Palaeontological Heritage Impact Assessment of the proposed wind farms in the coastal region of the Kouga Local Municipality near the villages of Oyster Bay and St Francis Bay.

Assessment conducted in terms of
Section 38 (8) of the National Heritage Resources Act (Act 25 of 1999)

Prepared for:
Arcus GIBB, Engineering & Science

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Report by

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EXECUTIVE SUMMARY

Dr Billy de Klerk, Curator of Earth Sciences at the Albany Museum, Grahamstown was appointed by Arcus GIBB to conduct a palaeontological heritage assessment in three areas along the Kouga Municipal coastline in three clusters which have been targeted as areas where wind turbines could be erected. They are the
1. Western Cluster - between the Tsitsikama River and Oyster Bay
2. Central Cluster – to the north-east of Oyster and
3. Eastern Cluster – between Paradise Beach and St Francis Bay.

Declaration

Dr W.J. (Billy) de Klerk (PhD) is a Palaeontologist, Specialist Scientist, employed by the Eastern Cape Department of Sport Recreation Arts and Culture (DSRAC) and is also an Associate Researcher in the Department of Geology at Rhodes University, Grahamstown. He has 34 years of working experience in the Earth Sciences and having served two terms as President of the Palaeontological Society of Southern Africa, is accredited by the society to conduct Palaeontological Heritage Impact assessments. He occasionally does independent specialist consulting and is in no way connected with the proponent, other than delivery of consulting services.

Glossary

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.*
Permian: *A geological time period dated between 299 – 251 Ma (million years ago).*
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.*
SAHRA: *South African Heritage Resources Agency – the compliance authority which protects national heritage.*

1. INTRODUCTION

Red Cap Investments (Pty) Ltd is proposing the establishment of a commercial wind energy facility and associated infrastructure in three clusters located along the Kouga Local Municipal coastline in the vicinity of Oyster Bay and St Francis Bay (Figure 1). The brief was to conduct a data survey / database assessment of the palaeontology and the fossil potential within the footprint of the three clusters as outlined in Figure 1.

Location

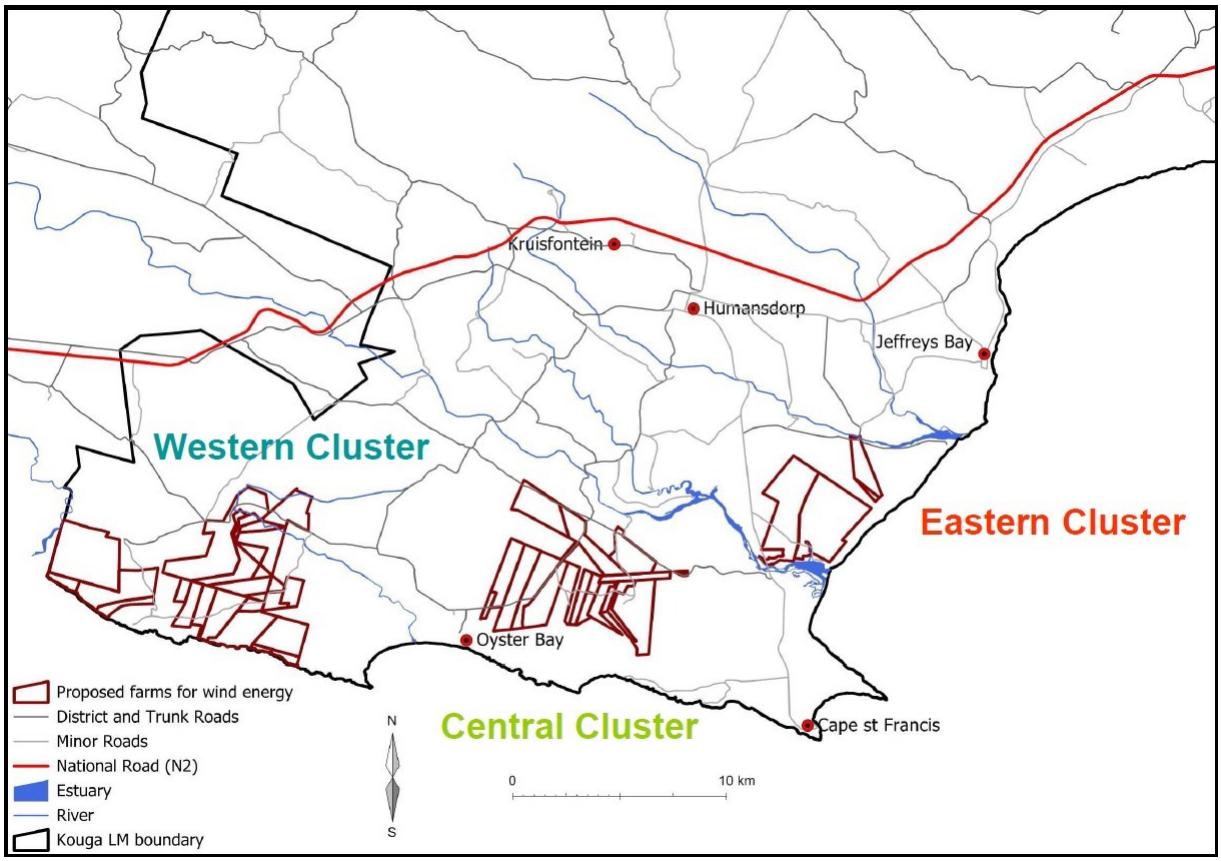

Figure 1. Locality map showing the footprints of the Western, Central and Eastern clusters of farms in the Kouga Local Municipality that have been proposed for the production of wind energy.

The area under consideration is essentially underlain by two widely differing aged sediments. Firstly the older Palaeozoic sediments of the Table Mountain Group ("Table Mountain Sandstones") and the lower Bokkeveld Group and secondly by thin veneers of Plio-pleistocene and Holocene coastal aeolian sediments of the Algoa Group (Nanaga and Schelm-Hoek Formations respectively). The Table Mountain and lower Bokkeveld Group rocks are generally sparsely fossiliferous while as are the younger aeolian sediments. Fossils of marine organisms have over the past 150 years been collected from these sedimentary rocks and are today preserved in South African museum and universities, making up part of the National Estate.

2. GEOLOGICAL BACKGROUND & SETTING

Table Mountain Group

Rifting occurred across what is today known as the southern Cape about 450 million years ago. This rifting had the effect of thinning the crust and resulted in the invasion of the sea, giving rise to the “Agulhas Sea” across the southern Cape. Sediments that subsequently accumulated in this newly formed basin produced what is today seen as the Cape Supergroup of rock (Figure 2).

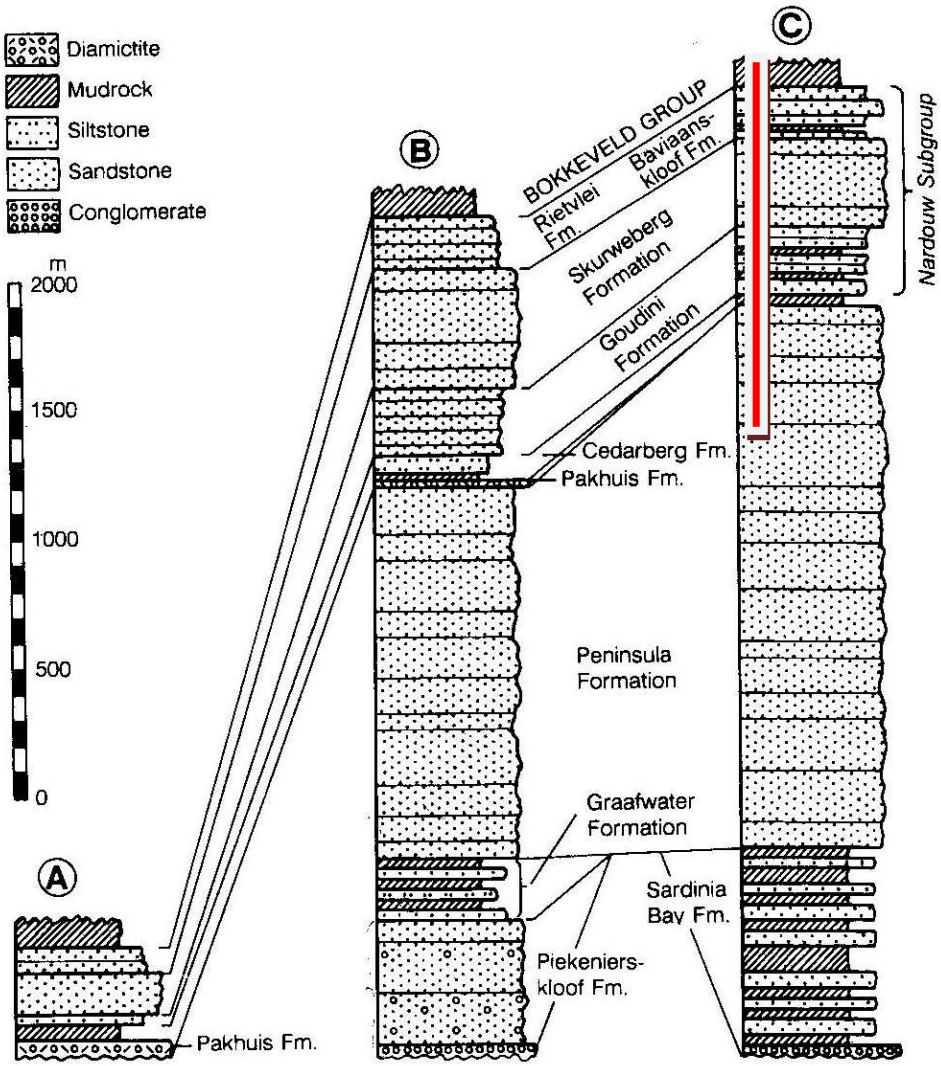

Figure 2. Stratigraphic subdivision of the Table Mountain Group (From Johnson *et al.* 1999). Column C, measured in the Eastern Cape, is most relevant to the present field study. The rock type formations that occur in Figure 3 are indicated here by the vertical red line.

As indicated on the 1: 250 000 geological map 3324 Port Elizabeth (Figure. 3), the Kouga Wind Farm area is entirely underlain by mid-early Palaeozoic (Ordovician – lower Devonian) sediments of the **Table Mountain Group** (Cape Supergroup) and the basal part of the **Bokkeveld Group** (Ceres subgroup). Relevant geological references include Rust (1967), Hiller (1982), Malan & Theron (1989), Broquet (1992), Johnson *et a*l., (1999), De Beer (2002), Thamm & Johnson (2006), and Tankard *et al*., (2009). These rocks are mostly craggy, resistant-weathering fluvial sandstones and minor pebbly conglomerates of the **Peninsula Formation** (Ordovician) and **Nardouw Subgroup** (Silurian) that respectively

underlie and overlie the thin **Cederberg Formation o**f Latest Orodovician (Hirnantian) age. This unit is made up of a thin, coarsening-upwards succession of mudrocks, siltstones and sandstones that was deposited within shallowing, frigid postglacial seas following the Gondwana glaciation. This rock unit has yielded a world-famous fossil biota that includes some of the earliest known primitive fish and, exceptionally, several vertebrate and invertebrate taxa preserving the original structure of soft tissues, as well as trace fossils, microfossils and simple plant remains (Almond, 2008). The palaeontological sensitivity of this unit is therefore very high indeed and any new excavations into fresh bedrock are of always of considerable palaeontological interest.

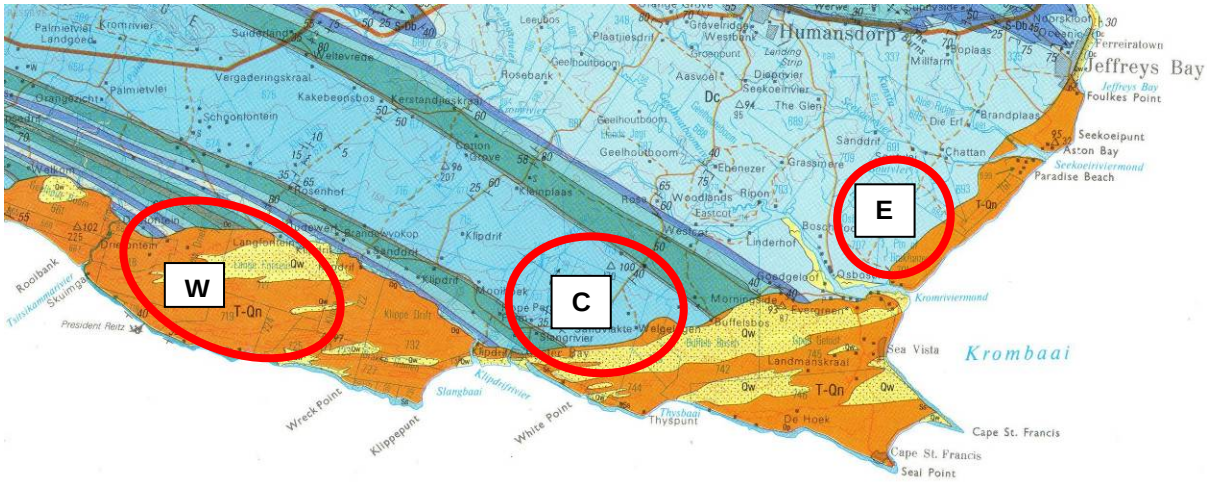

Figure 3. Portion of the 1: 250 000 scale geological map 3324 Port Elizabeth (Published by the Council for Geoscience, Pretoria, 1991) showing bedrock geology of the three clusters under consideration (indicated by red circles). From oldest to youngest: Table Mountain Group. Nardouw Subgroup – Peninsula Frm = **Op**; Cedarberg Frm = **Oc** (grey); Goudini Frm. = **Sg** (dark green); Skurweberg Frm. = **Ss**; Baviaanskloof Frm. = **Db** (dark blue). Bokkeveld Group, Ceres Subgroup (**Dc**) – basal Gydo Frm. = **Dg** (pale blue). The outcrop of the palaeontologically sensitive Cederberg Formation (**Oc**) occurs as the thin grey lines occurring once in the West and twice in the Central Clusters. Turbines planned in the Eastern Cluster are situated on rocks (sub-outcrop) of the he Bokkeveld - Ceres Subgroup (**Dc**). The Table Mountain Group, the Peninsula Formation and Nardouw Subgroup are only sparsely fossiliferous while the Bokkeveld - Ceres Subgroup has a far better fossil potential.

Tectonic Deformation – Cape Supergroup rocks

As can be seen in Figure 3 the rocks of the Cape Supergroup have been severely deformed (folded and faulted) during the Cape Folding Event which took place approximately 310 million years ago (McCarthy and Rubidge, 2005). The greater temperatures and pressures experienced by these Cape Supergroup sediments resulted in regional low-grade metamorphic recrystallization of the sediments. The tectonism and low-grade metamorphic overprint effectively contributed to the destruction of any fossils in the original sediment. It is only in the low pressure zones of the folds that there is any possibility of finding undamaged fossils.

Weathering and Erosion

The generally flat-lying land surfaces of the Western Central and Eastern Cluster areas generally have a deep weathering profile and in places have been correlated with the African

Erosion Surface which developed between the late Jurassic (145 Ma) until the end of the early Miocene at approximately 15 Ma (Partridge and Maud, 1987). The end result of this prolonged erosion event resulted in advanced planation throughout the subcontinent resulting in the development of a deep-weathered profile. Any fossils within the weathered profile would also have been destroyed.

3. METHODS

1. Literature review & Museum Catalogue Search. A comprehensive review of the literature pertaining to the Peninsula Formation and the Nardouw and Ceres Subgroups was undertaken. In addition, a search of known fossils, housed in Eastern Cape museums, was undertaken from the accession catalogues.

2. Field Work. A full field day (6th December 2010) was spent in the footprint area to ascertain what the nature of the geology was and, more importantly, what the fossil potential would be.

4. OBSERVATIONS

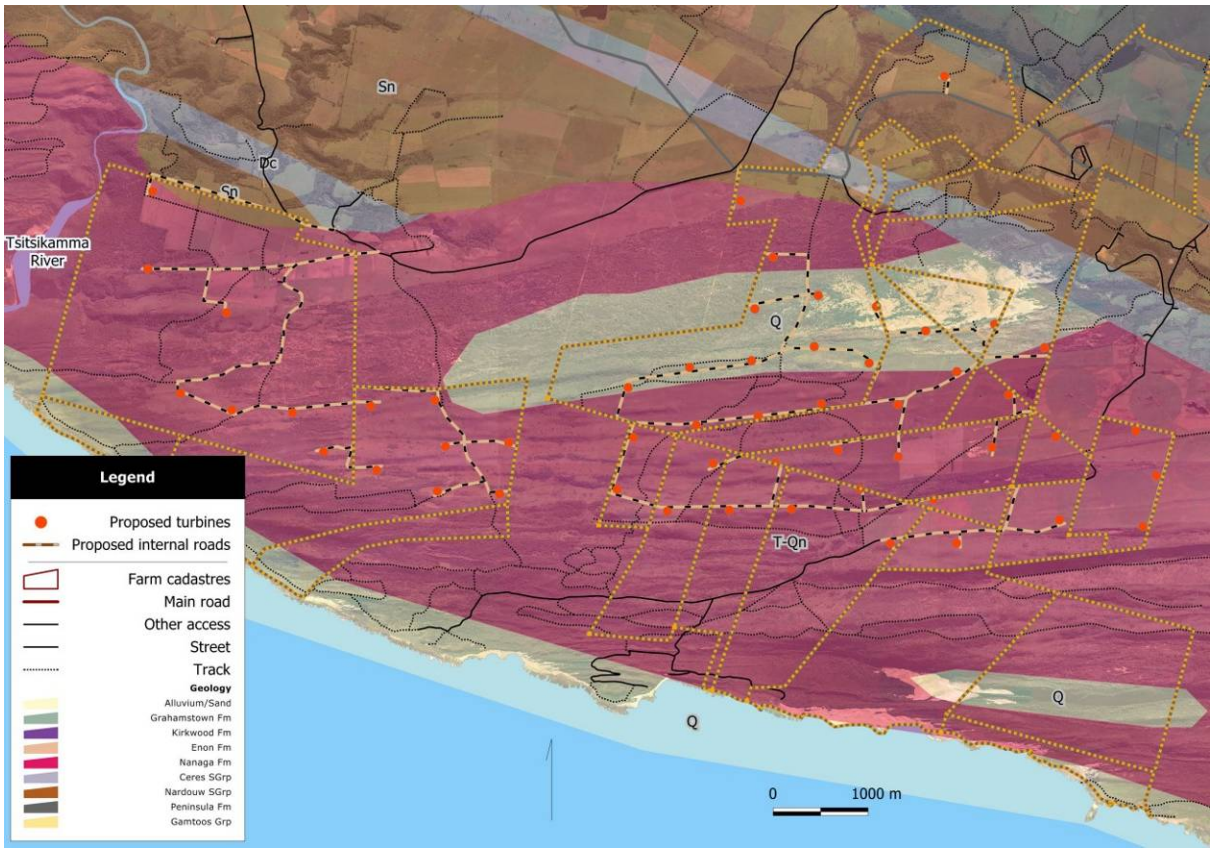

Figure 4. Western Cluster.

Within the Western Cluster only one wind turbine in the NE sector is sited on Table Mountain Group rocks (Goudini Frm. of the Nardouw Sub) (Figure 4). For the rest, the turbines are predominantly sited on aeolian sediments of the Nanaga (T-Qn) and in Schelm-Hoek (Q) Formations. Fresh exposures of the Cape Supergroup rocks are rare and are prdominatly found on the higher ground as isolated outcrops of quartzite (Figure 5).

<u>Fossil Potential</u> - It is therefore unlikely that any fossils would be found in either the Table Mountain or Algoa Group rocks during the construction phase of the turbines.

Figure 5. General view (looking south-west) in the Western Cluster area showing isolated resistant outcrop of quartzite. Generally there is a paucity of bedrock outcrop in the rolling nature of the countryside.

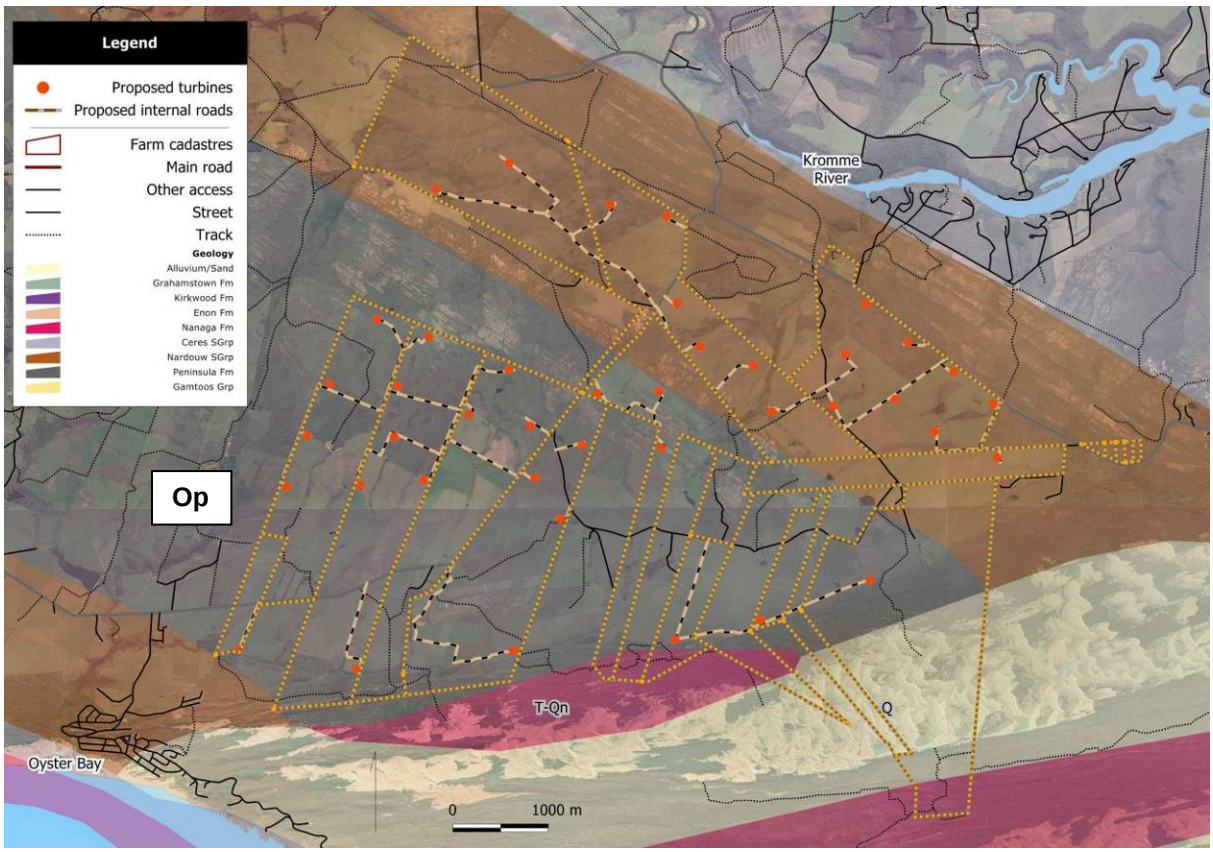

Figure 6. Central Cluster
Here all the wind turbines are sited on Cape Supergroup rocks. Firstly in the south (grey area) on Peninsula Formation (Op) and secondly in the northern area (brown) on Cedarberg Goudini and Skurweberg Formations.

<u>Fossil Potential.</u> It is unlikely that any fossils would be found in areas underlain by the Table Mountain Group rocks (metasediments).

Figure 7. Resistant Peninsula Frm (Table Mountain Grp), quartzites outcropping in the generally flat landscape. Coastal sand dunes of the Algoa Group, Schelm-Hoek Formation (Holocene) are seen exposed in the distance and also occur under the hilly vegetation cover.

Figure 8. Surface outcrop of Peninsula Frm (Table Mountain Grp) showing the highly resistant nature of the quartzite (34°08.669'S; 24°43.834'E).

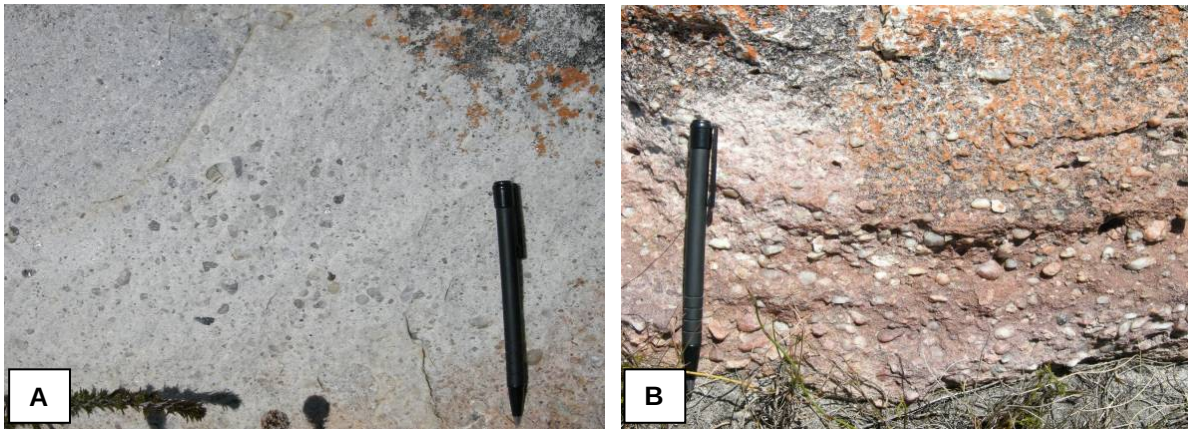

Figure 9. Detail of the coarse-grained Peninsula Formation quartzites shown in Figure 8. A fresh surface (A) clearly shows a matrix-supported small pebble grit while in B the partly wethared surface of the exposure show the well-rounded nature of the pebbles. These features all poin to the sediment having been deposited under high energy levels ruling out the possibility of fossil preservation (34°08.669'S; 24°43.834'E).

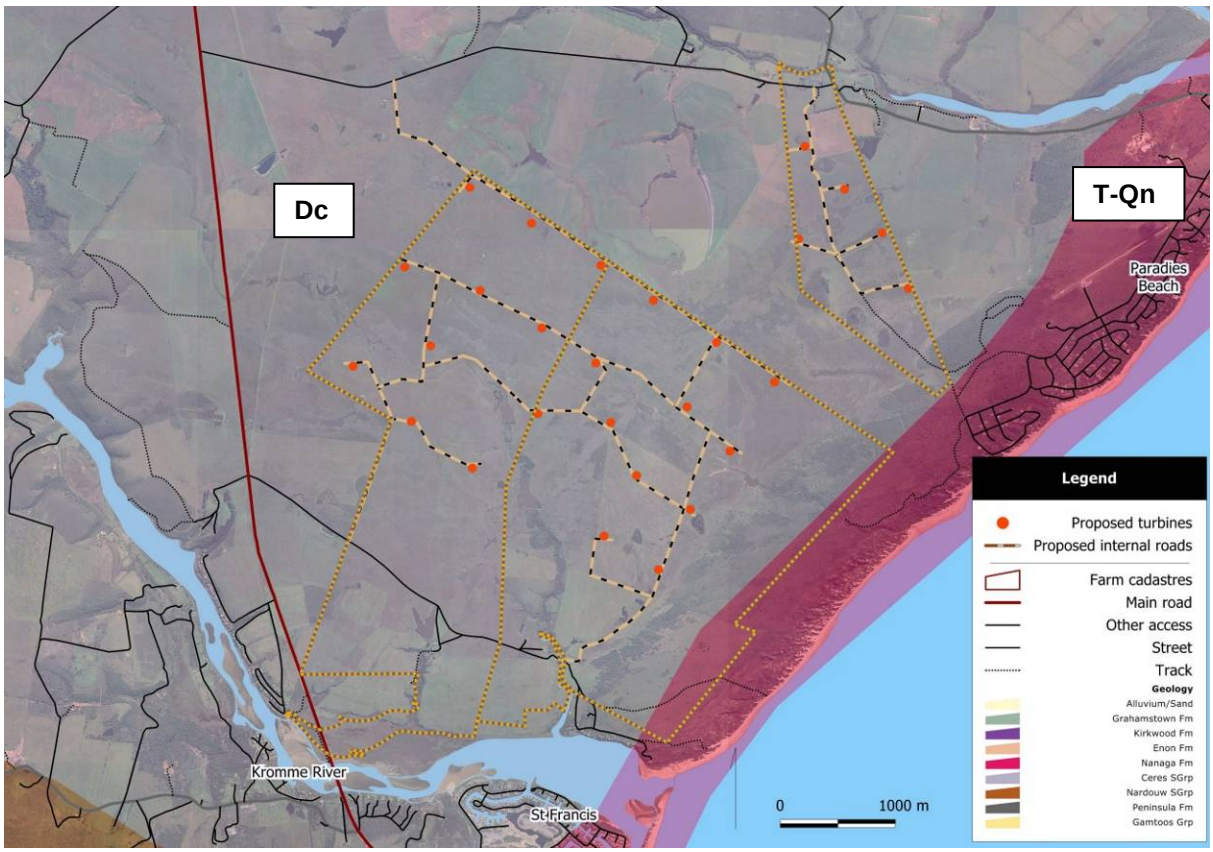

Figure 10 Eastern Cluster. Here all the wind turbines are all sited on Cape Supergroup rocks, specifically the Bokkeveld Group - Ceres Subgroup (Dc). T-Qn represents the Nanaga Formation Aeolian sands along the coastal strip.

The wind turbines are sited on a flat featureless plane that does not have any surface outcrop at all (Figure 11). The only indication of the subsurface sedimentary rocks is found in a road cutting along the R330 from Humansdorp to St Francis Bay (Figure 12)

Figure 11. Eastern Cluster featureless plane (view looking north-east). No bedrock outcrop is apparent.

Figure 12. Outcrop of Bokkeveld Group, Ceres Subgroup shales exposed in the R330 road cutting approaching the Kromme River and St Francis Bay from Humansdorp.

Figure 13. Bokkeveld Group – Ceres Subgroup shale in the R330 road cutting approaching the Kromme River. Note the well developed metamorphic cleavage that developed during the Cape Folding event some 310 million years ago destroying any potential fossils.

<u>Eastern Cluster - Fossil Potential.</u> The Bokkeveld Group - Ceres Subgroup has in the past yielded a diverse shelly invertebrate biota and trace fossils. Rare fish remains, plants and microfossils have also been recovered. It is however unlikely that any meaningful fossil will be found in this particular area as the underlying sediments have firstly been subjected to tectonic a overprint imparted by the Cape Folding Event that took place around 310 million years ago. This tectonism, coupled with low-grade regional metamorphism has effectively destroyed any fossils that may have been in the original sediments. Secondly a long period

of weathering and erosion coupled with repeated marine transgressions and regressions would also have had a negative effect on fossil preservation.

5. CONCLUSIONS AND RECOMMENDATIONS

As outlined in the section 2 above (p.4 - Geological Background and Setting), this area is underlain by sedimentary rocks of the Cape Supergroup – mainly of the Table Mountain group and by the Bokkeveld Group (Ceres Subgroup) in the Eastern Cluster. Fossil have in the past been recovered from these sediments throughout the southern Cape but in particular within the Western Cape. However, within the three Clusters of the Kouga Wind Farm development, two geological factors have effectively eliminated fossils from being preserved. Firstly the tectonic overprint of the Cape Folding Event that took place around 310 million years ago and secondly, the long period of weathering and erosion that produced the African Land Surface and the coastal plane. There is therefore a very low likely hood of finding well preserved fossils at any of the three Kouga Wind Farm Clusters.

The only rock unit that may be palaeontologicaly sensitive is the Cedarberg Formation that occurs in the Western and Central Cluster areas. Again the chances of encountering this thin unit is remote and it will also have the metamorphic overprint which has effectively destroyed any potential fossils. As such, the environmental impact significance can be rated as **Low** as tabulated in Table 1 below:

Table 1: Paleontological Impact Significance Rating

Nature of impact	Extent	Duration	Intensity	Probability	Significance - without mitigation	Significance - assuming mitigation	Status	Confidence level
Fossils in underlying sediments.	Local	Long term	Low	Improbable	Low	Low	Neutral	High

If at any stage during the construction phase of the wind turbines and the associated infrastructure, like roads and trenching for cables, any semblance of a fossil were to be observed, it would be vital to recover the fossil and report the occurrence to the geological staff at either the Albany Museum or Rhodes University in Grahamstown. Alternatively it can be reported to staff at the Council for Geosciences in Port Elizabeth. Generally fossils can be removed quickly and would therefore not delay or hinder construction operations.

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15 December 2010

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