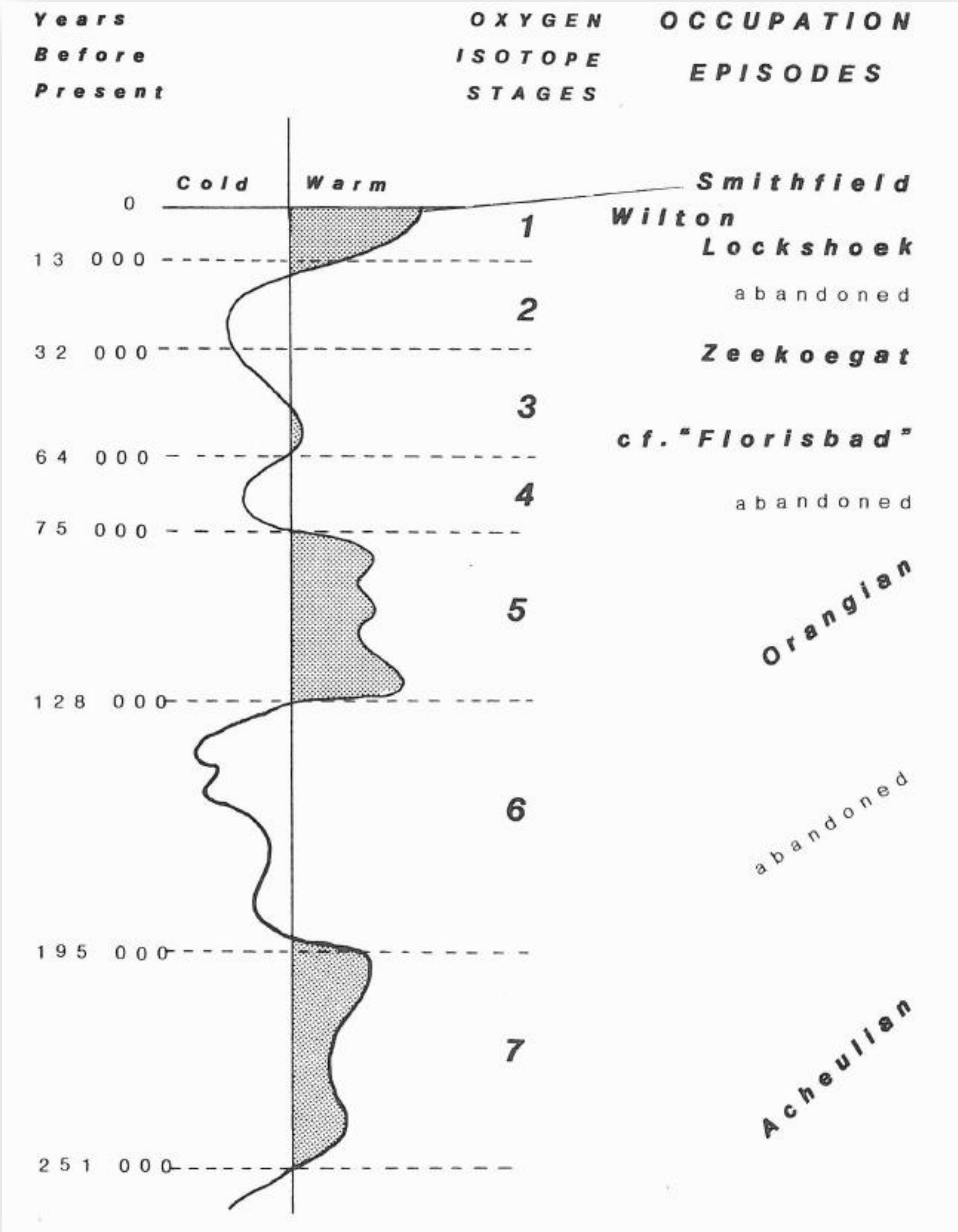

Figure 2 The sequence of occupation of the Karoo by humans as proposed by Sampson 1985 (after Sampson 1985).

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.

5.1.1 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. The project area lies in a mosaic of highly fossiliferous areas within the Karoo. The project area has been surveyed in detail by John, Almond and the anticipated impacts presented in this report. Almonds (2017) site report is included as Appendix B.

The geology and paleontology of the region has been a subject of research since the early 20th 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.

5.1.2 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 immediately west 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. 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 2 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 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. Similarly sites tend to be rare on exposed hilltops and very high ridges 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.

5.1.3 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 and Sneeuberg Mountains). Similarly *trekboer* settlers find their progress onto the upper escarpment halted at 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 Drostdy of Graaff Reinet (the northernmost regional center of the time) 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 *trapvloere* – 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 Reinet, 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 Karoo San brought to an end by force of arms (Franzen 2006). Noupoort was established in the 1870’s as a railway junction when the Union Railway Company established the railway system. It was a railway village until 1942 when it gained a formal municipality (Raper, Undated). It continues to play an important role in the functioning of the railway system but is not a tourist destination of consequence.

5.1.4 History of the farms

Indications are that most of the farms in the study area would have started as loan farms.
A loan farm was given out after a person petitioned the government for permission to use a piece of land. They paid tithes to the government for the use but it was not generally recorded in title deeds with surveyor’s diagrams. Many of these loan farms were circular in shape because of a custom that allowed the farmer to take a measurement from a central spot, such as a homestead, spring or rock formation. The walking-off distance was regarded as about 750 roods (2.8km), amounting to an area of around 3000 morgen (2570 hectares). Weak springs are at the centres of most of loan farms indicates the importance of even the most meagre water resources on this landscape. The formal granting of title deeds only took place in the early 19th century, however judging by the kinds of artefacts and structures found on the landscape, many of the farms were established informally long before land was formally granted or loaned.

6 Identified sensitivities

6.1 Palaeontology

Any form of bedrock excavation has the potential to affect continental sediments of the Beaufort Group. Most of the San Kraal WEF footprint will be situated in dissected rocky plateau areas underlain by continental sediments of the Katberg Formation (Upper Beaufort Group / Tarkastad Subgroup, Karoo Supergroup) of earliest Triassic age. Latest Permian sediments of the underlying Balfour Formation crop out along the foot of the Katberg escarpment but are generally mantled by a thick apron of colluvium (sandy and gravelly scree, hillwash) and alluvium. Elsewhere in the Main Karoo Basin these sediments have yielded locally abundant vertebrate fossils, large vertebrate burrows, a small range of invertebrate burrows but only rare plant remains. The uppermost Balfour and Katberg Formations preserve an important record of biological and palaeoenvironmental events on land during the catastrophic Permo-Triassic extinction of 252 Ma (million years ago) and subsequent biotic recovery. Several vertebrate fossil localities in the Noupoort area are noted in the scientific literature but only a few fossil remains were recorded during a four-day field assessment of the San Kraal WEF and associated powerline. These include fragmentary bones and teeth within calcrete breccias as well as several large vertebrate burrows, one with associated disarticulated bones. The paucity of recorded fossil sites here is probably due to (1) the very low exposure levels seen here of overbank mudrocks where most fossils are preserved, and (2) the predominance of amalgamated channel sandstone facies in the upper part of the Katberg Formation building the plateau areas. Scientifically-important fossil remains in the subsurface may well be compromised by the proposed WEF development during the construction phase, notably due to voluminous bedrock excavations for wind turbine footings (Almond 2017).

Excavations and other construction work undertaken into bedrock in order to install the wind turbines and associated infrastructure could expose, disturb, destroy or seal-in valuable fossil heritage. Although the direct impact will be local, these fossils are of importance to national as well as international research projects on the fossil biota of the ancient Karoo and the Permian mass extinction events.

6.2 Archaeological heritage

The pre-colonial heritage sensitivities of the site are typical of what has been found in the area before. Rock paintings are known to exist in the area while Orton (2014) located evidence of numerous Late Stone Age archaeological sites, stone features, graves and historic ruins in the Blydefontein area at the site of the nearby Noupoort WEF.

Experience throughout the Karoo has shown that high ridges seldom attracted any form of prehistoric occupation. Ridge tops tend to be dry, windswept and very cold in winter. Unless there was a large rock shelter, source of water or a raw material, it is not expected that the system of ridges with the study area are likely to be sensitive in terms of archaeology. The turbine sites which are normally situated on high ground are likely to be relatively insensitive.

Valley bottoms were rather more favoured by pre-colonial people for occupancy. Here there are normally sources of water, shelter from the prevailing winds as well as the potential for grazing small stock on or close to the sandy river beds. Also important were low ridges on or adjacent to flat plains. Khoikhoi kraals were almost always built adjacent to or against low ridges and cliffs. Anywhere where there is a cluster of rock that provided shelter from the wind or a shallow cave inevitably has archaeological material associated with it.

The field survey, which was comprehensive, identified some 19 archaeological occurrences and sites and historical period kraals and ruins. The majority of these sites consist of insignificant surface scatters of 3-4 stone artefacts of patinated hornfels of Middle Stone Age origin. There is one site (below) that requires mitigation is the form of collection of artefactual material prior to commencement of the construction phase. Appendix A contains details of all archaeological sites along with gradings.

Holbrook JG017-JG019: Four co-ordinates mark the presence of a scatter of Middle Stone Age material associated with rocky shelves and a stone outcrop which is worth mitigation. It lies some 30m from a turbine position and is therefore in danger of being impacted. The site contained a number of formal artefacts (blades, a scraper and regular cores in hornfels).

Figure 3 The Holbrook archaeological occurrences are associated with this rock outcrop.

Generally the archaeology of the high *suurveld* plateaux's is sparse and ephemeral. The area is bitterly cold in winter and there are no sizeable rock outcrops that provide shelter from the strong winds of the area. No ceramic period sites, rock engravings, San rock paintings were identified.

6.3 Landscape and setting

Aesthetic impacts along the escarpment of the Kikvorsberge will be affected. The escarpment while not dramatic, is a scenic area, while the N9 is a scenic Karoo route. It has strong wilderness qualities, typical Karoo vistas and a sense of isolation. The combined effect of wind energy facilities will impact the aesthetic qualities of the region which will diminish the value of the landscape as an aesthetic resource. The nearby Noupoort Wind

Figure 4. The nearby established Noupoort wind farm reflects how the San Kraal landscape will change.

Farm, which has been completed (figure 4), provides a good idea of the industrialising affect the turbines will have on the landscape. It can also be argued that tourism in this remote area is undeveloped. The Kikvorsberge are difficult to access and not generally used for tourism, but are used for grazing when vegetation quality allows.

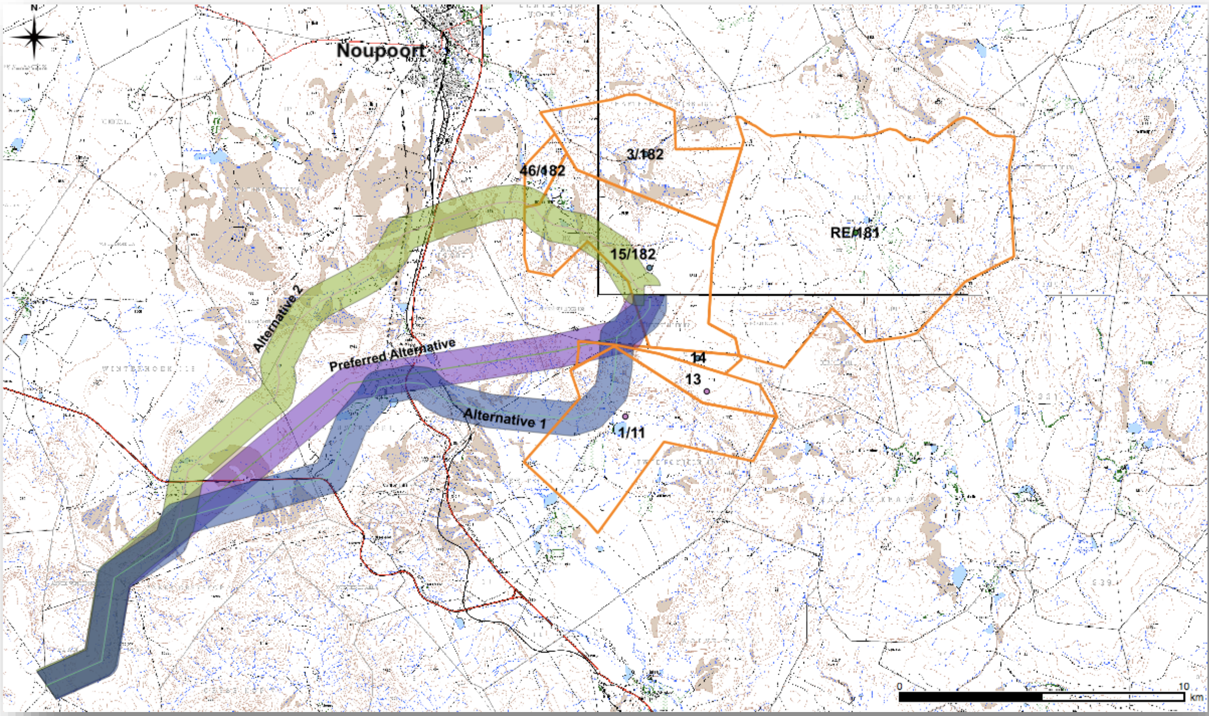

Figure 6 The three San Kraal grid connections and corridors.

7 Alternatives

Alternatives for grid connections have been proposed. Three options have been proposed for the San Kraal grid connections which will be overhead lines. All proposed OHLs pass over the Phezukomoya proposed WEF.

Preferred Alternative: This runs centrally through the project area joining the on-site substation with Umsobomvu substation.

Alternative 1 is the southern-most option joining the on-site substation with Umsobomvu substation.

Alternative 2: This is the northern most option, and the only one identified which will have an impact on heritage resources.

8 Impact Assessment

8.1 Potential Impacts associated with wind energy facilities.

Wind energy facilities are big developments that can produce a wide range of impacts that will affect the heritage qualities of an area. Each turbine site needs road access that can be negotiated by a heavy lift crane(s) which means that in 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 between 2 - 4m and over an area of some 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 that will connect to an onsite switching-station, where after the generated current will transported via 132kV transmission powerlines to the proposed 400kV Umsobomvu Substation to be located west of the facility, of which there after the generated electricity will be fed into the national grid via 400kV transmission lines.

8.2 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 that lies on it can be expected:

- Construction 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 power line/s;
- Construction of electrical infra-structure in the form of one or more sub-stations.

In terms of impacts to heritage, archaeological sites which are highly context sensitive are most vulnerable to the alteration of the land surface. The best way to manage impacts to archaeological materials is to avoid impacting them. This means micro-adjusting turbine positions where feasible, or routing access roads and cable alignments 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 from 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.

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

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

- Existing farm tracks be re-used or upgraded to minimise the amount of change to un-transformed landscape;
- A further walk through of the site prior to construction is not necessary, however there are both palaeontological and archaeological areas of sensitivity where

particularly the powerline will need to be micro-adjusted, It may be possible to do this during the line design phase through exchange of drawings, or if necessary by means of a short site visit to point out the areas of concern. Detailed depictions of areas of sensitivity are presented in Appendices A and B. During the EIA phase the population of heritage sites in and around the study area was sampled so that the findings can inform planning decisions. In this case almost complete (75%) survey coverage of the turbine positions has been achieved which means that mitigation of individual impacts, particularly to archaeological sites comes with a high level of confidence.

8.3 Impacts expected during operation of the wind energy facility

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

During the operational life of the wind farm, 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, but 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.
- 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 indefinitely. Bankruptcy or neglect by a wind energy company can result in turbines standing derelict for years creating a long term eyesore.

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

In the case of San Kraal, the expectation is that very few, if any people will be exposed to these kinds of impacts. There are no inhabited structures with or close to the project area therefore these impacts will not apply.

9 Accumulative impacts

Accumulative impacts in the Great Karoo are a concern. There are some proposals for renewable energy facilities within a 35 km radius (Figure 5), however it is anticipated that not all of these will be implemented. The combined effect of wind energy facilities will impact the aesthetic qualities of the region which will diminish the value of the landscape as an aesthetic resource and potentially affect its future in terms of conservation related enterprises which in recent years have blossomed throughout the central Karoo. Measurement of the accumulative impact of renewable energy facilities is extremely difficult due to the degree of subjectivity involved in making such a judgement.

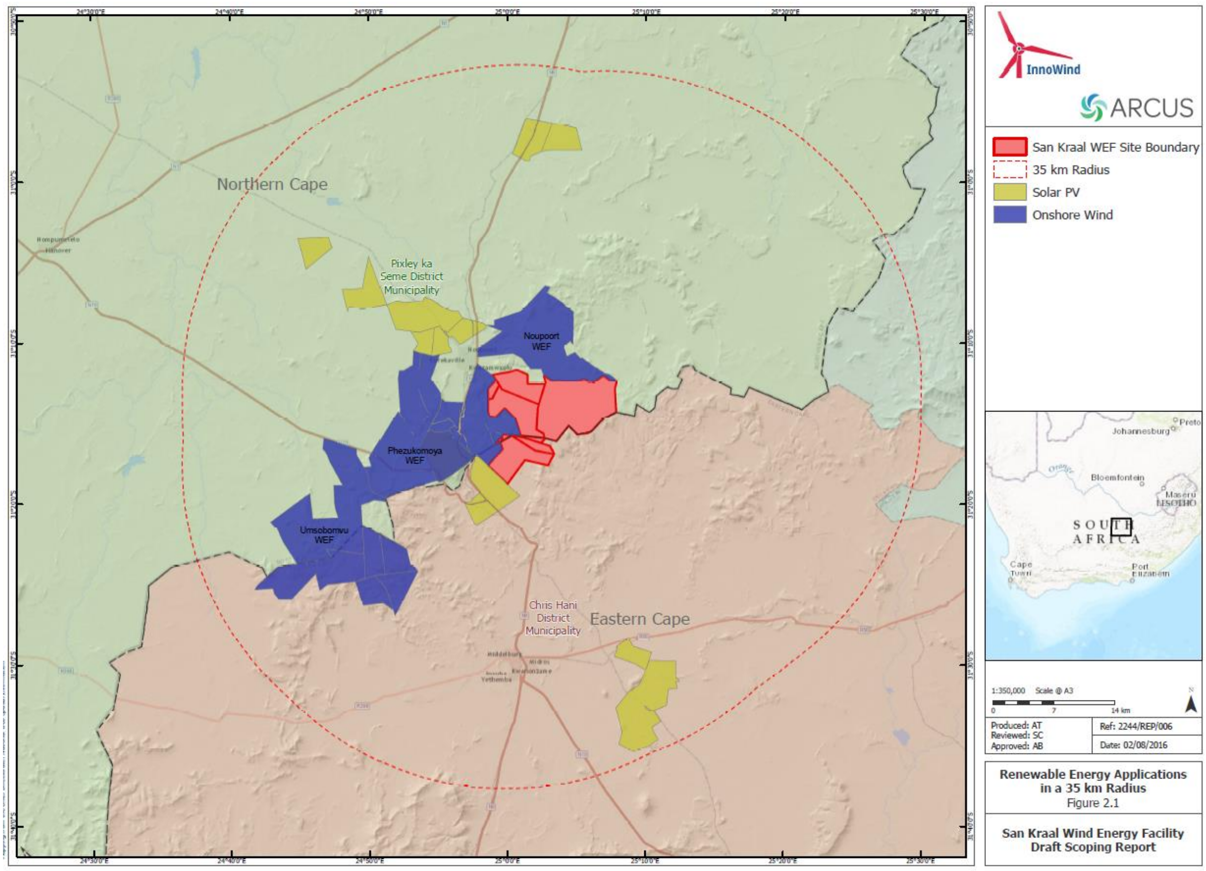

Figure 5. The map of renewable energy proposals shows the potential for accumulative impacts between De Aar, Noupoort and Middelburg (with a 35 km radius).

9.1 Accumulative impacts on physical heritage

The real assessment of accumulative impacts is difficult due to the variable consistency of available reports, and in some instances a clear lack of ability on the part of consultants to identify the complex phasing of the Stone Age heritage of the area. Some reports are field based, other desktop based and often field surveys are relegated to mitigation rather than supporting the assessment of impacts. Furthermore, the true accumulative impacts can only be established on the basis of audits of successful mitigation carried out, and this information is not available. Hence it is with a medium degree of confidence that the assessment of accumulative impacts is presented.

An examination of the four proposed wind energy facilities: Noupoort (Orton 2013) De Aar (Webley and Orton 2012) and Umsobomvu (Anderson 2013) and Phezukomoya (Hart in prep) within 35 km of the project area has revealed that each site has similar archaeology – mainly open scatters of Stone Age material, the majority of which is ungraded or have grade 3 ratings. De Aar, Although outside the radius was included for comparative purposes. That fact the typically the wind farm developments will only affect less than 1 percent of the project area, and the actual instances of physical impacts to tangible heritage are very low. Indications are that the accumulative impacts will be of low consequence. Solar PV applications are rather more damaging in that full preparation and clearing of the surface areas of sites is generally required which is very destructive to archaeological/heritage material without mitigation. The land parcels involved tend to be smaller than with wind energy facilities but avoidance of lesser significance Grade 3 archaeological sites is more difficult. It is noted however that heritage professionals have activated protection measures for more important sites in the , Noupoort CSP (Van der Walt 2016) and Klipgat (Tomose 2012) Dida facilities (Booth 2012) and Tollie (Booth and Sanker 2012). Some loss of grade 3 heritage is expected, but since this category of grade is the most common, the accumulative impact is tolerable. Unfortunately the true assessment of accumulative impacts can only be determined through the auditing of the success of mitigation measures for newly established renewable energy facilities in the 35 km radius. Indications are that much of the heritage mitigation that has been suggested has not been carried out according to the record of submissions contained within the SAHRIS database. There are few applications to remove archaeological or palaeontological material with respect to renewable energy projects in general. This could mean that mitigation through adjusting infrastructure positions is successful, or that heritage sites are not being mitigated through removal or systematic excavation. No finds of fossils in the context of construction of renewable have been lodged which is an indication that finds of such material are not being reported. Hence the general success of mitigation measures is very difficult to establish accurately.

The accumulative impacts to palaeontological resources are difficult to measure as the overall population of fossils is not known. In reality the resource is huge as the fossiliferous Beaufort group continues deep underground (1km or more). Palaeontologists only have access to surface manifestations. Very few of the palaeontological surveys that have been done in the area are more an assessment of rock type and the likelihood of there being fossils rather than an exercise in locating fossils at the points of impact within a given development activity. Virtually every report has recommended some form of monitoring and mitigation, but very seldom have such measures been implemented to date (judging by online and published literature). It is only once palaeontologists have seen deep into site excavations can the frequency and extent of fossils be commented on in any meaningful way. Indications are that the accumulative impacts are likely to be quite low given the massive size of the resource.

Table 1 Summary of accumulative impacts

<table>
<tr><td colspan="8">Impact Phase: Construction and operation</td></tr>
<tr><td colspan="8"><u>Possible</u> Impact or Risk: Risk of accumulative damage to the National Estate.</td></tr>
<tr><td></td><td>Extent</td><td>Duration</td><td>Intensity</td><td>Status</td><td>Significance</td><td>Probability</td><td>Confidence</td></tr>
<tr><td>Without Mitigation</td><td>M</td><td>M</td><td>L</td><td>Negative</td><td>L</td><td>L</td><td>M</td></tr>
<tr><td>With Mitigation</td><td>M</td><td>M</td><td>L</td><td>Negative</td><td>L</td><td>L</td><td>M</td></tr>
<tr><td colspan="3">Can the impact be reversed?</td><td colspan="5">Aesthetic and cultural landscape impacts can be reversed after the life of the facilities. Damage to physical heritage cannot be reversed, however few archaeological sites have been destroyed in development projects within the 35 km radius (in terms of SAHRIS records).</td></tr>
<tr><td colspan="3">Will impact cause irreplaceable loss or resources?</td><td colspan="5">No, not if rehabilitation can be achieved after life of the facilities. Loss of palaeontological resources is unclear, loss of archaeological resources appear to be relatively few.</td></tr>
<tr><td colspan="3">Can impact be avoided, managed or mitigated?</td><td colspan="5">Impacts can be managed provided that mitigation is carried through. Records on the SAHRIS database contain very few applications to remove or destroy archaeological or palaeontological material from projects in the area which indicate mitigation through avoidance of impacts has been successful.</td></tr>
<tr><td colspan="8">Mitigation measures:
Methods must be developed my heritage authorities to assess the success of mitigation action within renewable energy projects. Given the lack of information at present it is difficult to judge success of mitigation, and therefore the degree of accumulative impact that has taken place.</td></tr>
<tr><td colspan="2">Can any residual risk be monitored/managed?</td><td colspan="6">N/a</td></tr>
<tr><td colspan="2">Will this impact contribute to any cumulative impacts?</td><td colspan="6">Indications are that the San Kraal project will generally have a low accumulative on physical heritage and not result in a significant impact to the National Estate.</td></tr>
</table>

10 Impacts of grid connection

Three alternatives for grid connections have been proposed.

The impact of the proposed San Kraal connections is of rather a lesser intensity than those associated with the wind energy facility. The footings for the towers are shallower and the service road is normally a simple track. It is possible that archaeological sites could be disturbed but the rather shallower excavations mean the palaeontological impacts will be less. The lines will cause an aesthetic impact for up to a 5 km radius (depending on topography and weather) which means that there is potential for accumulative impacts close to regional substations where grid connections converge. The presence of a certain amount of infrastructure in the area such as the N9 and the electrical and linear infrastructure of the railway system are 20th century clutter which means that the presence of additional powerlines lines are unlikely to be out of place in the local environment.

10.1 Archaeology

The field survey has shown that the area is sparsely inhabited and that there are no occupied heritage structures and very few significant archaeological sites that will be affected by the powerline alternatives. The impacts of the Preferred Alternative and Alternative 1 will be of very low significance, while selection of Alternative 2 will trigger a need for mitigation of an archaeological site which lies on Phezukomoya Land crossed by the San Kraal Alternative 2 grid connection. This is:

Farm Hartebeeshoek JR001: This site consists of two historic stone wall kraals which have been imposed over a scatter of artefacts of Stone Age origin which includes hornfels scrapers and cores. There is also an old stone barn and ash heap. While the site lies within a proposed cable route of Phezukomoya, it also lies within the San Kraal overhead powerline corridor Alternative 2 (Figure 8). The likelihood is that the site can be avoided, however determining the edge of the site will have to be done by an archaeologist thereafter it can be cordoned off.

10.2 Palaeontology

No palaeontological No-Go areas or highly-sensitive fossil sites have been identified within the main WEF development footprint on the Katberg sandstone plateau All fossil finds here are assigned a low field rating (Local Resource IIIC) and do not warrant mitigation. A 50 m-radius protective buffer zone is proposed for several vertebrate burrow sites along a stream bed on farm Winterhoek 118 (Field rating Local Resource IIIB). They lie close to the alignment of the **Alternative 1 132 kV** powerline route which, if chosen, should be moved slightly to the southeast in this sector to lie outside the proposed buffer zone Alternative 1 is the least-preferred route option from a heritage viewpoint for this reason, with no preference for either one of the other two route options under consideration.

10.3 Route preference

The Preferred Alternative are favoured over Alternative 1 and Alternative 2.

Figure 7 **Hartebeeshoek JR001 - historic kraals have been built over an earlier Stone Age (MSA) scatter.**

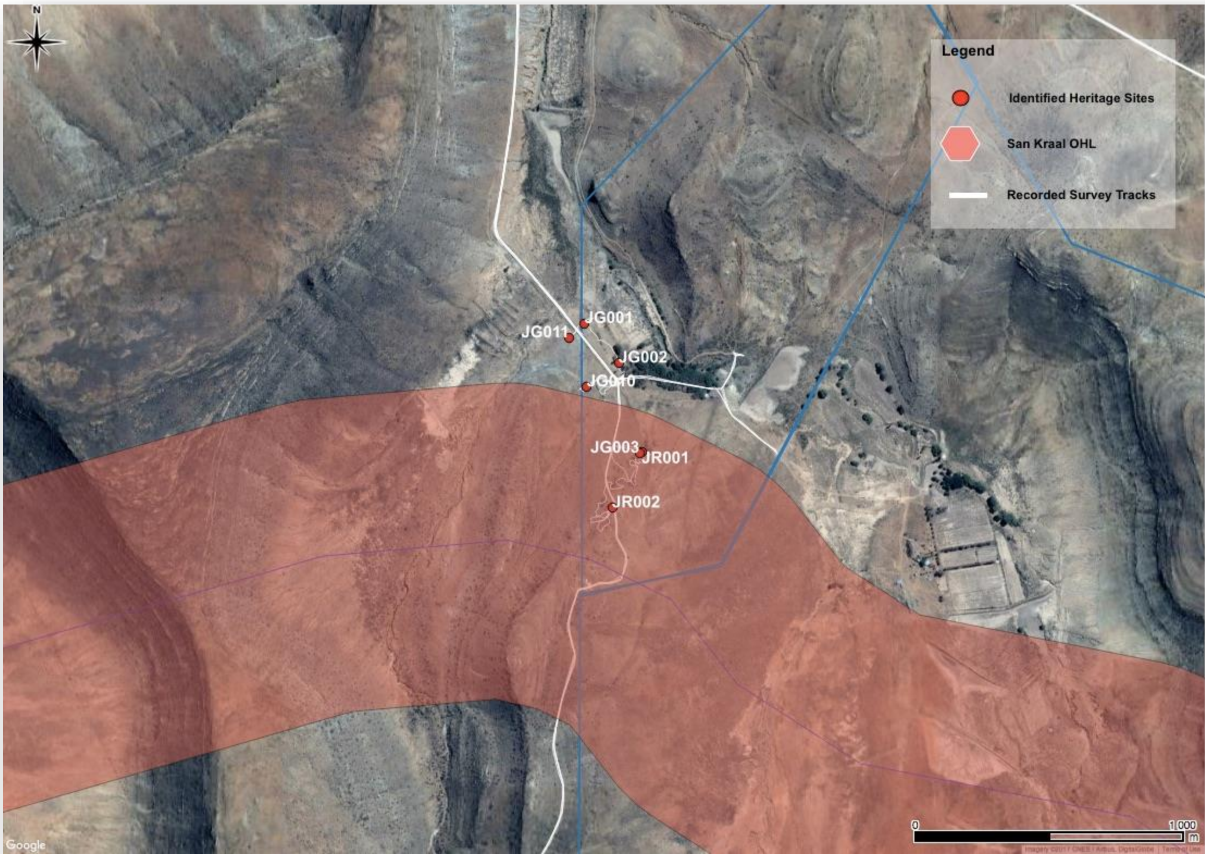

Figure 8 San Kraal Alternative 2 OHL corridor with identified heritage sites.

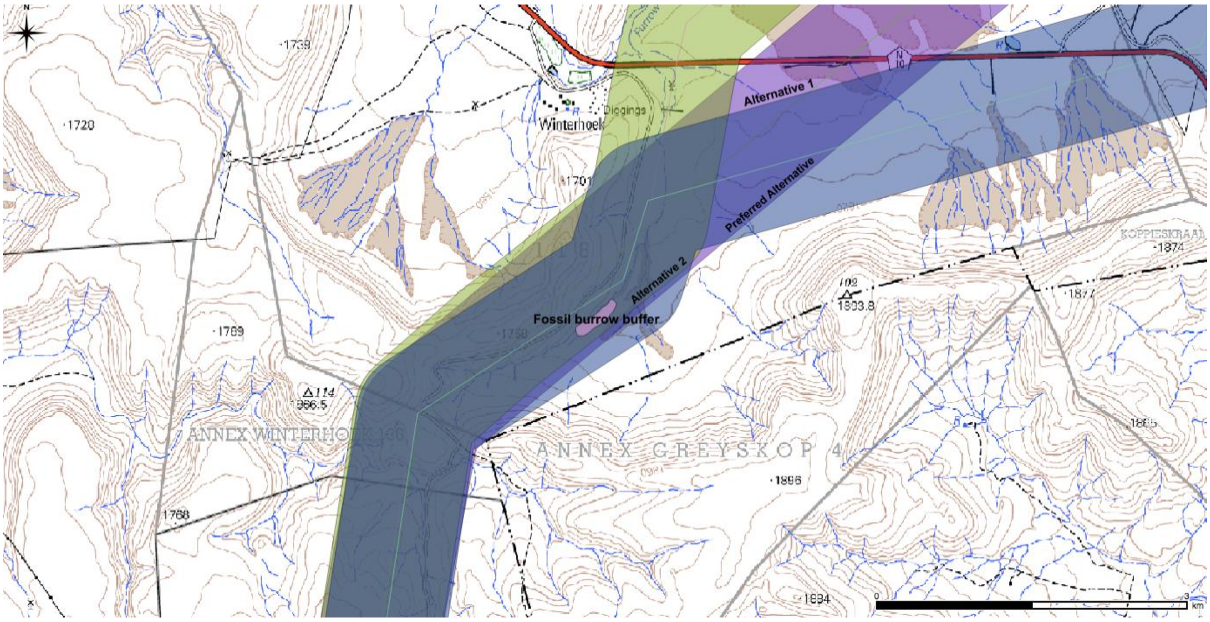

Figure 9 At the convergence of the powerlines is a palaeontologically sensitive area that contains fossil burrows of prehistoric vertebrates along a stream bed. Pylons may need to be micro-sited to avoid this area.

10.4 Impacts to palaeontological heritage

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

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

Extent of impacts: It is expected that impacts will be limited (local) There is a chance that the excavations for pylon bases could potentially impact buried fossil material, similarly excavation of cable trenches and clearing of access roads could impact material that lies buried in the surface mudstones. Potential impacts caused by power line and proposed access roads are similarly likely to be limited and local. The physical survey of the study area has shown that palaeontological material is not common on the site, with only a few fragments of fossil bone seen. One area has been buffered.

Significance of impacts: In terms of the information that has been collected, indications are that impacts to palaeontology could occur in the shale or sedimentary rock areas but not in dolerites. Few impacts are expected in the high areas where many of the turbines are to be situated, however information is based on surface observation only. The impacts have the potential to be of medium negative significance (Almond 2017), 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 2 Palaeontological impacts

Impact Phase: Construction							
Possibility of encountering unique fossils during excavation for turbine footings							
	Extent	Duration	Intensity	Status	Significance	Probability	Confidence
Without Mitigation	Local	Permanent	Medium	Negative	Medium -	M	H
With Mitigation	Local	Permanent	Low	Neutral – Positive.	Low	l	H
Can the impact be reversed?	NO – palaeontological heritage resources are non-renewable and key contextual data for fossils (sedimentology, taphonomy) is difficult to reconstruct following disturbance						
Will impact cause irreplaceable loss or resources?	Possible but UNLIKELY – well-preserved, scientifically valuable fossils are scarce within the project area. Many of the fossils concerned are probably of widespread occurrence (Exceptions: well-preserved, articulated vertebrate skeletons, vertebrate trackways).						
Can impact be avoided, managed or mitigated?	YES – effective mitigation of chance fossil finds by the ECO and a professional palaeontologist is possible, avoidance of “burrow find” buffer zone, implementation of preferred alternative.						
Mitigation measures: 1) Safeguarding of chance fossil finds (preferably in situ) during the construction phase by the responsible ECO, followed by reporting of finds to Heritage Western Cape / SAHRA. 2) Palaeontologist to monitor 10% of bulk excavations for turbine bases as per SAHRA requirement. 3) Recording and judicious sampling of significant chance fossil finds by a qualified palaeontologist, together with pertinent contextual data (stratigraphy, sedimentology, taphonomy) within the final footprint. 4) Curation of fossil material within an approved repository (museum / university fossil collection) by a qualified palaeontologist. 5) Avoidance of “burrow” buffer zone.							
Can any residual risk be monitored/managed?	YES, through ongoing application of the fossil chance finds procedure by ECO.						
Will this impact contribute to any cumulative impacts?	YES. Cumulative impacts, albeit very low-level, on local fossil heritage resources are anticipated. The accumulative impact is of very low significance.						

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

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

Table 3 Impacts to archaeology

Impact Phase: Construction only							
Possible Impact or Risk: Displacement or destruction of archaeological material, structures or kraals.							
	Extent	Duration	Intensity	Status	Significance	Probability	Confidence
Without Mitigation	L	M	L	Negative-neutral	Low-neutral	L	H
With Mitigation	L	M	L	Neutral	Low-neutral	L	H
Can the impact be reversed?	Minor mitigation is required with respect to micro-siting of Alternative 2, or remaining with the preferred alternative.						
Will impact cause irreplaceable loss or resources?	No, the very few occurrences noted are well represented in other area.						
Can impact be avoided, managed or mitigated?	Yes, impacts can be managed through avoiding use of Alternative 2.						
Mitigation measures: 1) Do not disturb and old stone kraals or ruins, do not remove stone from walls, or artefacts from the earth or earth surface. 2) Avoid farm yards and buildings (none in the alignment). 3) Report any chance discoveries of human remains to an archaeologist or a heritage authority.							
Can any residual risk be monitored/managed?	YES, mainly through avoidance or seeking advice from and archaeologist or heritage authority if necessary.						
Will this impact contribute to any cumulative impacts?	No. If mitigation is implemented there will be no accumulative impacts.						

10.6 Impacts to landscape quality

Compared with the turbines the impact of the grid connection will be small in comparison, and not particular aggressive. There will be backdrop scenery which will help absorb the lines and substation. If lattice towers are used, the impact to the landscape will be very low but monopoles will still be acceptable.

Table 4 Impacts to landscape quality

Impact Phase: Construction and operation

Possible Impact or Risk: Alteration of sense of place, destruction of landscape quality.							
	Extent	Duration	Intensity	Status	Significance	Probability	Confidence
Without Mitigation	L	M	L	Negative-	Low	H	H
With Mitigation	L	M	L	Negative	low	H	H
Can the impact be reversed?	Impact can be reversed after the life of the facility.						
Will impact cause irreplaceable loss or resources?	No, not if rehabilitation can be achieved after life of the facility.						
Can impact be avoided, managed or mitigated?	Yes, this can be achieved through tower choice and alignment adjustment although either tower type (monopole or Lattice) will be acceptable. Findings of the VIA are applicable.						
Mitigation measures: 1) Avoid farmsteads and structures (at least 400 m buffer). 2) Consider using a lattice tower form as these are visually more permeable, at a distance and are almost invisible against a backdrop.							
Can any residual risk be monitored/managed?	Yes, through good rehabilitation after life of facility, removal of towers.						
Will this impact contribute to any cumulative impacts?	Yes, this will make a minor contribution to a general aesthetic degeneration of the Great Karoo In the Noupoort area.						

11 Impacts in the proposed San Kraal WEF

11.1 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, *may* result in an un-redeemable loss to science and knowledge.

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

Significance of impacts: In terms of the information that has been collected, indications are that impacts to palaeontology will be low provided that mitigation is in place. Without mitigation it is suggested that impacts will be of medium negative significance.

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 5 Impacts to Palaeontology

Impact Phase: Construction							
<u>Possibility of encountering unique fossils during excavation for turbine foundations</u>							
	Extent	Duration	Intensity	Status	Significance	Probability	Confidence
Without Mitigation	L	H	M	Negative	Medium -	M	H
With Mitigation	L	H	L	Neutral – Pos.	Low	L	H
Can the impact be reversed?	NO – palaeontological heritage resources are non-renewable and key contextual data for fossils (sedimentology, taphonomy) is difficult to reconstruct following disturbance						
Will impact cause irreplaceable loss or resources?	Possible but UNLIKELY – well-preserved, scientifically valuable fossils are scarce within the project area. Fragments of incidental fossil bone are a widespread occurrence (Exceptions: well-preserved, articulated vertebrate skeletons, vertebrate trackways).						
Can impact be avoided, managed or mitigated?	YES – effective mitigation of chance fossil finds by the ECO and a professional palaeontologist is possible.						
Mitigation measures: 1) Safeguarding of chance fossil finds (preferably *in situ*) during the construction phase by the responsible ECO, followed by reporting of finds to Heritage Western Cape / SAHRA. 2) The monitoring of 10% of excavations into bedrock as per SAHRA guideline. 3) The avoidance of any buffer zones as recommended by the palaeontologist. Recording and judicious sampling of significant chance fossil finds by a qualified palaeontologist, together with pertinent contextual data (stratigraphy, sedimentology, taphonomy) within the final footprint. 3) Curation of fossil material within an approved repository (museum / university fossil collection) by a qualified palaeontologist.							
Can any residual risk be monitored/managed?	YES, through ongoing application of the fossil chance finds procedure by ECO.						
Will this impact contribute to any cumulative impacts?	YES. Cumulative impacts, albeit low-level, on local fossil heritage resources are anticipated as a result of construction of the considerable number of wind energy facilities that have been proposed for the central Karoo.						

Palaeontological mitigation

- During the construction phase a chance-finds procedure should be applied should substantial fossil remains such as vertebrate bones, teeth or trackways, plant-rich fossil lenses or dense fossil burrow assemblages be exposed by excavation or discovered within the development footprint. The responsible Environmental Control Officer should safeguard the fossils, preferably *in situ*, and alert the responsible heritage management authority (Heritage Western Cape for the Western Cape or ECPRHA for the Eastern Cape so that appropriate action can be taken by a professional palaeontologist, at the project owners 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.

- SAHRA has indicated that 10 percent of bedrock excavations must be monitored by a palaeontologist. This means that excavation of at least one turbine foundation and an area of deep road cutting (10%) should be done with a palaeontologist present.

- Palaeontological mitigation recommendations should be incorporated into the Construction Environmental Management Plan (EMP) for the 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.

11.2 Impacts to archaeological material:

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

Extent of impacts: It is expected that impacts will be very limited, if any (local). Most of the areas that will be affected by the proposed activity are archaeologically depleted due to their unfavourable habitation conditions.

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

Table 6 Impacts to archaeological heritage

Impact Phase: Construction only							
Possible Impact or Risk: Displacement or destruction of archaeological material.							
	Extent	Duration	Intensity	Status	Significance	Probability	Confidence
Without Mitigation	L	H	L	Negative-neutral	Low	L	H
With Mitigation	L	H	L	Negative neutral	Low	L	H
Can the impact be reversed?	Mitigation is required at one turbine position only (WTG 78) which is close to some scatters of archaeological material. Heritage impacts cannot be reversed, but can be mitigated.						
Will impact cause irreplaceable loss or resources?	No, the very few occurrences noted are well represented in other areas.						
Can impact be avoided, managed or mitigated?	This impact be avoided through adjustment of turbine position WTG 78, or if needed by systematic collection of the archaeological material.						
Mitigation measures: Precautions only. 1) Do not disturb and old stone kraals or ruins, do not remove stone from walls, or artefacts from the earth or earth surface. 2) Report any chance discoveries of human remains to an archaeologist or a heritage authority. 3) Moderate mitigation requirements have been identified that involve the avoidance of, or professional collection of archaeological material from archaeological sites. These lie within 30 m of the proposed position of WTG 78.							
Can any residual risk be monitored/managed?	YES, mainly through avoidance or seeking advice from and archaeologist or heritage authority if necessary.						
Will this impact contribute to any cumulative impacts?	No. The sites have a grade 3 rating. While locally interesting sites of this age are well represented in the Great Karoo.						

11.3 Impacts to 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.

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

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

Table 5. Impacts to colonial period heritage

<table>
<tr><td colspan="8">Impact Phase: Construction mainly but appropriate at all times as well.</td></tr>
<tr><td colspan="8"><u>Possible</u> Impact or Risk: Displacement or destruction structures.</td></tr>
<tr><td></td><td>Extent</td><td>Duration</td><td>Intensity</td><td>Status</td><td>Significance</td><td>Probability</td><td>Confidence</td></tr>
<tr><td>Without Mitigation</td><td>L</td><td>L</td><td>L</td><td>Negative-neutral</td><td>Low</td><td>L</td><td>H</td></tr>
<tr><td>With Mitigation</td><td>n/a
L</td><td>L</td><td>L</td><td>Negative - neutral</td><td>Low</td><td>L</td><td>H</td></tr>
<tr><td colspan="2">Can the impact be reversed?</td><td colspan="6">In the unlikely event of impacts occurring, they cannot be reversed without compromising authenticity. Even though precautionary mitigation provided, significance of impact does not change.</td></tr>
<tr><td colspan="2">Will impact cause irreplaceable loss or resources?</td><td colspan="6">No, this kind of heritage is well represented in the region.</td></tr>
<tr><td colspan="2">Can impact be avoided, managed or mitigated?</td><td colspan="6">Yes, impacts can be managed at level of ECO.</td></tr>
<tr><td colspan="8">Mitigation measures: precautionary only

1) Do not disturb and old stone kraals or ruins, do not remove stone from walls, or artefacts from the earth or earth surface.
2) Do not demolish without authority authorisation, ideally reuse old structures and cottages, care for the fabric but change it as little as possible.</td></tr>
<tr><td colspan="2">Can any residual risk be monitored/managed?</td><td colspan="6">YES, mainly through avoidance or seeking advice from an archaeologist or heritage authority if necessary.</td></tr>
<tr><td colspan="2">Will this impact contribute to any cumulative impacts?</td><td colspan="6">No. Impacts are not expected.</td></tr>
</table>

11.4 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 the Roggeveld-Komsberg region.

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

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

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

Table 7 Impacts to cultural landscape and setting

<table>
<tr><td colspan="8">Impact Phase: Construction and operation</td></tr>
<tr><td colspan="8"><u>Possible</u> Impact or Risk: Alteration of sense of place, destruction of landscape quality.</td></tr>
<tr><td></td><td>Extent</td><td>Duration</td><td>Intensity</td><td>Status</td><td>Significance</td><td>Probability</td><td>Confidence</td></tr>
<tr><td>Without Mitigation</td><td>L</td><td>M</td><td>M</td><td>Negative</td><td>Medium</td><td>M</td><td>H</td></tr>
<tr><td>With Mitigation</td><td>L</td><td>M</td><td>M</td><td>Negative</td><td>Medium-</td><td>M</td><td>H</td></tr>
<tr><td colspan="2">Can the impact be reversed?</td><td colspan="6">Impact can be reversed after the life of the facility.</td></tr>
<tr><td colspan="2">Will impact cause irreplaceable loss or resources?</td><td colspan="6">No, not if rehabilitation can be achieved after life of the facility.</td></tr>
<tr><td colspan="2">Can impact be avoided, managed or mitigated?</td><td colspan="6">No. Some moderate reduction in impacts may be possible with adherence to findings of the VIA</td></tr>
<tr><td colspan="8">Mitigation measures:
1) Mitigation can be achieved only in part due to size of turbines.
2) Adhere to findings and recommendations of the VIA</td></tr>
<tr><td>Can any residual risk be monitored/managed?</td><td colspan="7">N/a</td></tr>
<tr><td>Will this impact contribute to any cumulative impacts?</td><td colspan="7">Yes, this will contribute to a general aesthetic degeneration of the Kikvorsberg escarpment - remote scenic but seldom visited central Karoo.
It has been deemed an ideal locality in terms of wind resources, however the high volume of proposals for the area will result in industrialisation of a natural place of good aesthetic value. Depending on how many are eventually built the impact on cultural/heritage sense of place could be high.</td></tr>
</table>

12 Positive and negative impacts on environment

In terms of human made heritage, that is archaeology and built environment the impact is likely to be neutral or negative. There are other benefits associated with the project such as job creation for and around the community of Noupoort; also the project will have economic benefits for local businesses and service providers (e.g. accommodation for workers during construction); and as an addition, the project will have small positive benefit in that the data that is collected during the assessment or mitigation thereafter contributes to the general pool of research information..

The landscape qualities of the site are likely to be negatively impacted as a result in the physical changes to the appearance and character of the area. It will lose its sense of isolation and much of its sense of country.. The land however is not good for farming and the area is sparsely inhabited which means the change in the quality of the place will not affect many people.

Archaeological resources in the development site are sparse, and the majority of these will not be impacted by the proposal. Mitigation has been suggested for one turbine site only.

The successful detection of fossiliferous material on site during and before construction can be of benefit to science as these areas have the potential to contribute new knowledge. In contrast the destruction of fossil material during excavation or blasting constitutes a permanent and irreversible negative impact, especially if rare or unique specimens are lost.

12.1 Conclusion

Provided that mitigation is carried out as indicated, the overall impact of the proposed facility is tolerable and generally of low significance. Hence the proposed activity is supported. In terms of grid connections, the Preferred Alternative is supported. No preferred location for the batching plant or turn-in's for Umsobomvu substation are offered.

12.2 Mitigation

Moderate mitigation requirements have been identified that involve the avoidance of, or professional collection of archaeological material from two archaeological sites. One of these lies with 30 m of the proposed position of WTG 78, the other on Phezukomoya within the San Kraal grid connection corridor.

- In this case the mitigation requirement will be to sample the material on the site, or demarcate its boundaries with a temporary fence during construction to create a "no go zone". A 50 m buffer zone is also an alternative, however that will involve moving turbine 78 by an equivalent distance.
- A further site that will need moderate mitigation lies in the corridor of option 2 powerline hence preference for the Preferred Alternative is expressed Indications are that as the line is situated at present within the corridor, impacts can be avoided. Selection of option 2 is acceptable, however the line and service track must avoid site Hartebeeshoek JR001 by a 50 m buffer. Alternatively the site will need to be collected.

- At the point at which the powerline corridors converge, there is a stream bed where a number of trace fossils (early vertebrate burrows) have been identified. According to Almond (2017) the buffer zone must be avoided by the grid connections. The preferred grid connection alternative is supported.

12.3 Impact of mitigated layout

The final mitigated layout prepared by the proponent (December 2017) successfully avoids the identified impacts as described above and is therefore supported.

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14 Appendix A San Kraal Archaeological Observations

Green highlights = mitigation required. Please note that certain archaeological sites have more than one co-ordinate.

Area	WF Feature	Archaeological Observations	Associated Archaeological Waypoint	N	E	Proximity	Description	Grading	Photo
HBHK	WTG 1-12	n/a					COULD NOT ACCESS		
HOLBROOK	WTG 13	NO					No archaeology to observe here. Located on fence line between Hollbrook and Hartebeeshoek farms.		
HBHK	WTG 14	NO					No archaeology observed on route the network cable or the turbine location.		
HBHK	WTG 15	NO					Grassy flatland. No observed archaeology.		
HBHK	WTG 16	NO					Grassy flatland. No observed archaeology.		
HBHK	WTG 17	NO					No archaeology observed on route the network cable or the turbine location.		

Area	WF Feature	Archaeological Observations	Associated Archaeological Waypoint	N	E	Proximity	Description	Grading	Photo
HOLBROOK	WTG 18	NO					No archaeology to observe here. Located on fence line between Hollbrook and Hartebeeshoek farms.		
HOLBROOK	WTG 19	NO					No archaeology to observe here.		
HOLBROOK	WTG 20	NO					No archaeology to observe here. Approximately 20m from existing track.		
HBHK	WTG 21	NO					Grassy flatland. No observed archaeology.		
HBHK	WTG 22	NO					Grassy flatland. No observed archaeology.		
BKFT	WTG 23	NO					No archaeology observed on route the network cable or the turbine location.		
BKFT	WTG 24	NO					No archaeology observed on route the network cable or the turbine location.		
BKFT	WTG 27	NO					No archaeology observed on route the network cable or		

Area	WF Feature	Archaeological Observations	Associated Archaeological Waypoint	N	E	Proximity	Description	Grading	Photo
							the turbine location.		
BKFT	WTG 28	NO					No archaeology observed on route the network cable or the turbine location.		
BKFT	WTG 29	NO					Grassy flatland. No observed archaeology.		
BKFT	WTG 30	NO					Grassy flatland. No observed archaeology.		
BKFT	WTG 31	NO					Grassy flatland. No observed archaeology.		
BKFT	WTG 32	NO					Grassy flatland. No observed archaeology.		
BKFT	WTG 33	NO					No archaeology observed here.		
BKFT	WTG 34	NO					No archaeology observed here.		
BKFT	WTG 35	NO					No archaeology observed here.		
BKFT	WTG 36	NO					No archaeology observed here.		

Area	WF Feature	Archaeological Observations	Associated Archaeological Waypoint	N	E	Proximity	Description	Grading	Photo
BKFT	WTG 37	NO					Flat grassy land, no archaeology observed here.		
BKFT	WTG 38	NO					Flat grassy land, no archaeology observed here.		
BKFT	WTG 39	NO					No archaeology to observe here.		
BKFT	WTG 40	NO					No archaeology to observe here.		
BKFT	WTG 41	NO					No archaeology to observe here.		
BKFT	WTG 42	NO					No archaeology to observe here.		

Area	WF Feature	Archaeological Observations	Associated Archaeological Waypoint	N	E	Proximity	Description	Grading	Photo
HOLB ROO K	WTG 43	YES	JR008	-31.265264°	25.044311°	Approximately 200m from WTG 43	Large kraal about 100m2 with track running through it. Crosses into HBHK farm, includes a spring.	3	
		YES	JR009	-31.265125°	25.044786°	Approximately 200m from WTG 43	Smaller rock kraal adjacent to JR008.	3	

Area	WF Feature	Archaeological Observations	Associated Archaeological Waypoint	N	E	Proximity	Description	Grading	Photo
		YES	JR010	-31.265135°	25.044889°	Approximately 200m from WTG 43	Kraal butted up against rock shelter used as natural kraal.	3	
		YES	JR011	-31.265184°	25.045084°	Approximately 200m from WTG 43	Smaller kraal adjacent to JR008.	3	No image available
		YES	JR012	-31.265457°	25.046036°	Approximately 200m from WTG 43	Small rock shelter kraal SE of other kraals. Kraals seem to face erosion gully downstream from spring. Nice sense of place. No stone artefacts observed.	3	
		YES	JG013	-31.265672°	25.044031°	Approximately 200m from WTG 43	Historical kraal complex.	3	See image for JR008 above
HOLB ROO K	WTG 44	YES	JR013	-31.256548°	25.047231°	Approximately 300m from WTG 44	Large kraal stone wall about 50m2.	3	

Area	WF Feature	Archaeological Observations	Associated Archaeological Waypoint	N	E	Proximity	Description	Grading	Photo
		YES	JR014	-31.256381°	25.047226°	Approximately 300m from WTG 44	Shepherds cottage adjacent to kraal.	3	
HOLBROOK	WTG 45	NO					No archaeology to observe here.		
HOLBROOK	WTG 46	YES	JG015	-31.266264°	25.058187°	Approximately 200m from WTG 56	Stone cairn on rocky platform. Historical.		
HOLBROOK	WTG 47	NO					No archaeology to observe here.		
HOLBROOK	WTG 48	NO					No archaeology to observe here.		

Area	WF Feature	Archaeological Observations	Associated Archaeological Waypoint	N	E	Proximity	Description	Grading	Photo
HOLB ROO K	WTG 49	NO					No archaeology to observe here.		
HOLB ROO K	WTG 50	n/a					DID NOT ACCESS		
HOLB ROO K	WTG 51	NO					No archaeology observed on route the network cable or the turbine location.		
HOLB ROO K	WTG 52	YES	JR006	-31.237321°	25.043682°	Approximately 300m from network cable between WTG 53 and WTG 52.	Large Kraal rock wall behind (west) of JR003 and JR004. No stone artefacts present.	3	
		YES	JR003	-31.237027°	-31.237027°	Approximately 300m from network cable between WTG 53 and WTG 52.	Historical homestead complex, rock wall building.	3	

Area	WF Feature	Archaeological Observations	Associated Archaeological Waypoint	N	E	Proximity	Description	Grading	Photo
		YES	JR004	-31.237077°	25.044362°	Approximately 300m from network cable between WTG 53 and WTG 52.	Ruin of a house, two rooms, rock walls.	3	
HOLB ROO K	WTG 53	YES	JR007	-31.237388°	25.044846°	Approximately 300m from network cable between WTG 53 and WTG 52.	Stone wall and ruin house directly west of JR003 and east of JR004. No stone artefacts observed.	3	
HOLB ROO K	WTG 54	NO					No archaeology to observe on the connecting network cable or turbine location.		
HOLB ROO K	WTG 55	NO					No archaeology to observe on the connecting network cable or turbine location.		

Area	WF Feature	Archaeological Observations	Associated Archaeological Waypoint	N	E	Proximity	Description	Grading	Photo
HOLB ROO K	WTG 56	NO					No archaeology to observe on the connecting network cable or turbine location.		
HOLB ROO K	WTG 57	NO					Rocky landscape with shrubs. No archaeology was observed.		
HBHK	WTG 58	n/a					DID NOT ACCESS		
HBHK	WTG 59	n/a					DID NOT ACCESS		
HBHK	WTG 60	n/a					DID NOT ACCESS		
HBHK	WTG 61	n/a					DID NOT ACCESS		
HOLB ROO K	WTG 62	YES	JR005	-31.209009°	25.045385°	In close proximity to WTG 62 and network cable.	Small scatter of artefacts on a flat rocky landscape.		

Area	WF Feature	Archaeological Observations	Associated Archaeological Waypoint	N	E	Proximity	Description	Grading	Photo
HOLB ROO K	WTG 63	YES	JG012	-31.215235°	25.048868°	In close proximity to 63	Rocky deflation with scatter of weathered MSA flakes.		 
HOLB ROO K	WTG 64	NO					No archaeology to observe here.		
HOLB ROO K	WTG 65	NO					No archaeology to observe here.		
HOLB ROO K	WTG 66	NO					No archaeology to observe here.		
HOLB ROO	WTG 67	NO					No archaeology to observe here.		

Area	WF Feature	Archaeological Observations	Associated Archaeological Waypoint	N	E	Proximity	Description	Grading	Photo
K									
HOLB ROO K	WTG 68	NO					No archaeology to observe here.		
HOLB ROO K	WTG 69	n/a					DID NOT ACCESS		
HOLB ROO K	WTG 70	NO					No archaeology to observe here.		
HOLB ROO K	WTG 71	NO					No archaeology to observe here.		
HOLB ROO K	WTG 72	NO					No archaeology to observe here.		
HOLB ROO K	WTG 73	NO					No archaeology to observe here.		
HOLB ROO K	WTG 74	NO					No archaeology to observe here.		
HOLB ROO K	WTG 75	NO					No archaeology to observe here.		
HOLB ROO K	WTG 76	NO					No archaeology to observe here.		

Area	WF Feature	Archaeological Observations	Associated Archaeological Waypoint	N	E	Proximity	Description	Grading	Photo
HOLB ROO K	WTG 77	NO					No archaeology to observe here.		
HOLB ROO K	WTG 78	YES	JG017	-31.247626°	25.078736°	In close proximity to 78	Artefact scatter MSA silcrete core, located on NE side of rocky outcrop 30m from WTG 78.	3	 

Area	WF Feature	Archaeological Observations	Associated Archaeological Waypoint	N	E	Proximity	Description	Grading	Photo
		YES	JG018	-31.247650°	25.078614°	In close proximity to 78	Small scatter of MSA artefacts patinated including thumbnail scraper.	3	 

Area	WF Feature	Archaeological Observations	Associated Archaeological Waypoint	N	E	Proximity	Description	Grading	Photo
		YES	JG019	-31.247760°	25.078694°	In close proximity to 78	Small scatter of MSA artefacts patinated including thumbnail scraper.	3	 

Area	WF Feature	Archaeological Observations	Associated Archaeological Waypoint	N	E	Proximity	Description	Grading	Photo
		YES	JG020	-31.248576°	25.078860°	In close proximity to 78	Further scatter of stone artefacts in the lee of rocky shelf.	3	 
HBHK	WTG 101	n/a					DID NOT ACCESS		
BKFT	WTG 102	NO					No archaeology observed on route the network cable or the turbine location.		

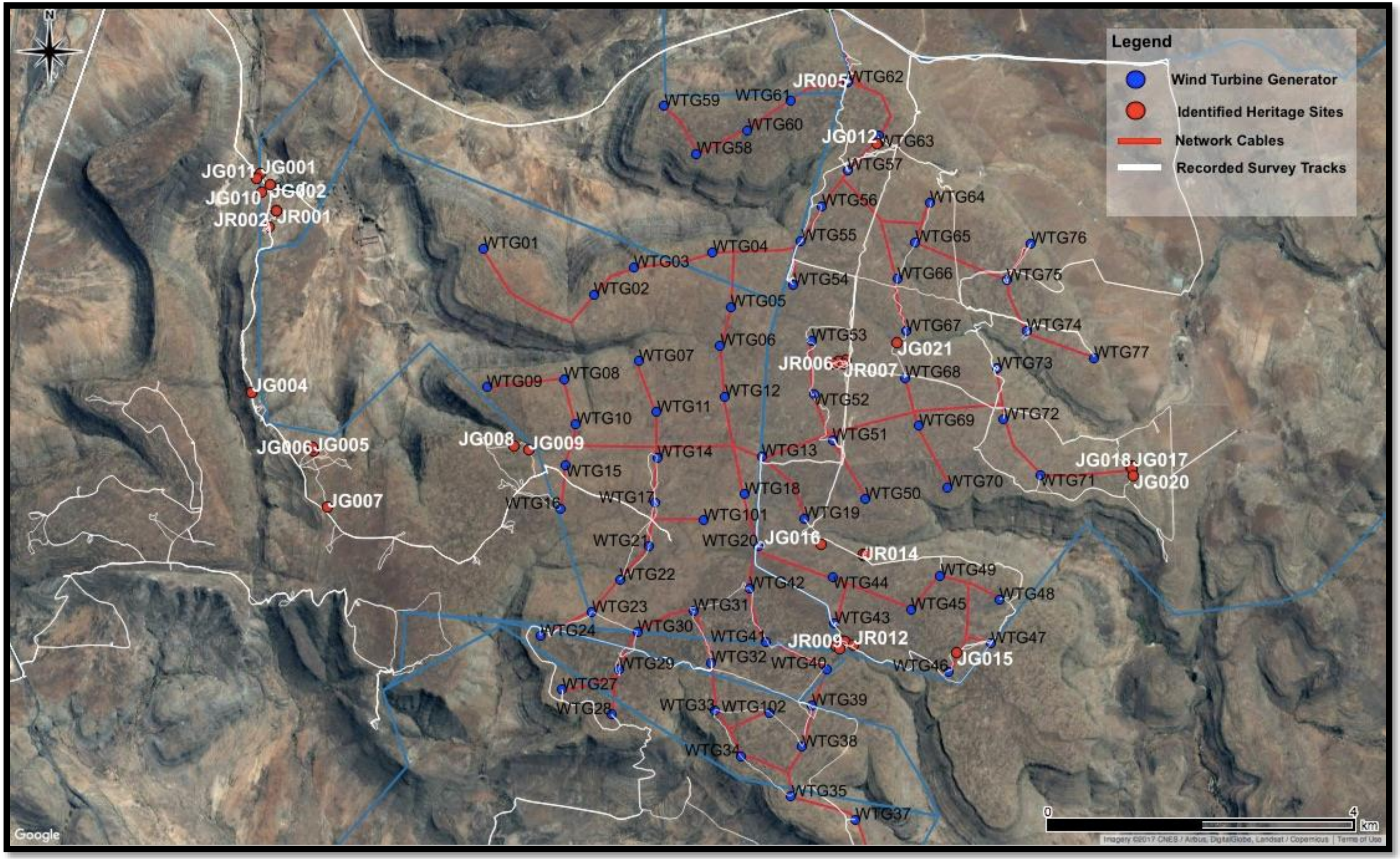

Figure Appendix 1. The proposed SAN Kraal WEF with recorded heritage sites, track logs and turbine layout.

15 Appendix B Palaeontological Heritage Report Proposed Mainstream San Kraal Wind Energy Facility near Noupoort, Northern and Eastern Cape

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October 2017

EXECUTIVE SUMMARY

San Kraal Wind Farm (Pty) Ltd are proposing to construct the San Kraal Wind Energy Facility (WEF) with up to 75 wind turbines and an approximately 25 km long grid connection to the Umsobomvu substation. The project area spans the border between the Noupoort District, Northern Cape and Middelburg District, Eastern Cape. Most of the San Kraal WEF footprint will be situated in dissected rocky plateau areas underlain by continental sediments of the Katberg Formation (Upper Beaufort Group / Tarkastad Subgroup, Karoo Supergroup) of earliest Triassic age. Latest Permian sediments of the underlying Balfour Formation crop out along the foot of the Katberg escarpment but are generally mantled by a thick apron of colluvium (sandy and gravelly scree, hillwash) and alluvium. Elsewhere in the Main Karoo Basin these sediments have yielded locally abundant vertebrate fossils, large vertebrate burrows, a small range of invertebrate burrows but only rare plant remains. The uppermost Balfour and Katberg Formations preserve an important record of biological and palaeoenvironmental events on land during the catastrophic Permo-Triassic extinction of 252 Ma (million years ago) and subsequent biotic recovery. Several vertebrate fossil localities in the Noupoort area are noted in the scientific literature but only a few fossil remains were recorded during a four-day field assessment of the San Kraal WEF and associated powerline. These include fragmentary bones and teeth within calcrete breccias as well as several large vertebrate burrows, one with associated disarticulated bones. The paucity of recorded fossil sites here is probably due to (1) the very low exposure levels seen here of overbank mudrocks where most fossils are preserved, and (2) the predominance of amalgamated channel sandstone facies in the upper part of the Katberg Formation building the plateau areas. Scientifically-important fossil remains in the subsurface may well be compromised by the proposed WEF development during the construction phase, notably due to voluminous bedrock excavations for wind turbine footings.

No palaeontological No-Go areas or highly-sensitive fossil sites have been identified within the main WEF development footprint on the Katberg sandstone plateau (Fig. 33). All fossil finds here are assigned a low field rating (Local Resource IIIC) and do not warrant mitigation. A 50 m-radius protective buffer zone is proposed for several vertebrate burrow sites along a stream bed on farm Winterhoek 118 (Field rating Local Resource IIIB). They lie close to the alignment of the Alternative 1 132 kV powerline route which, if chosen, should be moved slightly to the southeast in this sector to lie outside the proposed buffer zone (See Figs. 35 and 36 herein). Alternative 1 is the least-preferred route option from a heritage viewpoint for this reason, with no preference for either one of the other two route options under consideration.

Due to the low extent, inferred moderate severity and permanent duration of potential palaeontological impacts, the impact significance of the proposed WEF is assessed as *medium (negative)* before mitigation. Confidence levels in this assessment are *medium*, given (1) the extensive palaeontological literature on the Karoo bedrocks concerned weighed against (2) very low levels of bedrock exposure within the study area and (3) the unpredictable distribution of well-preserved fossils.

Given (1) the significant potential for scientifically-valuable fossils being disturbed, damaged or destroyed during the construction phase of the WEF as well as (2) the high level of uncertainty regarding fossil distribution in the subsurface, a precautionary approach to palaeontological mitigation is considered appropriate here. Following discussions with SAHRA (Dr Ragna Redelstorff, Oct. 2017), it is therefore proposed that initially a representative sample (*c*. 10%) of excavations for wind turbine footings be monitored by a professional palaeontologist during the early construction phase. The monitoring protocol should be developed by the palaeontologist appointed in consultation with the developer and SAHRA so as to maximise the palaeontological outcome without interfering unduly with the construction program. On completion of this initial phase of monitoring, a Phase 2 palaeontological report, with recommendations for further specialist monitoring or mitigation (if any), should be submitted by the palaeontologist to SAHRA for comment. This stepwise monitoring approach is recommended because it may well prove impracticable to recognise, record and sample useful fossil material from turbine excavations due to factors such as excessive fragmentation of the bedrock and fossils, obscuring of freshly-excavated bedrock by soil or dust, or safety considerations.

Should the recommended mitigation measures for the construction phase of the WEF development be consistently followed-though, the impact significance would remain *medium* (*negative*) but would entail both positive and negative impacts. Residual negative impacts from inevitable loss of some valuable fossil heritage would be partially offset by an improved palaeontological database for the study region as a direct result of appropriate mitigation.

Given the comparatively small combined footprint of the alternative energy projects in the broader Noupoort region compared with the very extensive outcrop areas of the fossiliferous Balfour and Katberg Formations, the cumulative impact significance of the San Kraal WEF is assessed as LOW.

There are no fatal flaws in the proposed WEF project from a palaeontological heritage viewpoint and no objects to authorisation of the development, provided that the recommended mitigation measures are incorporated into the EMPr for this project and fully implemented.

1. PROJECT DESCRIPTION & BRIEF

The following list of infrastructural components for the proposed San Kraal WEF has been provided by ARCUS Consulting:

- .

- Up to 78 turbines with a generation capacity between 3 – 5 MW and a rotor diameter of up to 150 m, a hub height of up to 150 m and blade length of up to 75 m;
- Foundations (up to 25 x 25 m) and hardstands associated with the wind turbines;
- Internal access roads of between 8 m (during operation) and 14 m (during construction) wide to each turbine;
- Medium voltage underground electrical cables will be laid to transmit electricity generated by the wind turbines to the on-site switching station or substation;
- Overhead medium voltage cables between turbine rows where necessary;
- An on-site switching station (10 000 m^2);
- An 4 km medium voltage overhead line connecting the on-site switching station with the on-site medium voltage/132 kV substation;
- An on-site substation and OMS complex (180 000 m^2) to facilitate stepping up the voltage from medium to high voltage (132 kV) to enable the connection of the WEF to the proposed Umsobomvu WEF 132/400 kV Substation, and the generated power will be fed into the national grid;
- A 23 km 132 kV high voltage overhead power line from the on-site substation to the proposed 400 kV Umsobomvu substation to the national grid;
- 3 turn-in options of 45 000 m^2 – 450 000m^2 at Eskom MTS SS
- Two 90 000 m^2 alternative areas for batching plants, temporary laydown area and construction compound
- Temporary infrastructure including a site camp; and
- A laydown area approximately 7500 m^2 in extent, per turbine.

The total size of the land portions within which the proposed development will be located is 10 511.51 hectares. The footprint of the proposed development is estimated to be less than 1% of this area

Description	**Dimensions**		
	Length (m)	**Breadth (m)**	**Area (sqm)**
Eskom 400kV Umsobomvu substation	150	150	22500
San Kraal 132/33 kV switching station	150	100	15000
OMS Area	150	50	7500
Construction compound	50	40	2000
Container storage area	50	40	2000

The present combined desktop and field-based palaeontological heritage study of the San Kraal WEF study area contributes to the comprehensive Heritage Impact Assessment and heritage aspects of the Environmental Management Programme for the project compiled under the aegis of ACO Associates cc, Cape Town (Contact details: Mr Tim Hart, ACO Associates cc. Unit D17, Prime Park, 21 Mocke Road, Diep River, 7800. Tel: 021 706 4104. E-mail: Tim.Hart@aco-associates.com). The EIA process for the project is being co-ordinated by Arcus Consulting, Cape Town (Contact details: Ms Ashlin Bodasig and Ms Anja Albertyn, Arcus Consulting, Cape Town, Office 220 Cube Workspace. Cnr Long Street and Hans Strydom Road, Cape Town 8001. Tel: 021 412 1533. E-mail: AnjaA@arcusconsulting.co.za or AshlinB@arcusconsulting.co.za).

2. 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. The likely impact of the proposed development on local fossil heritage is then determined on the basis of (1) the palaeontological sensitivity of the rock units concerned and (2) the nature and scale of the development itself, most significantly the extent of fresh bedrock excavation envisaged. When rock units of moderate to high palaeontological sensitivity are present within the development footprint, a Phase 1 field assessment study by a professional palaeontologist is usually warranted to identify any palaeontological hotspots and make specific recommendations for any monitoring or mitigation required before or during the construction phase of the development.

On the basis of the desktop and Phase 1 field assessment studies, the likely impact of the proposed development on local fossil heritage and any need for specialist mitigation are determined. Adverse palaeontological impacts normally occur during the construction rather than the operational or decommissioning phase. Phase 2 mitigation by a professional palaeontologist – normally involving the recording and sampling of fossil material and associated geological information (*e.g.* sedimentological data) may be required (a) in the pre-construction phase where important fossils are already exposed at or near the land surface and / or (b) during the construction phase when fresh fossiliferous bedrock has been exposed by excavations. To carry out mitigation, the palaeontologist involved will need to apply for palaeontological collection permits from the relevant heritage management authorities, *i.e.*. ECPHRA for the Eastern Cape (ECPHRA contact details: Mr Sello Mokhanya, 74 Alexander Road, King Williams Town 5600; Email: smokhanya@ecphra.org.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.

2.1. Information sources

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

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

2. A review of the relevant satellite images, topographical maps and scientific literature, including published geological maps and accompanying sheet explanations, as well as several previous desktop and field-based palaeontological assessment studies in the broader Noupoort – Middelburg study region (*e.g.* Almond 2011, 2012, 2015, 2017, Butler 2014, 2016 and Gess 2012a, 2012b);

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

4. A four-day palaeontological reconnaissance field assessment of the San Kraal WEF project area on 3-6 October 2017 by the author and one assistant.

2.2. Assumptions & limitations

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

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

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

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

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

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

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

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

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

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

In the case of the San Kraal WEF study area near Noupoort in the Northern and Eastern Cape preservation of potentially fossiliferous bedrocks is favoured by the semi-arid climate and sparse vegetation but bedrock exposure is very limited by extensive superficial deposits (sandy soils, scree), especially in areas of low relief such as the plateau areas where the majority of the WEF infrastructure will be placed. Vehicle access to most of the upland plateau areas is currently challenging and very limited.

In practice, approximately two thirds of the fieldwork time was spent traversing the core WEF project area on the Katberg sandstone plateau – uniformly regarded as palaeontologically uninformative due to superficial sediment cover - and perhaps some 10% of time in the powerline project area. However, it is considered that sufficient bedrock and cover sediment exposures were examined during the course of this study to assess the broader palaeontological heritage sensitivity of the study area (See Appendix). Comparatively few academic palaeontological studies or field-based fossil heritage impact studies have been carried out in the region, so any new data from impact studies here are of scientific interest.

2.3. Legislative context for palaeontological assessment studies

The San Kraal WEF alternative energy project is located in an area that is underlain by potentially fossiliferous sedimentary rocks of Late Palaeozoic to Mesozoic and younger, Late Tertiary or Quaternary, age (Sections 3 and 4). The construction phase of the proposed development will entail substantial excavations into the superficial sediment cover and locally into the underlying bedrock as well. These include, for example, excavations for the wind turbine foundations, hard standing areas, internal access roads, underground cables, transmission line pylon footings, electrical substations, operations and services workshop area/office building, laydown areas and construction site camp. All these developments may adversely affect potential fossil heritage within the study area by destroying, disturbing or permanently sealing-in fossils at or beneath the surface of the ground that are then no longer available for scientific research or other public good. The operational and decommissioning phases of the wind energy facility are unlikely to involve further adverse impacts on local palaeontological heritage, however.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

3. GEOLOGICAL CONTEXT

The San Kraal WEF study area is situated in dissected, semi-arid mountainous terrain of the Agter-Renosterberg – Kikvorsberg Ranges which are situated within the Upper Karoo geomorphic province of the RSA (Partridge *et al.* 2010). The core WEF development area where most of the infrastructure will be situated, including wind turbines and access roads, is located on an undulating, grassy sandstone plateau reaching elevations of *c*. 1840 m amsl. (Figs. 5, 6, 33 & 34). The steep margins of the plateau are incised by several narrow stream valleys reflecting erosional down-cutting during more pluvial periods in the geological past.

The geology of the Noupoort study region is shown on 1: 250 000 sheet 3124 Middelburg (Cole *et al.* 2004) (Fig. 2) and has been briefly described in a previous WEF palaeontological assessment for the Noupoort area by Almond (2012). Most of the study area, including the core development area, is underlain by Early Triassic (*c*. 250 Ma = million years old) fluvial sediments of the **Katberg Formation** (**TRk**, yellow with red stipple in Fig. 2) which forms the lowermost subunit of the Tarkastad Subgroup (Upper Beaufort Group, Karoo Supergroup). Levels of tectonic deformation in this region are very low, as shown by recorded dips here of only two to three degrees within the Tarkastad Subgroup, with most of the succession being subhorizontal.

Very small outcrop areas of Karoo sediments assigned to the underlying **Adelaide Subgroup** (**Pa**, pale blue in Fig. 2) are mapped in the western foothills of the Kikvorsberg close to the N9 and Noupoort town. These older bedrocks belong to the uppermost portion of the **Balfour Formation**, namely the **Palingkloof Member** of Latest Permian to Earliest Triassic age. According to Cole *et al.* (2004) this succession consists largely of reddish mudrocks and has a thickness of only some 20 m or so in the Noupoort area (*e.g.* Carlton Siding). Given their location at the foot of the Katberg escarpment, the Adelaide Subgroup rocks here are largely covered by colluvial debris (gravelly scree, hillwash sands) and are furthermore unlikely to be directly impacted by the Noupoort wind farm development, with the possible exception of a access roads in lowland areas. For these reasons, the Balfour Formation rocks will not be treated in any detail in this study. It should be noted, however, that they are of considerable palaeontological significance elsewhere in the Main Karoo Basin since they record the catastrophic end-Permian mass extinction event and ensuing biotic recovery among continental biotas (*e.g.* Smith & Ward 2001, Smith *et al.* 2002, Retallack *et al.* 2003 and 2006, Ward *et al.* 2005, Smith & Botha 2005, Botha & Smith 2007, Smith & Botha-Brink 2014, Smith *et al.* 2012). Good erosion gulley exposures of Palingkloof Member mudrocks and thin-bedded sandstones are seen on Hartebeest Hoek 182, just outside the San Kraal WEF study area (Fig. 3).

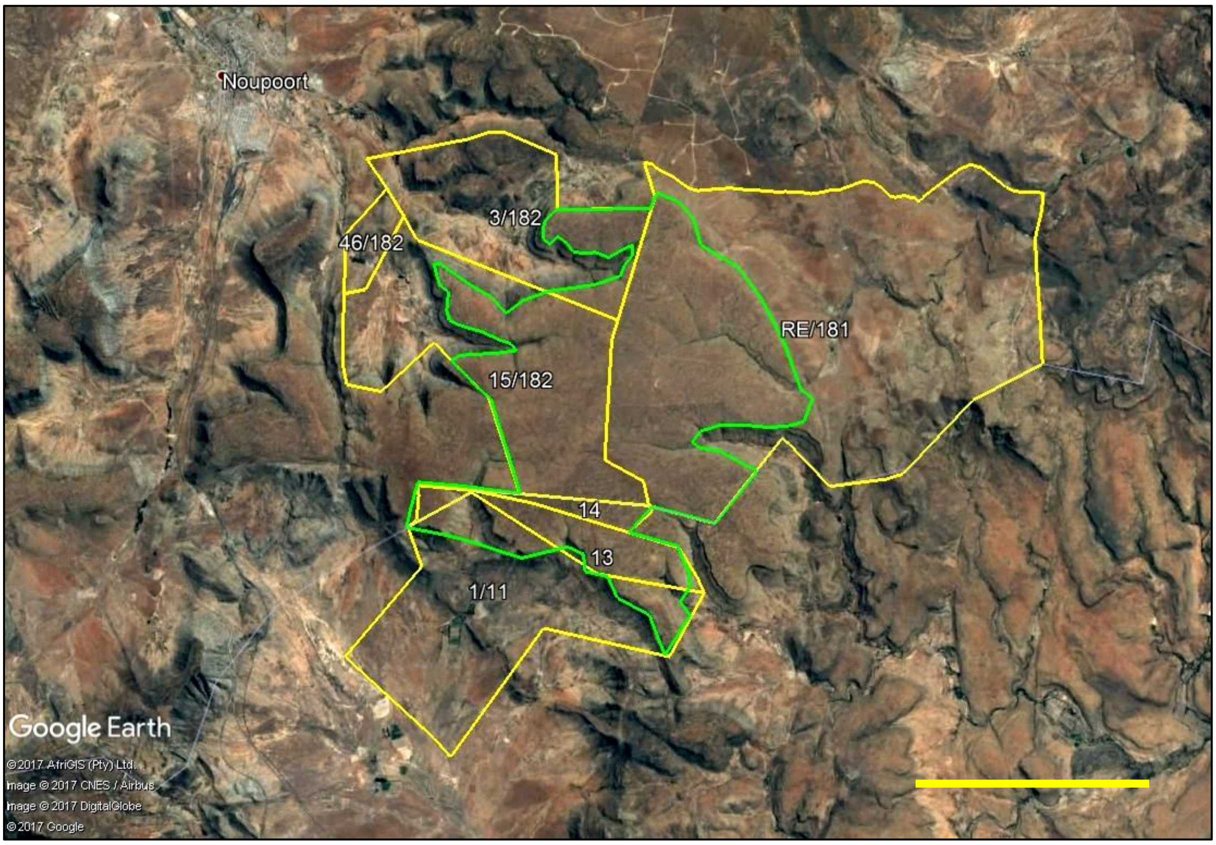

Fig. 1. Google Earth© satellite image of the region to the south-east of Noupoort showing the study area for the proposed San Kraal WEF (yellow polygon) as well as an outline of plateau areas where the majority of the WEF infrastructure will be sited (green polygon). Scale bar = 5 km. North towards the top of the image.

The Katberg Formation forms the regionally extensive, sandstone-rich lower portion of the Tarkastad Subgroup (Upper Beaufort Group) that can be traced throughout large areas of the Main Karoo Basin. In the Middelburg sheet area it reaches a maximum thickness of some 400 m, but close to Noupoort thicknesses of 240-260 m are more usual. The predominant sediments are (a) prominent-weathering, pale buff to greyish, tabular or ribbon-shaped sandstones up to 60 m thick (Figs. 4, 7 & 8) that are interbedded with (b) recessive-weathering, reddish or occasionally green-grey mudrocks (Figs. 17 & 18). Up to four discrete sandstone packages can be identified within the succession. In the Noupoort area the overall sandstone:mudrock ratio is close to 1:1. Katberg channel sandstones are typically rich in feldspar and lithic grains (*i.e.* lithofeldspathic). They build laterally extensive, tabular, multi-storey units with an erosional base that is often marked by intraformational conglomerates up to one meter or more thick consisting of mudrock pebbles, reworked calcrete nodules and occasional rolled fragments of bone (Figs. 14 to 16, 30). While the basal Katberg succession is often marked by a major cliff-forming sandstone unit, in the Noupoort area there is a transitional relationship with the underlying Adelaide Subgroup that is marked by a broadly upward-thickening series of sandstone sheets (Fig. 4). The cliff-forming uppermost part of the Katberg Formation in the study area that underlies the plateau areas is composed of amalgamated channel sandstone facies with only a small proportion of overbank mudrocks. Internally the moderately well-sorted sandstones are variously massive, horizontally-laminated or tabular to trough cross-bedded while heavy mineral laminae occur frequently. Sphaeroidal carbonate concretions up to 10 cm across, sometimes secondarily ferruginised, are common. The predominantly purple-brown Katberg mudrocks are typically massive with horizons of pedocrete nodules (calcretes) and mudcracks but packages of thin-bedded grey-green and purple-brown mudrocks passing up into heterolithic successions of interbedded grey-green fine sandstone and siltstone are also occasionally seen (Fig. 17). Mudrock exposure within the study area is very limited indeed due to extensive mantling of these recessive-weathering rocks by superficial sediments (soils, scree, downwasted gravels, hillwash *etc*).

The highland plateau areas that form the great majority of the WEF project area vary from fairly grassy and featureless to rugged terrain with numerous low kranzes and pavements of Katberg sandstone (Figs. 5 to 7, 9). Karstic (solution-weathering) features such as polygonal cracks (tessellation / alligator cracking), rock basins (*gnammas*) and rock doughnuts are well-developed on some of the better-exposed sandstone *kranzes* and sandstone pavements in these (*cf* Grab *et al.* 2011) (Figs. 10 to 12). Another interesting feature observed on weathered sandstone surfaces are shallow subcircular to irregular etched depressions generated by epilithic lichens that have been well-studied on younger Clarens Formation feldspathic sandstones in the Golden Gate National Park (*ibid*. and refs. therein) (Fig. 13). The lichen etching appears to postdate the karstic weathering and associated case-hardening and continues to the present day, especially on more shaded, south-facing surfaces.

The Karoo Supergroup sedimentary rocks in the Noupoort study area are extensively intruded by Early Jurassic (183 ± 2 Ma) igneous intrusions of the **Karoo Dolerite Suite** (**Jd**) (Cole *et al.* 2004, Duncan & Marsh 2006) (Fig. 19). The sills and dykes have thermally metamorphosed or baked the adjacent mudrocks and sandstones to resistant-weathering hornfels and quartzite respectively (Figs. 20-21).

In most parts of the study area, including both the flatter-lying plateau regions and low-lying *vlaktes* as well as steeper hillslopes, the Permo-Triassic bedrocks are mantled with a variety of **superficial deposits** of probable Late Caenozoic (mostly Quaternary to Recent) age. A wedge-shaped prism or apron of sandy to gravelly colluvium and hillwash mantles the foot of the Katberg escarpment (piedmont fans) (Fig. 23), while the escarpment slopes themselves are largely obscured by sandstone scree, apart from the thicker, prominent-weathering Katberg channel sandstone bodies (Fig. 4). Thick sandy to gravelly alluvial deposits are encountered in more major stream valleys at the foot of the Katberg escarpment, where they are often incised by deep erosional *dongas*, while thick sandy alluvium is seen in shallow palaeovalleys on the plateaux (Figs. 24 & 25). The Katberg sandstones underlying the buildable plateau areas in the study region are largely overlain by thin, orange-brown sandy soils as well as angular, poorly-sorted gravels of downwasted sandstone (Fig. 22). Well-developed Late Caenozioc pedocretes (*e.g.* calcrete) were not encountered during the field study, although modest creamy calcrete is seen locally in the vicinity of dolerite intrusions.

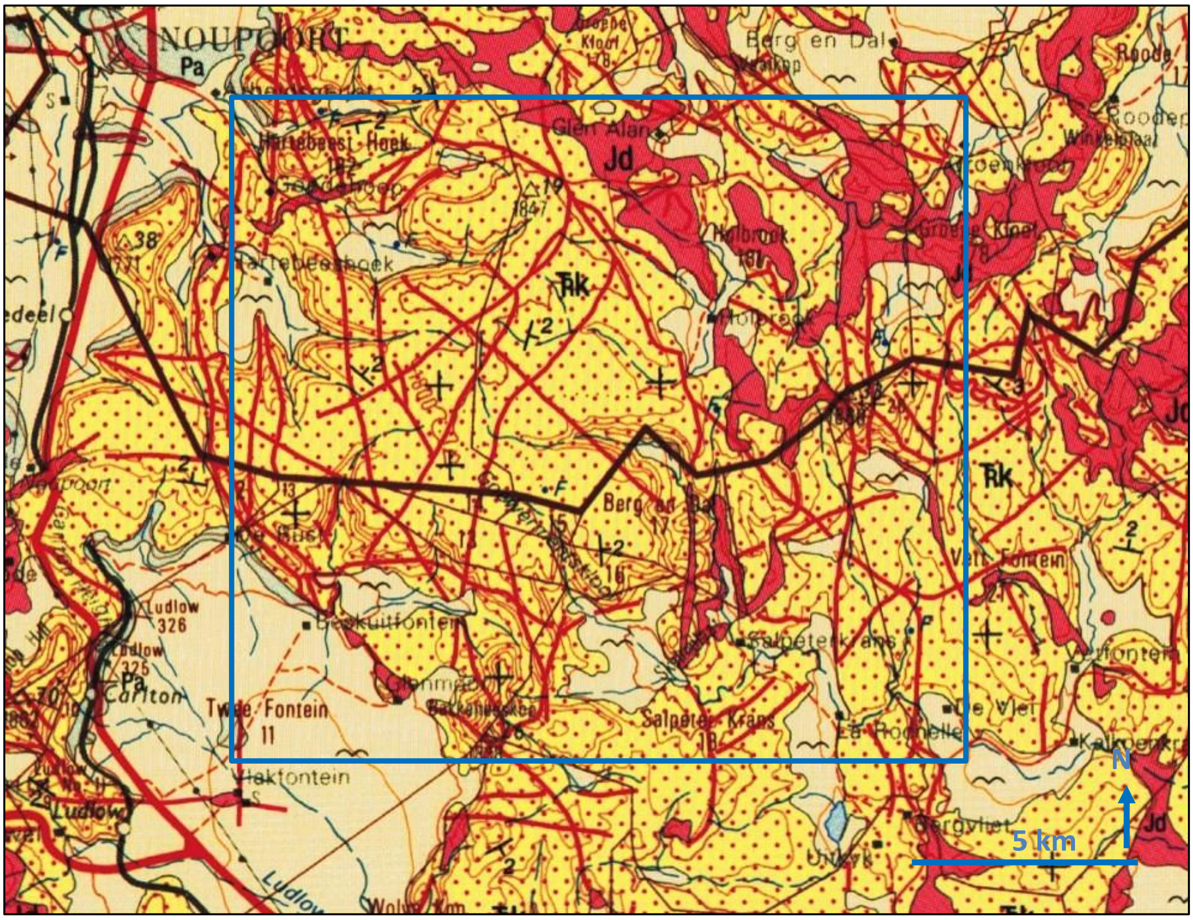

Fig. 2. Extract from 1: 250 000 geology sheet 3124 Middelburg (Council for Geoscience, Pretoria) showing *approximate* outline of the San Kraal WEF study area to the southeast of Noupoort, Northern & Eastern Cape (blue rectangle). The main geological units represented here are:

Pa (pale blue) = Late Permian to Earliest Triassic Adelaide Subgroup (Lower Beaufort Group, Karoo Supergroup)
TRk (yellow with red stipple) = Early Triassic Katberg Formation of the Tarkastad Subgroup (Upper Beaufort Group, Karoo Supergroup)
Jd (red) = Early Jurassic Karoo Dolerite Suite
Pale brown areas with "flying bird"symbol = Quaternary to Recent alluvium

***N.B.* Other Caenozoic superficial deposits such as colluvium (scree *etc*), soils and surface gravels are not depicted here but in fact cover much of the landscape.**

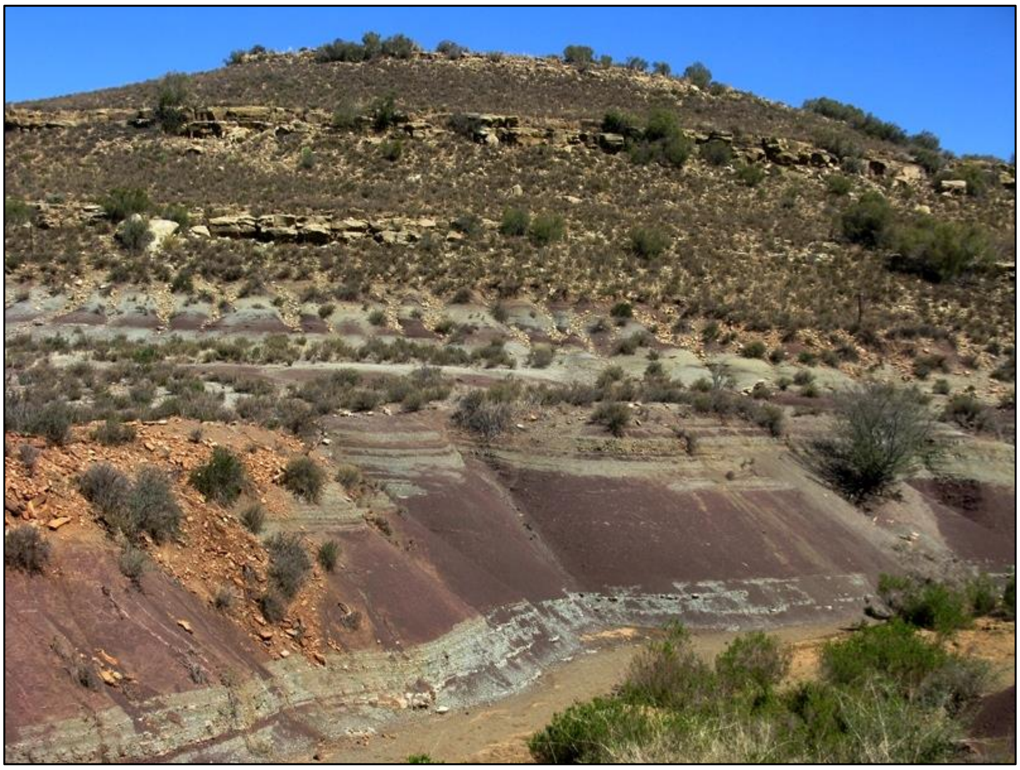

Fig. 3. Excellent erosion gulley and hillslope exposures of colour-banded overbank mudrocks and thin sandstones of the uppermost Balfour Formation (Palingkloof Member) underlying the prominent-weathering channel sandstones of the Katberg Formation, Hartebeest Hoek 182 (Loc. 073).

Fig. 4. Northwest-facing escarpment of the Katberg Formation on the southern side of Oorlogspoort, Hartebeest Hoek 182, showing spaced, laterally-persistent channel sandstones with intervening overbank mudrocks largely obscured by sandstone scree (Loc. 023). Note cliff of amalgamated Katberg channel sandstones on the horizon.

Fig. 5. View north-eastwards across grassy upland plateau on Farm RE14 showing area with very little bedrock exposure (Loc. 038). Surface mantled by sandy soils and downwasted sandstone gravels.

Fig. 6. Sandstone plateau area on Holbrook 181 showing shallow incised stream valley, rocky Katberg sandstone outcrops and rubbly sandstone surface rubble (Loc. 055).

Fig. 7. *Kranz* built by thick cross-bedded Katberg channel sandstones on Tweefontein 1/11 (Loc. 033).

Fig. 8. Large scale tabular current cross-bedding within the Katbeg Formation on Holbrook 181 (Loc. 048).

Fig. 9. Extensive Katberg sandstone pavement on Hartebeest Hoek 182 showing large-scale jointing as well as karstic weathering features (Loc. 063).

Fig. 10. Detail of pavement seen in previous illustration to show polygonal jointing, shallower surface cracks as well as solution hollows (Loc. 063).

Fig. 11. Typical karstic tessellation or alligator cracking shown by Katberg sandstone surface on Tweefontein 1/11 (Loc. 036) (Scale = 15 cm).

Fig. 12. Small, steep-sided rock basin or *gnamma* resulting from karstic weathering of Katberg sandstone on farm RE14 (Loc. 038).

Fig. 13. Good example of lichen weathering on Katberg sandstone surface, Holbrook 181 (Loc. 046) (Scale is *c.* 15 cm long).

Fig. 14. Cross-bedded, secondarily-ferruginised, fine-grained calcrete channel breccio-conglomerate at the base of a thick Katberg channel sandstone, Hartebeest Hoek 182 (Loc. 069) (Hammer = 27 cm).

Fig. 15. Extensive exposure of thick, greyish calcrete nodule breccio-conglomerate within Katberg Formation on Holbrook 181 (Loc. 045) (Hammer = 27 cm). The breccio-conglomerate contains sparse reworked bone and tooth fragments (See Fig. 30).

Fig. 16. Thick coarse mudstone intraclast breccio-conglomerates towards base of a Katberg channel sandstone, Ooorlogspoort, Hartebeest Hoek 182 (Loc. 062) (Hammer = 27 cm).

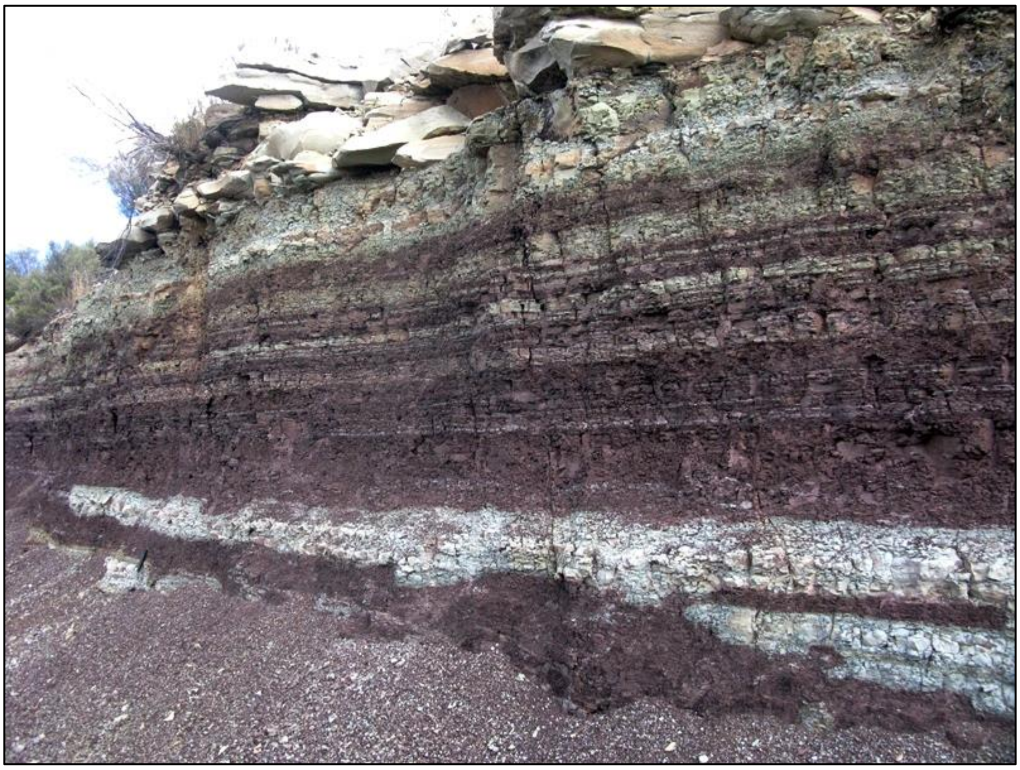

Fig. 17. Upward-coarsening package of irregularly colour-banded overbank mudrocks and thin-bedded sandstones exposed in a borrow pit in Oorlogspoort, Hartebeest Hoek 182 (Loc. 056) (Hammer = 27 cm).

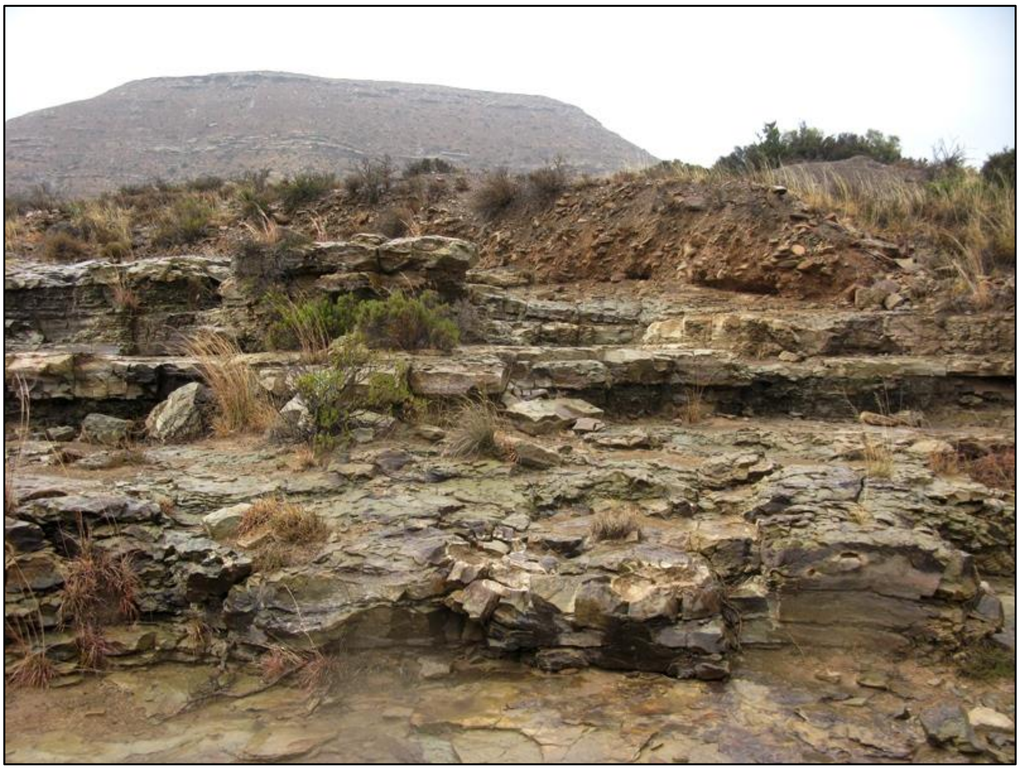

Fig. 18. Streambed exposure of interbedded thin crevasse-splay sandstones and grey-green overbank mudrocks, probably within the lower Katberg Formation, Tweefontein 1/11 (Loc. 029). Note overlying thick alluvial gravels.

Fig. 19. Typical rubbly weathering with boulder-sized corestones of dolerite dyke intruding the Lower Beaufort Group country rocks on Hartebeest Hoek 182 (Loc. 026).

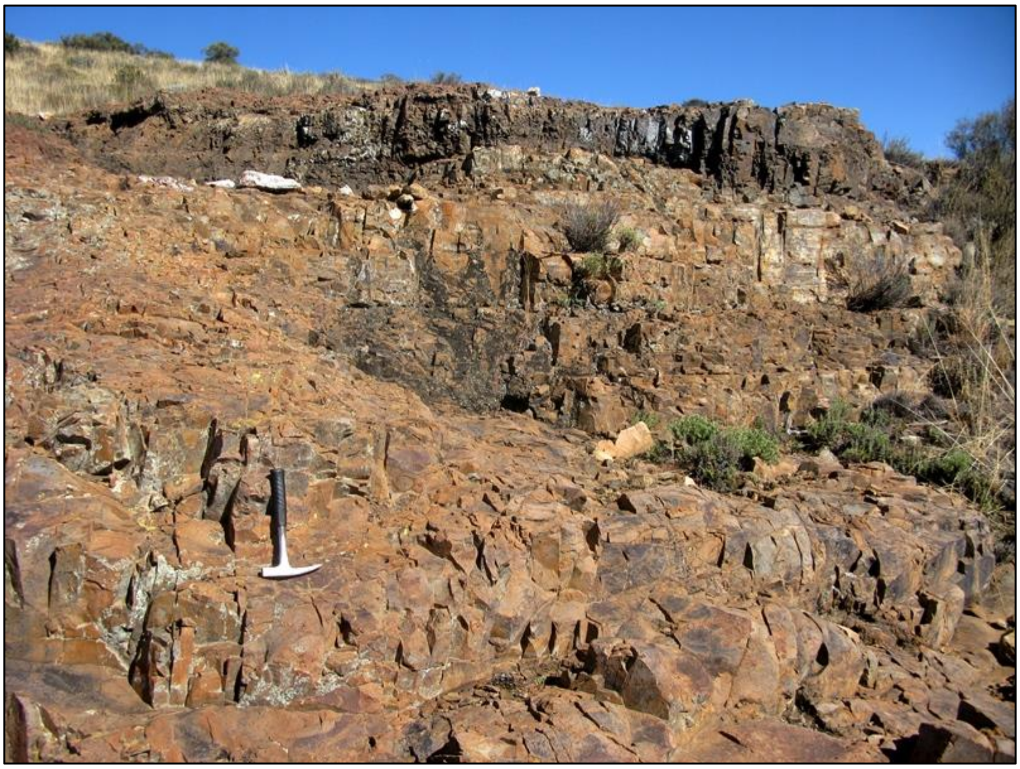

Fig. 20. Thick, columnar-jointed dolerite dyke containing baked rafts or xenoliths of Katberg sedimentary rocks, Hartebeest Hoek 182 (Loc. 060) (Hammer = 27 cm).

Fig. 21. Katberg thin-bedded channel sandstone sharply overlying dark grey overbank mudrocks, here baked by dolerite intrusion to form quartzite and hornfels, Hartebeest Hoek 182 (Loc. 071) (Hammer = 27 cm).

Fig. 22. Downwasted surface gravels of sandstone overlying Katberg sandstone pavement, Tweefontein 1/11 (Loc. 035).

Fig. 23. Thick, eroded piedmond fan of sandy and gravelly colluvial and alluvial deposits mantling foot of the Katberg escarpment, Hartebeest Hoek 182 (Loc. 025).

Fig. 24. Erosion gulley exposure of thick sandy alluvium in stream valley on Katberg plateau, Holbrook 181 (Loc. 049) (Hammer = 27 cm).

Fig. 25. Sandy soils with well-developed stone line overlying weathered Katberg mudrocks and overlain in turn by dark grey modern carbonaceous soils, Farm RE13 (Loc. 037) (Hammer = 27 cm).

4. PALAEONTOLOGICAL HERITAGE

The fossil heritage within each of the major rock units that are represented within the San Kraal WEF study area is outlined here, together with a brief account of Beaufort Group fossil records from the Noupoort region itself. Note that a separate account of fossils from the uppermost Adelaide Subgroup (Pa) is not given because the upper part of the Palingkloof Member (Balfour Formation) belongs to the same assemblage zone (*i.e.* the *Lystrosaurus* AZ) as the overlying Katberg Formation. Occasional limited exposures of Palingkloof Member rocks were identified in the field (Fig. 3) but these do not fall within the WEF project area and are very unlikely to be impacted by the proposed development.

GPS data for geological and fossil localities mentioned in the text and figure legends are provided separately in the Appendix to this report.

4.1. Fossil heritage in the Katberg Formation and uppermost Adelaide Subgroup

The Katberg Formation is known to host a diverse and palaeontologically important terrestrial fossil biota of Early Triassic (Scythian / Induan - Early Olenekian) age, *i.e.* around 252 million years old (Groenewald & Kitching 1995, Rubidge 2005, Smith *et al.* 2012). The biota is dominated by a range of therapsids (“mammal-like reptiles”), amphibians and other tetrapods, with rare vascular plants and trace fossils, and has been assigned to the ***Lystrosaurus* Assemblage Zone** (**LAZ**). This surprisingly rich fossil assemblage characterizes Early Triassic successions of the upper part of the Palingkloof Member

(Adelaide Subgroup) as well as the Katberg Formation. It should also be noted that while the dicynodont *Lystrosaurus* is also recorded from the uppermost beds of the Latest Permian *Dicynodon* Assemblage Zone it only becomes super-abundant in Early Triassic times (*e.g.* Smith & Botha 2005, Botha & Smith 2007 and refs. therein).

Useful illustrated accounts of LAZ fossils are given by Kitching (1977), Keyser and Smith (1977-1978), Groenewald and Kitching (1995), MacRae (1999), Hancox (2000), Smith *et al.* (2002), Cole *et al*. (2004), Rubidge (2005 *plus* refs therein), Damiani *et al.* (2003a), Smith *et al.* (2012) among others. These fossil biotas are of special palaeontological significance in that they document the recovery phase of terrestrial ecosystems following the catastrophic end-Permian Mass Extinction of 252 million years ago (*e.g.* Smith & Botha 2005, Gastaldo *et al.* 2005, Botha & Smith 2007, Smith & Botha-Brink 2014 and refs. therein). They also provide interesting insights into the adaptations and taphonomy of terrestrial animals and plants during a particularly stressful, arid phase of Earth history in the Early Triassic.

Key tetrapods in the *Lystrosaurus* Assemblage Zone biota are various species of the medium-sized, shovel-snouted dicynodont *Lystrosaurus* (by far the commonest fossil form in this biozone. contributing up to 95% of fossils found), the small captorhinid parareptile *Procolophon*, the crocodile-like early archosaur *Proterosuchus*, and a wide range of small to large armour-plated "labyrinthodont" amphibians such as *Lydekkerina* (Figs. 26 and 27). Botha and Smith (2007) have charted the ranges of several discrete *Lystrosaurus* species either side of the Permo-Triassic boundary. Also present in the LAZ are several genera of small-bodied true reptiles (*e.g.* owenettids), therocephalians, and early cynodonts (*e.g. Galesaurus, Thrinaxodon*). Animal burrows are attributable to various aquatic and land-living invertebrates, including arthropods (*e.g. Scoyenia* and *Katbergia* scratch burrows), as well as several subgroups of fossorial tetrapods such as cynodonts, procolophonids and even *Lystrosaurus* itself (*e.g.* Groenewald 1991, Damiani *et al.* 2003b, Abdala *et al.* 2006, Modesto & Brink 2010, Bordy *et al.* 2009, 2011). Vascular plant fossils are generally rare and include petrified wood ("*Dadoxylon*") as well as leaves of glossopterid progymnosperms and arthrophyte ferns (*Schizoneura*, *Phyllotheca*). An important, albeit poorly-preserved, basal Katberg palaeoflora has recently been documented from the Noupoort area (Carlton Heights) by Gastaldo *et al.* (2005). Plant taxa here include sphenopsid axes, dispersed fern pinnules and possible peltasperm (seed fern) reproductive structures. Pebbles of reworked silicified wood of possible post-Devonian age occur within the Katberg sandstones in the proximal outcrop area near East London (Hiller & Stavrakis 1980, Almond unpublished obs.). Between typical fossil assemblages of the *Lystrosaurus* and *Cynognathus* Assemblage Zones lies a possible *Procolophon* Acme Zone characterized by abundant material of procolophonids and of the amphibian *Kestrosaurus* but lacking both *Lystrosaurus* and *Cynognathus* (Hancox 2000 and refs. therein).

Most vertebrate fossils are found in the mudrock facies rather than channel sandstones. Articulated skeletons enclosed by calcareous pedogenic nodules are locally common, while intact procolophonids, dicynodonts and cynodonts have been recorded from burrow infills (Groenewald and Kitching, 1995). Fragmentary rolled bone and teeth (*e.g.* dicynodont tusks) are found in the intraformational calcrete nodule conglomerates at the base of some the channel sandstones. Vertebrate burrows occur within both mudrock and sandstone facies.

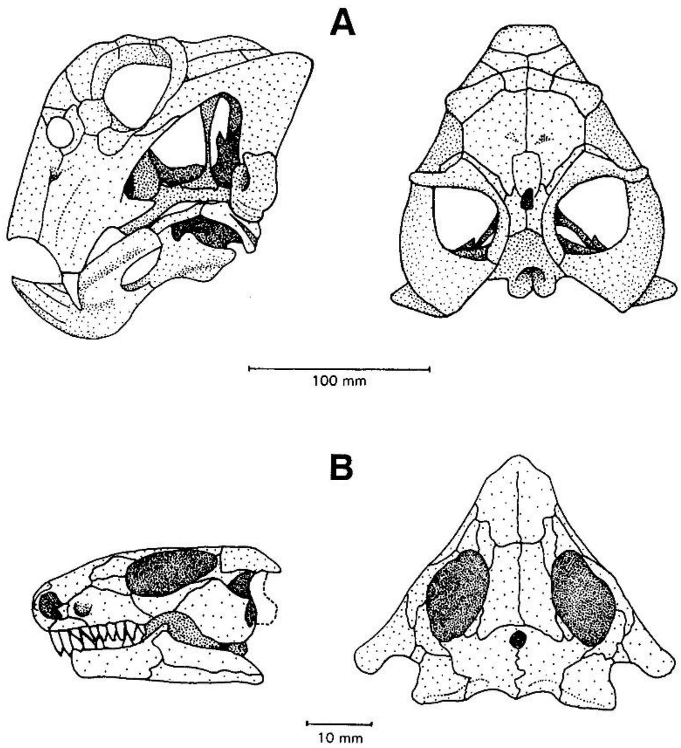

Fig. 26. Skulls of two key tetrapod genera from the Early Triassic *Lystrosaurus* Assemblage Zone of the Main Karoo Basin: the pig-sized dicynodont *Lystrosaurus* (A) and the small primitive reptile *Procolophon* (B) (From Groenewald and Kitching, 1995).

Several Karoo vertebrate fossil sites are reported from the Katberg Formation and underlying rocks in the Middelburg – Noupoort region by Kitching (1977; see Karoo biozonation map in Fig. 28 herein as well as updated Karoo vertebrate fossil site map of Nicolas 2007 abstracted in Fig. 29). For example, Kitching recorded as many as five different species of *Lystrosaurus* from good mountain slope exposures as well as road and railway cuttings in the Carlton Heights area near Noupoort. Abundant lystrosaurids, including three species of the genus, were found at Edenvale and on Noupoort Commonage (*ibid*., pp. 89-100). It is interesting that the spectrum of *Lystrosaurus* species recorded by Kitching (1977) in the Noupoort region – if correctly identified - suggests that Latest Permian beds referable to the *Dicynodon* Assemblage Zone may in fact be present here (*cf.* Botha & Smith 2007). This is supported by a recent search for fossil records from the Noupoort area in the Karoo fossil database at the BPI (Wits University) kindly undertaken by Mr Mike Day. Sites on the farms Naauwport 1, Bergendal 179, New Jakkalsfontein 172 and Carolus Poort 167 have yielded abundant material of *Lystrosaurus* together with *Procolophon*, *Tetracynodon* and a few specimens of *Dicynodon*. An unusually diverse LAZ assemblage has recently been recorded from Barendskraal near Middelburg by Damiani *et al.* (2003a). The spectrum of nine or more tetrapod species found here includes *Lystrosaurus* (albeit with low abundance), therocephalians, archosaurs and several procolophonid reptiles. The poorly-preserved fossil flora recorded by Gastaldo *et al.* (2005) from the basal Katberg at Carlton Heights near Noupoort is of special interest because plant fossils are so rare in this stratigraphic interval. Scrappy compressions of reedy plants within Katberg sandstones were illustrated by Almond (2015) from the Umsobomvu WEF project area southwest of Noupoort.

Sparse, highly-weathered postcranial remains as well as poorly-preserved *Lystrosaurus* skull material was reported just to the SW of Noupoort by Butler (2014). Gess (2012b) recorded locally abundant vertebrate body fossils, including *Lystrosaurus* and a small cynodont, plant stems, vertebrate burrows and *Katbergia* ("roots") on Portion 1 of Naauw Poort Farm 1 located *c*. 11 km south of Noupoort. On farm Blydefontein 168, situated just to the north of the San Krall WEF study area, Almond (2012) recorded fragmentary reworked skeletal remains, including disarticulated skulls, postcrania and teeth (especially dicynodont tusks) within greyish calcrete conglomerates. Some of the fossils were clearly encased in ferruginous pedogenic calcrete *before* they were exhumed and reworked. Overlying massive grey-green siltstones contain rare "bone-bed" concentrations (*e.g. Lystrosaurus* skull and postcrania) and horizons of large ferruginous calcrete nodules representing palaeosols. A small number of, mostly fragmentary, vertebrate fossils were reported from Katberg overbank mudrocks and calcrete breccia beds in the Umsobomvu WEF study area southwest of Noupoort by Almond (2015); they did include one well-articulated lystrosaurid skeleton with associated skull, however.

Low-diversity trace fossil assemblages recorded from Katberg rocks in the Noupoort area – for example south of the Oologspoort road - include locally abundant vertical cyclindrical structures attributed to *Skolithos* in the literature (*e.g.* Almond 2012) but more plausibly interpreted as plant stem casts, as well as small meniscate back-filled burrows ("*Taenidium*"). Numerous examples of the cm-wide subcylindrical invertebrate burrow *Katbergia* were observed by Almond (2012) in fresh road cuttings through the Katberg Formation along the N9 at Carlton Heights and localities further to the SW (Gess 2012, Almond 2015). These distinctive burrows penetrate down through grey-green mudrocks at an oblique angle and show surface scratch markings; they have been tentatively attributed to decapod crustaceans (Gastaldo & Rolerson 2008, Bordy *et al.* 2010). Several much larger, straight, gently-sloping vertebrate burrow casts cutting down through thin-bedded overbank mudrocks within the lower Katberg Formation are recorded from road cuttings on farm Naauw Poort 1 (Almond 2015). Further vertebrate burrow casts recorded on farm Winterhoek 118 are described and illustrated in the palaeontological report for the Phezukomoya WEF southwest of Noupoort (Almond 2017).

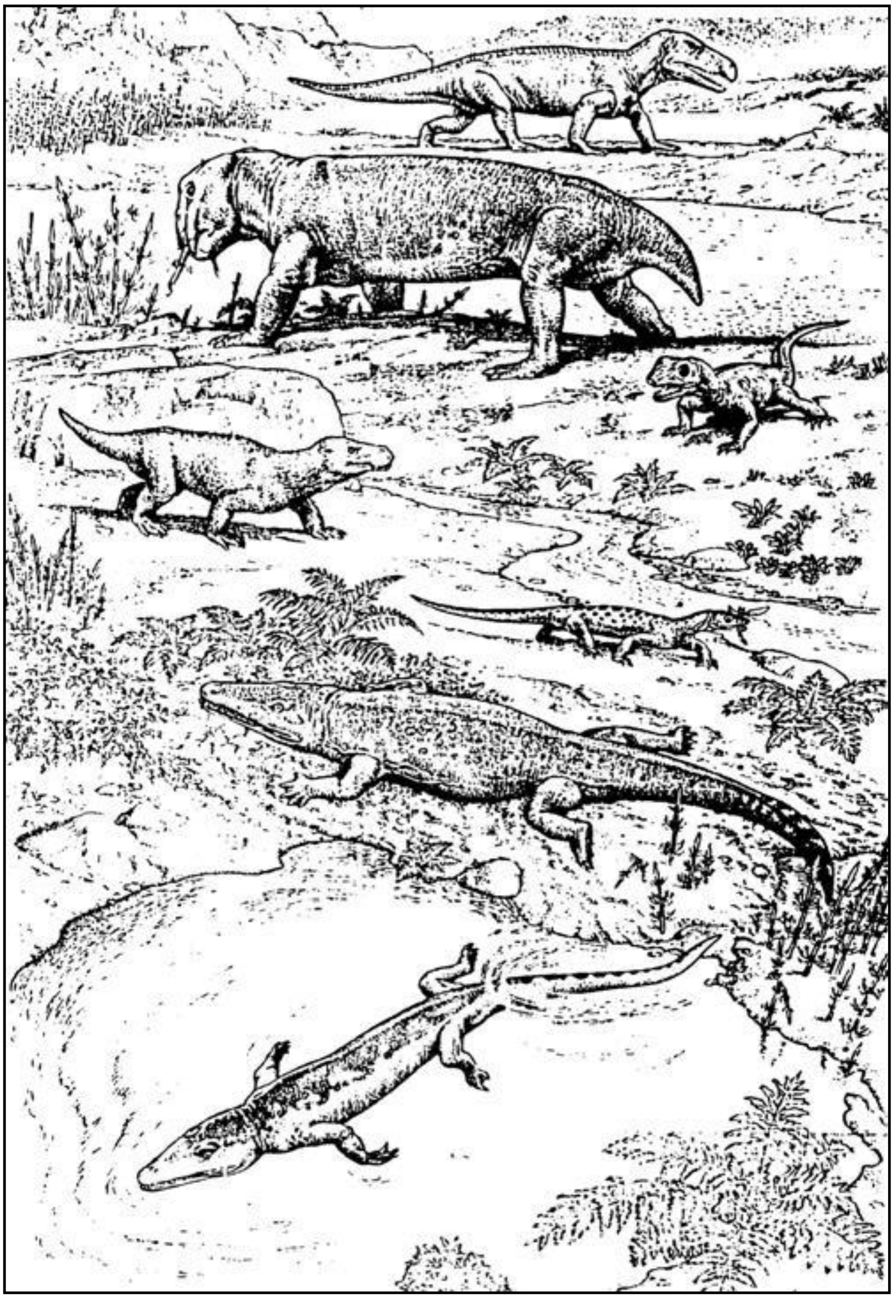

Fig. 27. Reconstruction of Early Triassic biotas of the *Lystrosaurus* Assemblage Zone (From Benton 2003 *When life nearly died*). Animals illustrated here include the crocodile-like archosaur reptile *Proterosuchus* (top) and below this the dominant, pig-sized dicyndont *Lystrosaurus*, a small predatory therocephalian therapsid (middle left), several small lizard-like reptiles such as procolophonids (middle right), and two large amphibians (bottom). Plants shown here include several ferns and reedy horsetails.

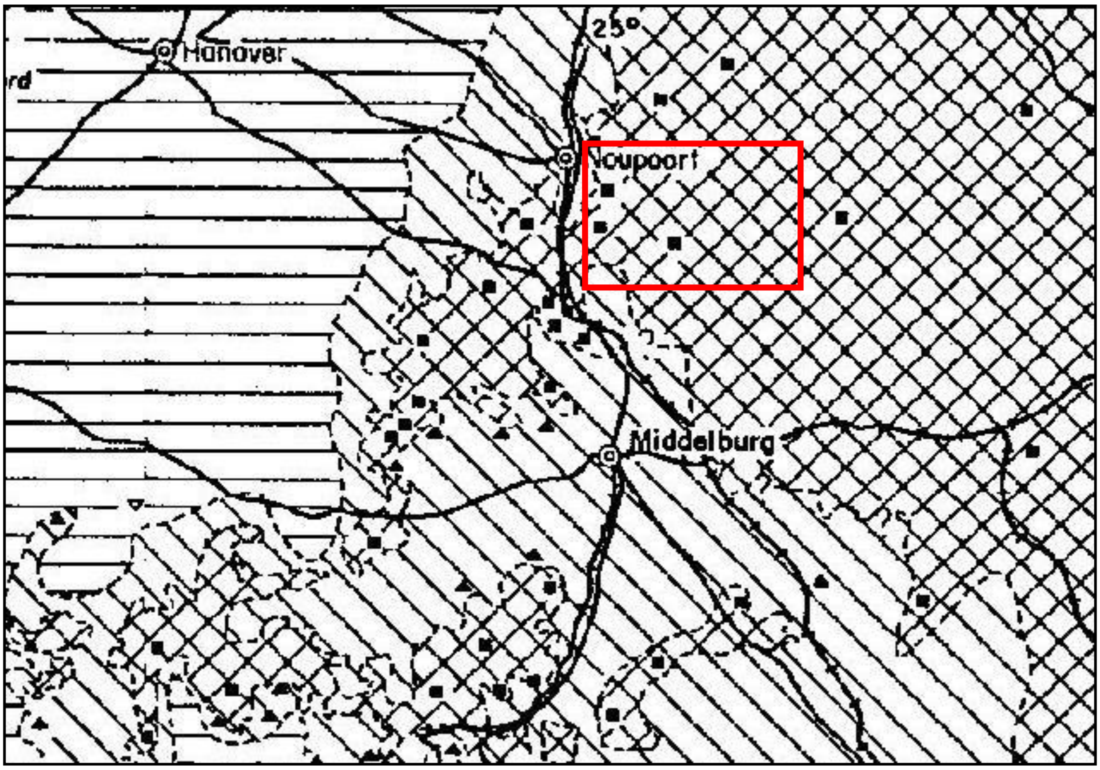

Fig. 28. Fossil zonation map of the Middelburg – Noupoort region showing the occurrence of several vertebrate fossil localities in the area to the southeast of Noupoort (red rectangle). Black squares here refer to fossils of the Early Triassic *Lystrosaurus* Assemblage Zone (mainly within the Katberg Formation). Triangles to the southwest are *Daptocephalus* (*Dicynodon*) AZ fossils within Late Permian rocks of the Adelaide Subgroup. Figure modified from Karoo biozonation map of Kitching (1977).

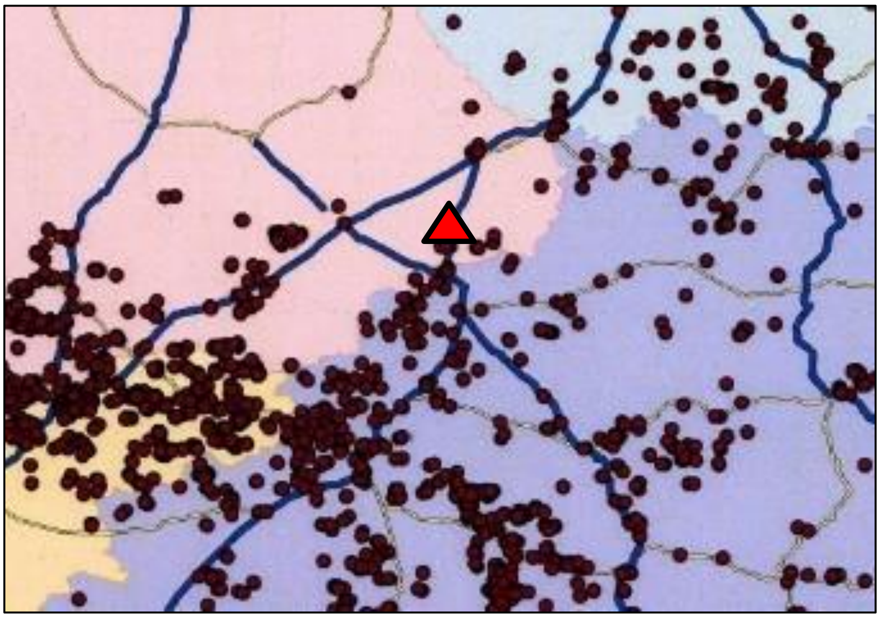

Fig. 29. Map of Beaufort Group vertebrate fossil localities in the vicinity of Noupoort (red triangle), abstracted from Nicolas (2007). Pink – N. Cape. Dark blue – Eastern Cape.

4.2. New palaeontological records in the WEF study area

No substantial, well-articulated Karoo vertebrate fossil remains were observed during the present field study of the San Kraal WEF study area near Noupoort. Since abundant and diverse vertebrate remains have been recorded from the same stratigraphic units elsewhere in the Main Karoo Basin (see refs. above), this lack of fossil finds is largely attributed to the paucity of overbank mudrock exposures that are the main locus of fossil preservation within the Permo-Triassic sedimentary bedrocks represented here. These mudrocks are only rarely seen along the escarpment areas, and almost never exposed on the sandstone plateaux where most of the WEF infrastructure will be situated (Figs. 4-6). The only vertebrate body fossils recorded here comprise a few isolated fragments of bone and teeth – most likely of therapsid affinity (and probably *Lystrosaurus* for the most part) – found embedded within calcrete nodule breccio-conglomerates that are associated with the bases of major sandstone packages of the Katberg Formation (Fig. 30 a-f, satellite images 33 & 34). These fossils represent vertebrate remains lying on the floodplain surface or already embedded within subsurface pedogenic calcrete palaeosols (fossil soils) that were re-exhumed or entrained by floods during episodes of major denudation of the arid Early Triassic landscape.

A series of indubitable to poorly-preserved and ambiguous, large vertebrate burrow casts (*c*. 30-50 cm diameter) have been recorded on the farm Winterhoek 118 close to one of the 132 kV grid connection routes for the San Kraal WEF (Locs. 119, 120, 122 and 123; see satellite maps Figs. 35 and 36). These are described and illustrated in the palaeontological report for the Phezukomoya WEF (Almond, 2017). One of the burrow casts is associated with disarticulated bones. Because of their scientific interest (Field Rating IIIB), it is recommended that the fossil burrow sites be protected by a 50 m-wide buffer zone.

Equivocal vertebrate burrows cross-cutting colour-banded overbank mudrocks are seen in the lower Katberg along Oorlogspoort (Fig. 31) but these require further study before their fossil burrow status is accepted; colouration may be deceptive, secondary (diagenetic) and unrelated to meaningful grain-size contrast. In the same area thin calcareous sandstones displaying numerous closely-spaced, vertical cyclindrical traces are now interpreted as casts of reedy plant stems rather than *Skolithos* invertebrate burrows (*cf* Almond 2012) (Fig. 32).

Apart from the Winterhoek 118 vertebrate burrows, all these fossil occurrences belong to categories that have been widely recorded within the extensive Katberg Formation outcrop area of the Main Karoo Basin and do not present obvious unique features. Their palaeontological research and conservation value is therefore assessed as LOW and they are assigned a provisional Field Rating IIIC Local Resource (Appendix 1).

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. 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 and diatoms in pan sediments. No fossil remains were recorded from the various Late Caenozoic superficial deposits examined during the present field assessment. Occasional embedded stone artefacts are of interest in constraining their age to the Middle Pleistocene or Holocene, *i.e.* the last *c.* 300 000 years.

Fig. 30. Fragmentary vertebrate fossils recorded from calcrete nodule breccio-conglomerates within the Katberg Formation: (a) Well-exposed fossiliferous breccia on Holbrook 181 (Loc. 045) (Hammer = 27 cm). (b) Small bone fragment, 20 mm long. (c) Small bone fragment, 35 mm long. (d) Bones enclosed in pedogenic calcrete prior to reworking (arrows; scale in mm). (e) Fragment of jaw bone with tusk, 38 mm long. (f) Fragment of tooth, 10 mm long. Fossils all from Loc. 045 with exception of tooth in (f) from Loc. 056 (See satellite images 33 and 34).

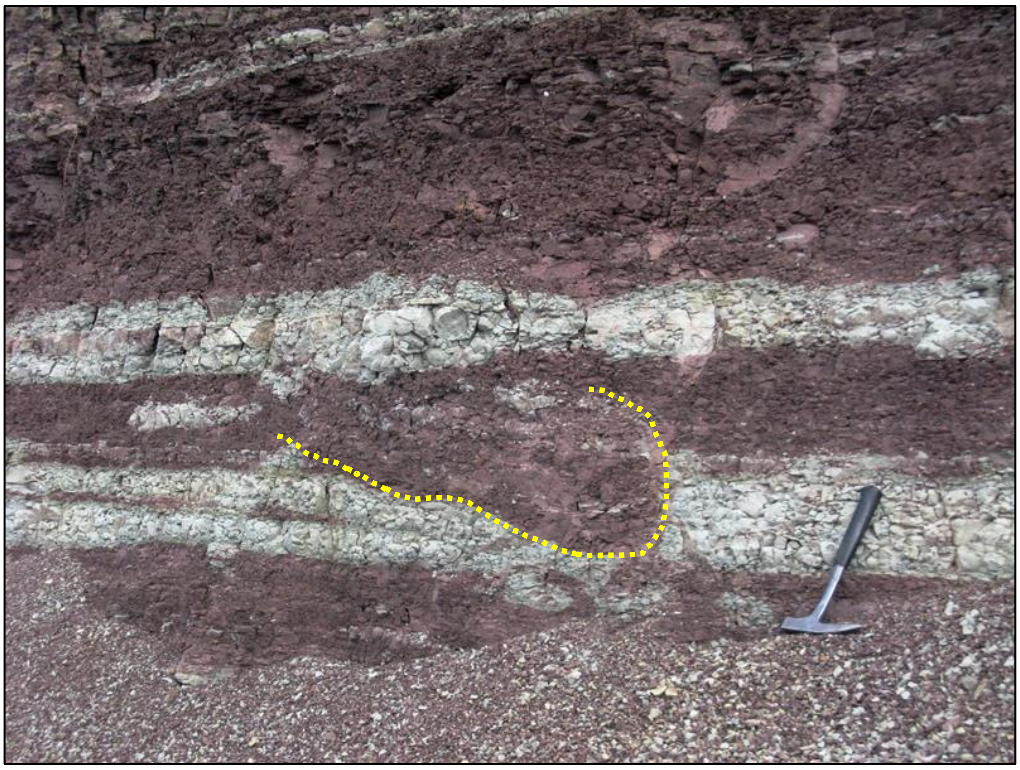

Fig. 31. Colour-banded overbank mudrocks within the lower Katberg Formation showing *equivocal,* mudrock-infilled "vertebrate burrow" (outlined), Oorlogspoort (Loc. 056) (Hammer = 27 cm).

Fig. 32. Thin calcareous sandstone with small cylindrical traces interpreted as stem casts of reedy vegetation, such as equisetalean ferns (Loc. 056) (Scale in cm).

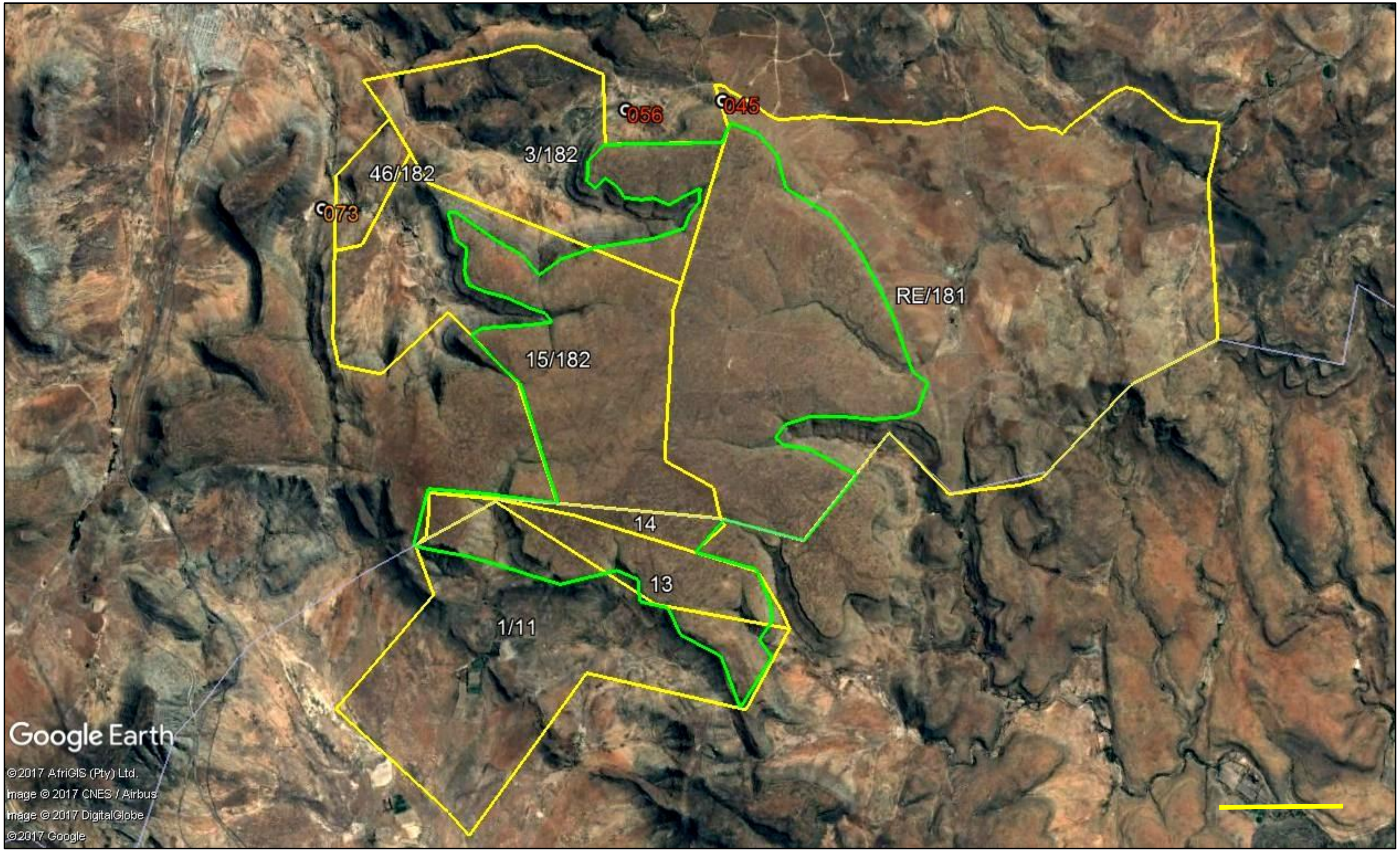

Fig. 33. Google earth© satellite image of the San Kraal WEF project area showing numbered Katberg Formation fossil localities (045, 056 in red) and good exposure of the Palingkloof Member of the Balfour Formation (073 in orange). All these sites lie outside the core WEF development area that is mainly located on the sandstone plateau (green polygon). See Appendix for locality details. Scale bar = 2 km.

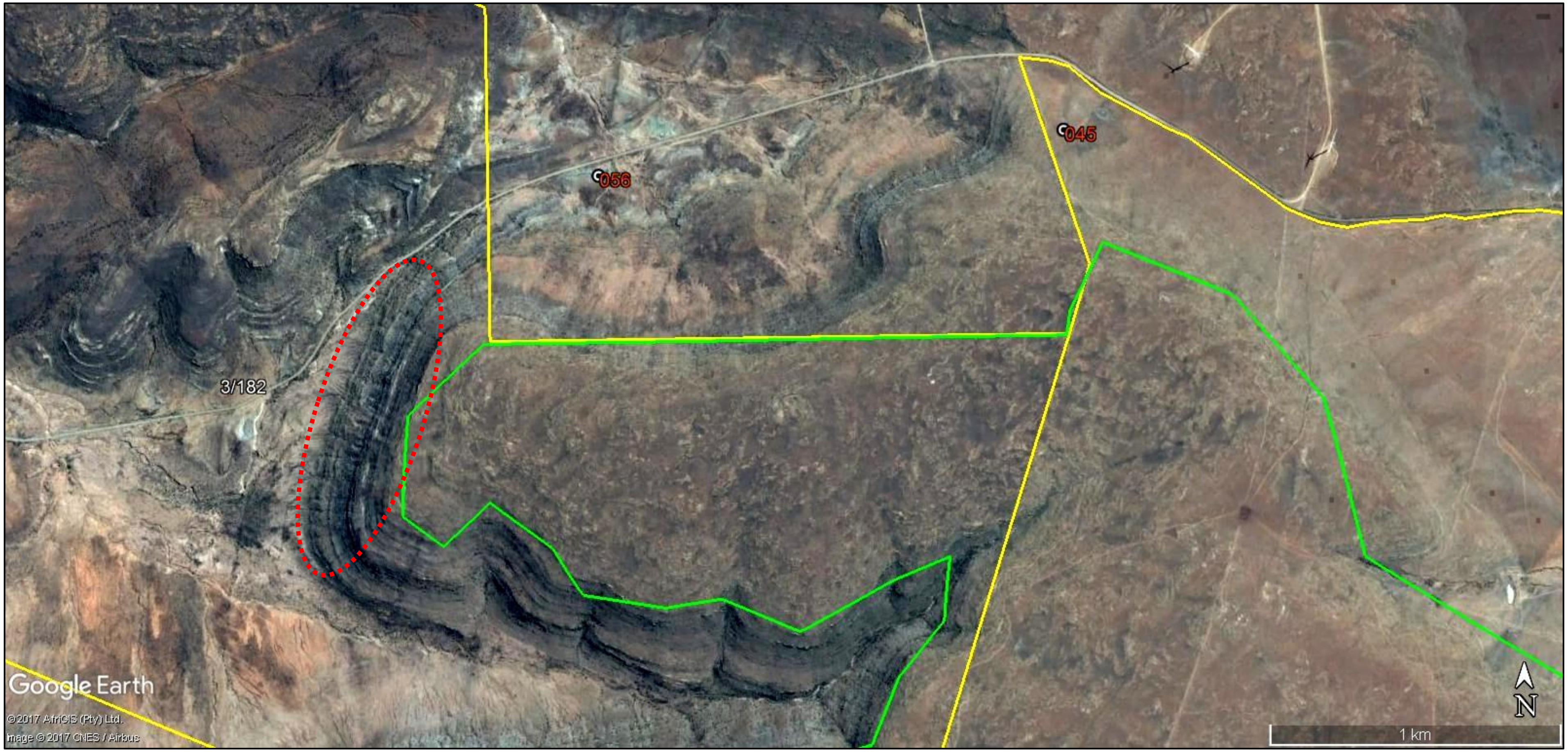

Fig. 34. Satellite image of northern sector of the San Kraal project area (yellow polygon) showing numbered vertebrate fossil localities (045, 056) within the Katberg Formation to the south of the Oorlogspoort dust road. A good escarpment section through the sharp-based Katberg Formation (Fig. 4) is present in the area outlined in red. The low-lying *vlaktes* to the west of the escarpment here are underlain by the Palingkloof Member (uppermost Balfour Formation) but mantled by thick alluvium and colluvium. Note rocky Katberg sandstone terrain on the plateau where most of the WEF infrastructure will be constructed (area outlined in green).

5. EVALUATION OF IMPACTS ON PALAEONTOLOGICAL HERITAGE

The San Kraal WEF study area is located in a region of the Great Karoo that is underlain by potentially fossiliferous sedimentary rocks of Permo-Triassic and younger, Late Tertiary or Quaternary, age (Sections 3 & 4). The construction phase of the proposed wind energy facility will entail substantial excavations into the superficial sediment cover and locally into the underlying bedrock as well. These include, for example, surface clearance and excavations for the wind turbine foundations, laydown and hardstanding areas, internal access roads, underground cables, transmission line pylon footings, electrical substations, operations and services workshop area/office building and construction camps. All these developments may adversely affect potential fossil heritage within the study area by destroying, disturbing or permanently sealing-in fossils preserved at or beneath the surface of the ground that are then no longer available for scientific research or other public good.

The inferred impact of the proposed San Kraal WEF on local fossil heritage resources – including the 132 kV grid connection - is briefly evaluated here, based on the system used by ARCUS Consulting. This assessment applies only to the construction phase of the development since further significant impacts on fossil heritage during the planning, operational and decommissioning phases of the facilities are not anticipated.

In general, the destruction, damage or disturbance out of context of fossils preserved at the ground surface or below ground that may occur during construction represents a *negative* impact that is limited to the development footprint (*local / within site boundary*). Such impacts can often be mitigated but cannot be fully rectified or reversed (*i.e. long-term, irreversible*). Most of the sedimentary formations represented within the study area contain fossils of some sort. The pervasive mantle of alluvium, scree and soil covering the vast majority of the potentially-fossiliferous overbank mudrocks within the WEF study area - including the sandstone plateau areas where most of the infrastructure will be situated – is almost certainly largely responsible for the lack of significant fossil finds here during the present field study. Fossils may be expected in the subsurface and negative impacts at some level on fossil heritage are therefore considered *certain*.

Most fossil occurrences represent taxa that probably occur widely within the study region (*i.e. not unique / irreplaceable*). However, occasional exceptional, scientifically-valuable fossils - such as well-preserved, well-articulated vertebrate skeletons as well as vertebrate burrows - have been recorded in the broader study region around Noupoort. Furthermore, the Beaufort Group bedrock succession underlying the WEF project area records major palaeoecological and evolutionary events across the Permo-Triassic boundary (catastrophic mass extinction event) which are an important focus of ongoing academic studies in Karoo palaeontology. The severity / intensity of anticipated impacts on palaeontological heritage before mitigation is assessed as *moderate (negative)*, given the predicted occurrence of sparse but scientifically-valuable (and potentially *irreplaceable*) fossils in the subsurface within the development footprint. Due to the low extent, moderate severity and permanent duration of potential impacts, the impact significance of the proposed WEF is assessed as *medium (negative)* before mitigation. Confidence levels in this assessment are *medium*, given (1) the extensive palaeontological literature on the Karoo bedrocks concerned weighed against (2) very low levels of bedrock exposure within the study area and (3) the unpredictable distribution of well-preserved fossils in the subsurface.

It should be noted that, should the recommended mitigation measures for the construction phase of the WEF development, as outlined in Section 6 of this report, be consistently followed-though, the impact significance would remain *medium* (*negative*) but would entail both positive and negative impacts. Residual negative impacts from inevitable loss of some valuable fossil heritage would be partially offset by an improved palaeontological database for the study region as a direct result of appropriate mitigation. This is a *positive* outcome because any new, well-recorded and suitably-curated fossil material from this palaeontologically little-known region would constitute a useful addition to our scientific understanding of Karoo Basin fossil heritage.

There are no fatal flaws in the proposed WEF project from a palaeontological heritage viewpoint and no objects to authorisation of the development, provided that the recommended mitigation measures are fully implemented.

5.1. Power line connection to the national grid

The San Kraal WEF will be connected to the National Grid *via* a *c*. 25 km-long 132 kV high voltage overhead power line from the on-site switching station to the proposed Umsobomvu substation situated some 23 km southwest of Noupoort (Fig. 35). A preferred powerline route option together with two alternative routes, Alternatives 1 and 2, are briefly assessed here based on palaeontological field experience of the region (adjoining Umsobomvu, San Kraal and Phezukomoya WEF field study areas) as well as recent field examination of short sectors of the powerline corridors.

All three route options traverse similar geological terrain underlain by Beaufort Group bedrocks with occasional elongate, steeply-dipping dolerite intrusions (See geological map, Fig. 2). Apart from the thicker channel sandstones, the Karoo bedrocks are rarely exposed and in low-lying areas are mantled by several meters of, at most, very sparsely-fossiliferous alluvial deposits, such as exposed in areas of deep *donga* erosion and along incised stream beds. With all three power line route options, direct impacts on surface or subsurface fossils as a result of the powerline construction (notably pylon footings, clearance for new access roads) are likely to be similar and minor (low impact significance), especially given the short length of the power line. The proposed sites for the on-site substation, switching station and connecting overhead powerline on the Katberg sandstone plateau within the main WEF project area are unproblematic from a palaeontological view (low impact significance).

As shown in Figure 36, the south-western sector of the powerline Alternative 1 passes close to an extensive stream bed exposure of Katberg Formation bedrocks which contain a scientifically interesting assemblage of large fossil vertebrate burrows, at least one of which is associated with disarticulated bones, possibly of the trace-maker itself (These occurrences are illustrated and described in the separate palaeontological report for the Phezukomoya WEF, Almond 2017). It is recommended that these fossil sites are protected by a 50 m-wide buffer zone (yellow shape) which would then be transgressed by the Alternative 1 powerline route. This is accordingly the least preferred route option on palaeontological heritage grounds. There is no preference between the currently preferred route and the Alternative 2 route. Should the Alternative 1 route be chosen on other grounds, it is recommended that the sector passing close to the fossil sites be moved south-eastwards to run at least 25 m from the stream bed where the fossil vertebrate burrows are exposed.

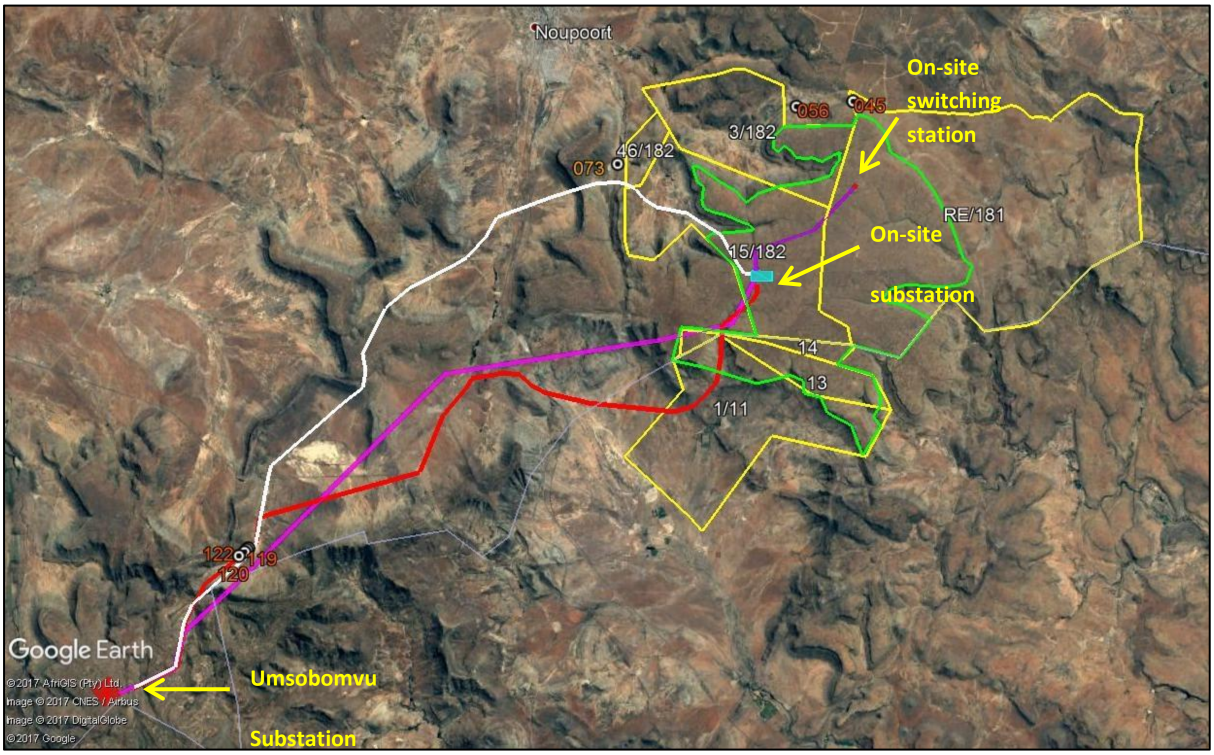

Fig. 35. Google Earth satellite image showing the preferred 132 kV power line connection between the San Kraal WEF and the Umsobomvu substation (purple line) as well as two other route options: Alternative 1 (red line) and Alternative 2 (white line).

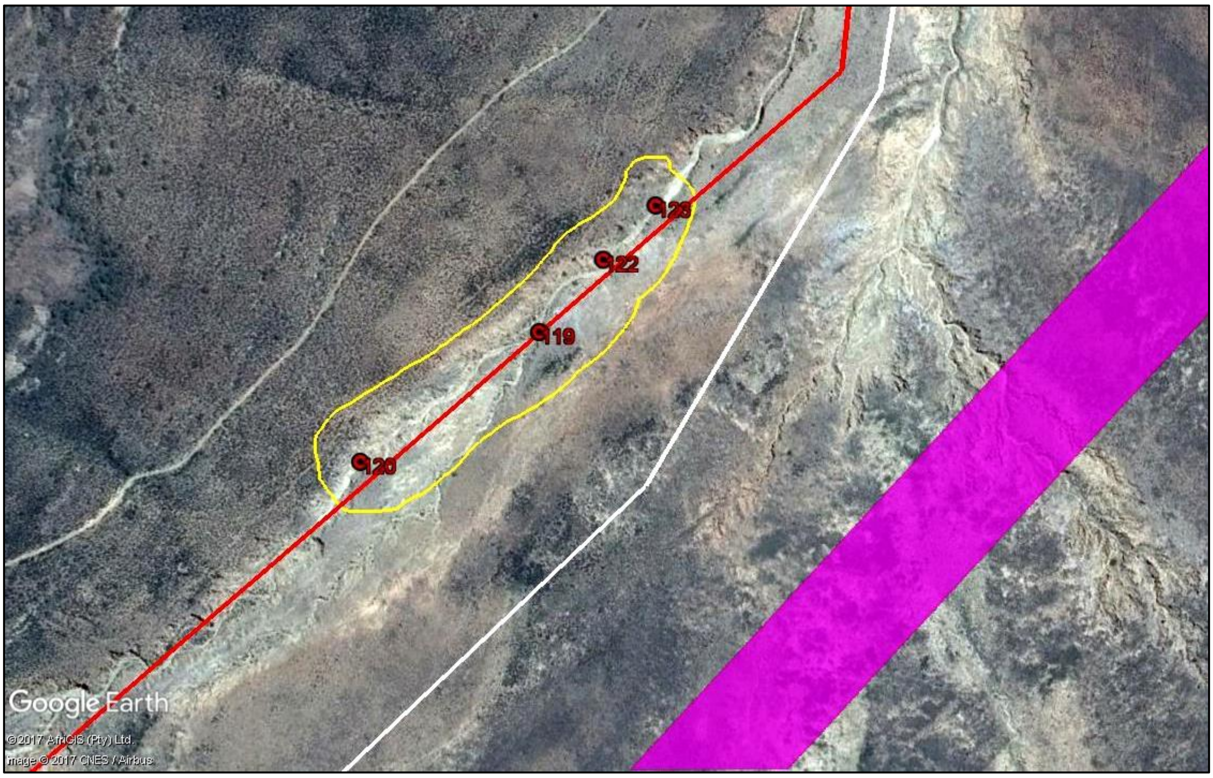

Fig. 36. Detail of the south-western sectors of the 132 kV powerline routes shown in the previous figure. Alternative 1 (red line) passes through the proposed 50 m-radius protective buffer (yellow shape) surrounding several important fossil vertebrate burrow sites in the Katberg Formation that are exposed in a deeply-incised stream bed (Locs. 119-123). Alternative 2 route option – white. Preferred route option – purple.

5.2. Cumulative impact assessment

Previous palaeontological assessments (PIAs) for several proposed or authorized alternative energy projects within a 35 km radius of the San Kraal WEF project area have been briefly reviewed (Note that heritage assessments for some projects have been accepted without a PIA; *e.g.* Dida Solar Energy Facility on the farm Rietfontein north of Noupoort). These include field-based assessments for the Noupoort WEF (Almond 2012), the Umsobomvu WEF (Almond 2015), the Phezukomoya WEF (Almond 2017) as well as several solar projects near Noupoort and Middelburg (Gess 2012a, 2012b, Butler 2016).

In the author's opinion:

- Palaeontological impact significances inferred for these projects that range from low (Noupoort and Umsobomvu WEFs) to medium (San Kraal and Phezukomoya, Naauwpoort 1 solar project) to unassessed reflect different assessment approaches rather than contrasting palaeontological sensitivities and impact levels;

- Meaningful cumulative impact assessments require comprehensive data on *all* major developments within a region, not just those involving alternative energy, as well as an understanding of the extent to which recommended mitigation measures are followed through;

- Trying to assess cumulative impacts on fossil assemblages from different stratigraphic units (in this case, Late Permian fossils from the Adelaide Subgroup and Early Triassic assemblages from the Tarkastad Subgroup) has limited value.

Given the comparatively small combined footprint of the alternative energy projects under consideration compared with the very extensive outcrop areas of the Balfour and Katberg Formations, the cumulative impact significance of the San Kraal WEF is assessed as LOW.

6. RECOMMENDATIONS FOR MONITORING AND MITIGATION

Given (1) the significant potential for scientifically-valuable fossils being disturbed, damaged or destroyed during the construction phase of the WEF as well as (2) the high level of uncertainty regarding fossil distribution in the subsurface, a precautionary approach to palaeontological mitigation is considered appropriate here. Following discussions with SAHRA (Dr Ragna Redelstorff, Oct. 2017), it is therefore proposed that initially a representative sample (*c*. 10%) of excavations for wind turbine footings be monitored by a professional palaeontologist during the early construction phase. The monitoring protocol should be developed by the palaeontologist appointed in consultation with the developer and SAHRA so as to maximise the palaeontological outcome without interfering unduly with the construction program. On completion of this initial phase of monitoring, a Phase 2 palaeontological report, with any recommendations for further specialist monitoring or mitigation, should be submitted by the palaeontologist to SAHRA for comment. This stepwise approach is recommended because it may well prove impracticable to recognise record and sample useful fossil material from turbine excavations due to factors such as excessive fragmentation of the bedrock and fossils, obscuring of freshly-excavated bedrock by soil or dust, or safety considerations.

No palaeontological No-Go areas or fossil sites requiring mitigation have been identified within the main WEF development footprint on the Katberg sandstone plateau. In the grid connection study area several vertebrate burrows exposed in a stream bed on Farm Winterhoek 118 close to 132 kV power line route Alternative 1 (Fig. 36) should be protected by a 50m-radius buffer zone. Should the Alternative 1 route rather than the currently preferred route be finally chosen, it is recommended that that sector passing close to the fossil sites be moved south-eastwards to run at least 25 m from the stream bed.

In addition to the specialist palaeontological monitoring outlined above, the ECO responsible for the construction phase of the project should be aware of the potential for important fossil finds and the necessity to conserve them for possible professional mitigation (See, for example, Macrae 1999 for a well-illustrated popular account of Karoo fossils). The ECO should monitor all substantial excavations into sedimentary rocks for fossil remains on an on-going basis during the construction phase.

Recommended mitigation of chance fossil finds during the construction phase of the WEF and associated grid connection involves safeguarding of the fossils (preferably *in situ*) by the responsible ECO and reporting of finds to SAHRA for the Northern Cape (Contact details: SAHRA, 111 Harrington Street, Cape Town. PO Box 4637, Cape Town 8000, South Africa. Phone: +27 (0)21 462 4502. Fax: +27 (0)21 462 4509. Web: www.sahra.org.za) and to ECPHRA for the Eastern Cape (ECPHRA contact details: Mr Sello Mokhanya, 74 Alexander Road, King Williams Town 5600; Email: smokhanya@ecphra.org.za). Where appropriate, judicious sampling and recording of fossil material and associated geological data by a qualified palaeontologist may be required by the relevant heritage regulatory authorities. Any fossil material collected should be curated within an approved repository (museum / university fossil collection) by a qualified palaeontologist. These recommendations should be included within the Environmental Management Programme for the proposed alternative energy project.

Given the internationally recognised value of Karoo fossil heritage (*e.g.* Macrae 1999, McCarthy & Rubidge 2005, Choiniere & Rubidge 2016), the known occurrence of scientifically-valuable fossil material in the Noupoort region, as well as the legal protection of all fossil remains under the National Heritage Resources Act (1999), these mitigation measures are considered to be essential.

7. ACKNOWLEDGEMENTS

Mr Tim Hart of ACO Associates, Cape Town, together with Ms Ashlin Bodasig and Ms Anja Albertyn of Arcus Consulting, Cape Town, are thanked for commissioning this study and for providing the relevant background information. As always, the logistical support and effective assistance of Ms Madelon Tusenius in the field is very much appreciated. Dr Ragna Redelstorff of SAHRA is thanked for helpful discussions regarding mitigation of Karoo WEF projects while Dr Pia Viglietti (Wits University, Johannesburg) kindly shared valuable stratigraphic insights.

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9. QUALIFICATIONS & EXPERIENCE OF THE AUTHOR

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

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

Declaration of Independence

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

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

APPENDIX: GPS LOCALITY DATA

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

Loc. No.	GPS DATA	COMMENTS
023	S31° 12' 43.4" E25° 00' 54.6"	Hartebeest Hoek 182. Good views of Katberg Fm succession on southern side of Oorlogspoort dust road. Lower part of succession with well-spaced, prominent-weathering, laterally-extensive, tabular, grey-green to pale brownish-weathering sandstones, with intervening thick mudrock packages largely obscured by sandstone scree. Closely-spaced to amalgamated channel sandstones towards top of Katberg succession form cliff around rim of plateau.
024	S31° 13' 50.6" E24° 59' 14.2"	Hartebeest Hoek 182. Alluvial-mantled *vlaktes* south of Hartebeest Hoek homestead. Views of Katberg escarpment.
025	S31° 14' 07.7" E24° 59' 28.4"	Hartebeest Hoek 182. Thick prism or apron of Late Caenozoic mixed colluvial, alluvial and sheetwash deposits along foot of Katberg escarpment. Gently-sloping, laterally-coalescent alluvial (piedmont) fans centred on stream gullies down escarpment. Poorly-sorted, semi-consolidated sandy and gravelly sediments exposed by donga erosion beneath mantle of rubbly, downwasted surface gravels of platy to blocky sandstone (majority), dolerite corestones, diagenetic calcareous concretions. Some clasts secondarily ferruginised / impregnated with manganese minerals.
026	S31° 12' 53.7" E24° 59' 10.9"	Hartebeest Hoek 182. Steep dolerite dyke with rubbly corestone-strewn surface in nek between Goedehoop and Hartebeest Hoek homesteads. Late Caenozoic calcrete development in superficial deposits in vicinity of dolerite (*e.g.* in farm tracks).
027	S31° 16' 52.3" E25° 01' 35.4"	Tweefontein 1/11 / Beskuitfontein. Views of west-facing steep Katberg escarpment cut by occasional steep, thick dolerite dykes (route of most tracks up to Katberg plateau). Almost no mudrock exposure of Lower Beaufort Group in escarpment or *vlaktes*.
028	S31° 17' 16.7" E25° 02' 13.2"	Tweefontein 1/11 / Beskuitfontein. Stream bed exposures of Lower Beaufort Group (probably upper Adelaide Subgroup) bedrocks – yellowish-green channel sandstones overlain by c. 2.5 m of alluvium including thin basal alluvial sandstone gravels and then well-sorted brownish sandy alluvium.
029	S31° 17' 16.2" E25° 02' 09.6"	Tweefontein 1/11 / Beskuitfontein. Extensive stream bed exposures of Lower Beaufort Group (probably Katberg Fm) bedrocks overlain by coarse rubbly alluvial gravels and finer, thick-bedded sandy alluvium with gravel lenticles. Yellowish-brown channel and crevasse-splay sandstones with thin (to 20 cm) lenticular mudflake breccio-conglomerates interbedded with thin-bedded grey-green overbank siltstones. Sharp basal sandstone contacts. Irregular rounded, pale creamy-coloured siliceous nodules and vugs are probably a consequence of nearby dolerite intrusion. Bedding planes with current ripple marks.
030	S31° 17' 34.7" E25° 02' 37.8"	Tweefontein 1/11 / Beskuitfontein. Nek in pass up to Katberg plateau. Views of Katberg escarpment showing thick, amalgamated channel sandstone package towards top of succession. Hillslope exposure of thin-bedded, tabular, purple-brown and blue-green overbank siltstone package with horizon of large, rusty-brown pedogenic calcrete concretions just below finely-gravelly, rusty-brown calcrete breccio-conglomerate horizon. Probably a finer-grained package within the Katberg Formation but with some facies resemblance to Palingkloof Member of Adelaide Subgroup. Overlying thick-bedded tabular channel sandstone with erosional base is Katberg-like.
031	S31° 17' 33.1" E25° 02' 41.4"	Tweefontein 1/11 / Beskuitfontein. Hillslope and farm track exposure through thick (several m) massive to thin-bedded, purple-brown overbank mudrocks. Overlying cross-bedded channel sandstone with well-developed (*c*. 1.5 to 2m thick), grey, massive to vaguely horizontally-bedded basal calcrete breccio-conglomerate – mainly composed of rounded to subangular reworked pedogenic calcrete clasts up to a few cm diameter. No reworked bone fragments seen.
032	S31° 17' 29.0" E25° 02' [illegible]	Tweefontein 1/11 / Beskuitfontein. Farm track exposure of thick, massive, purple-brown overbank mudrock package. Mudrocks weathered [illegible] surface.
033	S31° 16' 51.5"	Tweefontein 1/11 / Beskuitfontein. Prominent-weathering kranz of massive,

	E25° 02' 31.1"	thick-bedded, horizontal- to low-angle cross-bedded, Katberg channel sandstones on plateau. Karstic weathering features (*e.g.* polygonal solution cracks or tessellation / alligator cracking, case hardening). Downwasted sandstone surface gravels, some ferruginised, and orange-brown sandy soils.
034	S31° 16' 54.9" E25° 02' 31.2"	Tweefontein 1/11 / Beskuitfontein. Good examples of large-scale tabular to trough cross-bedding within Katberg channel sandstones.
036	S31° 16' 40.6" E25° 02' 23.9"	Tweefontein 1/11 / Beskuitfontein. Katberg tabular channel sandstones showing extensive good examples of complex etched surfaces due to lichen weathering (cf Grab *et al.* 2011). These features occur widely on the Katberg sandstone plateau areas, especially on damper south-facing slopes. Karstic weathering features also well seen here, including “rock doughnuts” with raised annular rim surrounding a central steep-edged depression, and other forms of rock basins (*ibid.*).
037	S31° 16' 27.4" E25° 02' 43.7"	Farm RE13. Artificial “adit” into thick, dark grey, sandy carbonaceous upper soils on hillslope besides dam. Underlying sandy subsoil with well-developed stone line grade down into weathered mudrock saprolite and fresher hackly-weathering grey-green and purple-brown siltstone.
038	S31° 16' 13.9" E25° 02' 17.0"	Farm RE14. Quarry site for joint blocks of Katberg sandstone used as fence poles etc. Circular solution hollows in sandstone nearby.
039	S31° 16' 04.8" E25° 01' 44.0"	Farm RE14. Good horizontal bedding within Katberg sandstones at top of kloof.
040	S31° 15' 52.9" E25° 00' 25.7"	Farm RE14. Viewpoint across deep kloof at Katberg escarpment. Flat-bedded to gently-dipping Katberg succession with no exposure of mudrock intervals.
041	S31° 16' 28.7" E25° 01' 19.7"	Farm RE13 (western tip).Sphaeroidal carbonate concretions within massive sandstones locally abundant.
042	S31° 16' 43.8" E25° 01' 15.8"	Tweefontein 1/11 / Beskuitfontein. Exposure of Katberg grey-green overbank mudrocks with deformed sandstone lenses (perhaps burrow casts).
043	S31° 12' 13.5" E25° 02' 38.6"	Holbrook 181. Bedding plane exposures of ferruginised mudflake intraclast breccio-conglomerates capped by sandstone within Katberg Fm.
044	S31° 12' 12.8" E25° 02' 40.6"	Holbrook 181. Extensive exposure of major (up to *c*. 3 m thick), grey to greenish-blue, medium to thick-bedded, clast-supported, pebbly calcrete breccio-conglomerate composed of reworked, predominantly well-rounded pedogenic calcrete clasts in a calcareous sandy matrix. Some elongate or platy clasts. Sharply overlain by thin-bedded sandstone and cut by occasional thin (dm) dolerite dykes.
045	S31° 12' 14.2" E25° 02' 40.9"	Holbrook 181. Same calcrete conglomerate bed as above. Sparse fragmentary bone and tusk fragments among calcrete clasts, as well occasional bones embedded within reworked calcrete concretions. Field Rating IIIC Local Resource
046	S31° 12' 50.8" E25° 02' 41.7"	Holbrook 181. Good example of lichen-weathered surfaces on Katberg sandstones.
047	S31° 13' 22.0" E25° 02' 27.0"	Holbrook 181. Karstified, jointed bedding plane exposures of Katberg sandstone showing alligator tessellation, case hardening, solution hollows *etc*. Large-scale trough cross-bedding (palaeocurrents towards the N).
048	S31° 13' 30.1" E25° 02' 24.2"	Holbrook 181. Large-scale sinuous tabular and trough cross-sets within Katberg sandstone (main palaeocurrents towards the S).
049	S31° 15' 55.4" E25° 02' 41.3"	Holbrook 181. Gulley wall exposures of thick (> 3 m) pale brown sandy alluvium with thin, fine-grained gravel lenses, occasional dispersed sandstone blocks, in shallow perched stream valley near escarpment edge , capped by dark brown carbonaceous soils and then modern orange-brown sandy soils.
050	S31° 16' 01.2" E25° 03' 12.0"	Holbrook 181 Erosion gulley exposures of dark, carbonaceous soils in shallow stream valley. Contain small-scale meniscate bioturbation fabrics perhaps attributable to termites or other invertebrates.
051	S31° 15' 38.1" E25° 03' 55.8"	Holbrook 181.Viewpoint eastwards of deeply-incised Katberg escarpment with steeply-dipping dolerite intrusion cutting through tabular channel

		sandstones.
052	S31° 15' 21.9" E25° 03' 26.1"	Holbrook 181. Viewpoint into deeply-incised kloof with only occasional small exposures of purple-brown mudrock facies. Most of escarpment slopes mantled by sandstone scree and soil.
053	S31° 14' 58.8" E25° 02' 07.0"	Holbrook 181. Karstified Katberg sandstone bedding planes, alligator tessellation, solution hollows, lichen-etched surfaces.
054	S31° 13' 46.0" E25° 03' 07.3"	Holbrook 181. View across Katberg sandstone plateau with no mudrock exposure, scattered low sandstone ridges.
055	S31° 12' 47.4" E25° 03' 09.9"	Holbrook 181. Karstic (*e.g.* small mushroom pedestals / chicken heads) and lichen weathering patterns in locally well-jointed Katberg sandstone exposures.
056	S31° 12' 18.8" E25° 01' 40.2"	Hartebeest Hoek 182 (on southern side of Oorlogspoort dust road, just outside project area). Elongate borrow pit exposure into horizontal, thin-bedded purple-brown and grey-green mudrocks and thin, fine-grained sandstones of the lower Katberg Formation (with some facies resemblances to the Palingkloof Member, Balfour Formation, Adelaide Subgroup). Occasional flat-topped sandstone lenses and thin-bedded, more heterolithic packages, locally with sand-infilled desiccation cracks. Colour banding secondary, at least in part. Overlying channel sandstone fairly flat but with locally gullied base. *Possible* but equivocal vertebrate burrow cast by siltstone (requires confirmation). Float blocks of thin-bedded sandstone containing dense assemblages of cyclindrical, vertical,sand-infilled casts – probably of reedy plan stems (*e.g.* equisetaleans). Towards base of exposed succession is thin (few cm), prominent-weathering bed of ferruginised, fine-grained calcrete breccia with rare tooth fragments Some of calcrete bodies are elongate, vermiform and may be calcretised rhizoliths. Field Rating IIIC Local Resource
057	S31° 12' 24.9" E25° 01' 25.7"	Hartebeest Hoek 3/182. Lower escarpment slopes on south side of Oorlogspoort dust road. Prominent-weathering tabular channel sandstones intercalated with thick purple-brown to grey-green mudrock packages as seen in previous locality (but here mostly obscured by sandstone scree).Base of exposed succession is major pale brown channel sandstone seen in stream bed and banks besides road, also assigned to Katberg Fm. Mudrock packages show well-developed sand-infilled polygonal desiccation cracks, horizons of sphaeroidal to irregular, rusty-brown pedogenic calcrete nodules, becoming more heterolithic with thin sandstone interbeds towards top. Base of channel sandstones sharp, flat to often gullied on a small scale, associated with thick (up to 0.5 m) coarse reworked mudclast and ferruginous calcrete breccias (occasionally cross-bedded), fluted sandstone soles, lenticular, pale grey calcrete breccio-conglomerates (*e.g.* infilling gulley bases). Sandstones massive to horizontally- and thin-bedded or low angle cross-bedded.
058	S31° 13' 37.8" E24° 58' 32.8"	Hartebeest Hoek 182. Good hillslope kranz exposures of well-bedded, tough, locally vuggy, baked, thin- to medium-bedded Katberg mudrocks that here have been metamorphosed to brownish-weathering hornfels within the thermal aureole of large dolerite dyke.
059	S31° 13' 38.6" E24° 58' 31.5"	Hartebeest Hoek 182. Columnar-jointed dolerite. Rafts of bedded Katberg sediment enclosed within the dolerite intrusion represent large xenoliths of pale grey metaquartzite and darker grey hornfels. Abundant dark grey flaked hornfels stone artefacts in the vicinity and possible evidence for Stone Age quarrying.
060	S31° 13' 39.9" E24° 58' 30.2"	Hartebeest Hoek 182. Contacts between thermally metamorphosed Katberg country rocks and intrusive dolerite.
061	S31° 13' 38.9" E24° 58' 34.0"	Hartebeest Hoek 182. Surface gravels dominated by angular blocks of pale brownish-grey quartzite (some flaked).
062	S31° 14' 31.4" E24° 58' 33.3"	Hartebeest Hoek 182. Extensive bedding plane and vertical sections through a well-jointed, thick, brownish-weathering, partially-ferruginised and baked calcrete basal breccia within the Katberg Fm, forming base of major sandstone package. Composite several m-thick section with interbedded horizons and lenses of breccia (fine- and coarse-grained calcrete gravels

		and mudrock intraclasts) and sandstone. Upper surface of bed shows karstified polygonal crack pattern.
063	S31° 15' 19.9" E25° 00' 08.9"	Hartebeest Hoek 182. Katberg plateau with extensive kartsified sandstone bedding surfaces – polygonal alligator cracking, steep-walled subrounded solution hollows (rock basins / gnammas), plus lichen weathering features on some joint blocks but not others (clearly post-dated karstificiation and case-hardening).
064	S31° 15' 04.5" E25° 00' 22.1"	Hartebeest Hoek 182. Katberg sandstone exposures showing trough cross-bedding. Downwasted rubbly, agular sandstone gravels overlying rocky areas. Lichen weathering.
067	S31° 15' 04.4" E24° 58' 56.6"	Hartebeest Hoek 182. Good examples of lichen weathering with living lichens *in situ*. Viewpoint towards west across eastern portion of Phezukomoya project area – dissected upland plateau area with occasional exposures of Katberg channel sandstone but not of intervening mudrocks.
068	S31° 14' 29.5" E24° 58' 34.0"	Hartebeest Hoek 182. Stream bed exposure of brownish-weathering, cross-laminated basal calcrete breccia sharply capped by sandstone, as well as mudflake breccias. Overhang of thick-bedded Katberg channel sandstone.
069	S31° 14' 29.9" E24° 58' 36.1"	Hartebeest Hoek 182. Extensive hillslope exposures of cross-bedded, ferruginised, finely gravelly calcrete basal breccia (several m thick). No sign of fossil bone observed. Sharply capped by thick channel sandstone package.
070	S31° 14' 29.7" E24° 58' 37.6"	Hartebeest Hoek 182. Base of thick Katberg cross-bedded channel sandstone package overlying *c*. 1m-thick coarse basal mudrock breccias – laterally equivalent to the thick calcrete basal breccias observed just to the west (Phezukomoya project area); *i.e.* calcrete breccias are lenticular in geometry.
071	S31° 13' 42.7" E24° 58' 30.5"	Hartebeest Hoek 182. Low (sev m) kranz of well-bedded, thermally-metamorphosed quartzite and hornfels within dolerite thermal aureole. Angular quartzitic surface rubble.
072	S31° 13' 10.4" E24° 58' 32.6"	Hartebeest Hoek 182. Extensive gently-sloping hillslope exposures of hackly-weathering purple-brown and grey-green overbank mudrocks – probably upper part of thick latest Permian Palingkloof Member mudrock package (Balfour Fm, Adelaide Subgroup). Horizons of brownish pedogenic calcrete concretions, very thin to thin grey-green crevasse-splay sandstones (heterolithic tops of few m-thick upward-coarsening packages), isolated lenticular sandstone bodies (gully infills or possibly vertebrate burrows – highly equivical), patches of small-scale wave ripples (playa ponds). Field Rating IIIC Local Resource
073	S31° 13' 10.7" E24° 58' 27.7"	Hartebeest Hoek 182. Excellent stream gulley exposures of lower part of Palingkloof Member succession showing colour-banded mudrocks and fine, thin-bedded sandstones in vertical profile. Shallow erosional cut-and-fill structures picked out by colour banding. Packages of massive mudrocks passing up into thinly-interbedded sandstone and siltstone couplets. Occasional prominent-weathering thin sandstones (probable crevasse splays) and brownish-weathering palaeocalcrete lenses within coarser grey-green tops of cycles. No large brown pedocrete nodules seen.
074	S31° 12' 35.6" E24° 58' 31.0"	Hartebeest Hoek 182. Extensive area of erosion-gullied, thick alluvial deposits north of farm dam wall. Several m-thick succession of well-bedded, occasionally laminated, brown sandy alluvium with occasional poorly-sorted gravel lenses and horizons. Downwasted coarser gravels at surface.
119	S31° 19' 08.0" E24° 51' 46.3"	Winterhoek 118. Stream bed exposure of pale buff Katberg Fm sandstones and grey-green overbank mudrocks showing several well-preserved, gently- to quite steeply-sloping, subcylindrical sandstone casts of vertebrate burrows (*c*. 30 cm wide) (See Almond 2017). Proposed Field Rating 111B Local Resource. 50 m-radius buffer zone recommended. Katberg Fm bedrocks are overlain here by thick alluvial succession with coarse gravels at base, brown sandy alluvium above and pale grey modern alluvium at the top.
120	S31° 19' 11.5"	Winterhoek 118. Stream bed exposure of baked Katberg Fm channel or

	E24° 51' 40.3"	thick crevasse-splay sandstone with probable baked sandstone casts of subhorizontal large (30-40 cm wide) vertebrate burrows exposed on the upper surface (See Almond 2017). Proposed Field Rating 111B Local Resource. 50 m-radius buffer zone recommended.
122	S31° 19' 06.0" E24° 51' 48.5"	Winterhoek 118. Stream bed exposure of hackly, grey-green Katberg overbank mudrocks with several probable sandstone casts of large vertebrate burrows (up to 60 cm diameter, compressed ellipsoidal cross-section) – perhaps a warren. Occasional small-scale (1 cm –diam.) *Katbergia* scratch burrows in area (See Almond 2017).. Proposed Field Rating 111B Local Resource. 50 m-radius buffer zone recommended.
123	S31° 19' 04.5" E24° 51' 50.3"	Winterhoek 118. Stream bed exposure of Katberg Fm mudrocks with baked sandstone cast of vertebrate burrow and associated, disarticulated skeletal remains – mainly limb bones - of a medium-sized tetrapod (probably therapsid). Proposed Field Rating 111B Local Resource. 50 m-radius buffer zone recommended (See Almond 2017).

Palaeontological assessment.