Palaeontological Heritage Input: combined field-based & desktop study

PROPOSED ABERDEEN WIND ENERGY FACILITY CLUSTER NEAR ABERDEEN, SARAH BAARTMAN DISTRICT, EASTERN CAPE PROVINCE

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EXECUTIVE SUMMARY

Atlantic Energy Partners (Pty) Ltd is proposing to develop a cluster of 4 x 170MW wind farms *plus* grid connection infrastructure on a site located between15 and 45 km west of the small town Aberdeen in the Sarah Baartman District (Dr Beyers Naude Local Municipality), Eastern Cape Province. The Aberdeen WEF Cluster project area is underlain at depth by potentially fossiliferous continental (fluvial / lacustrine) bedrocks of the Lower Beaufort Group (Adelaide Subgroup) that probably belong to the Middle Permian Abrahamskraal Formation. There are no historical records of fossil vertebrates from this area; this is largely due to the extremely poor levels of bedrock exposure found here. During the recent 4-day palaeontological field assessment only two occurrences of fossil vertebrates were recorded, both comprising material reworked into superficial gravels rather than *in situ*. Both fossil vertebrate sites have been adequately sampled and do not require further mitigation. Occasional trace fossil assemblages comprise low diversity, small-scale invertebrate burrows of limited scientific interest.

A background scatter of numerous petrified (silicified) wood blocks reworked from the Lower Beaufort Group bedrocks occurs within surface gravels and sands of eluvial and alluvial origin throughout most of the WEF Cluster project area; only a small sample of such occurrences have been recorded here. Much of the fossil wood material is poorly preserved and of limited scientific value. However, a small minority of blocks show well-developed seasonal growth rings and excellent preservation of the original woody fabric; these are potentially identifiable and may be of biostratigraphic and palaeoecological interest. Mitigation of the recorded fossil wood sites in particular is not recommended here, given the abundance and widespread occurrence of the material. However, it is recommended that a representative sample of well-preserved fossil wood material from the WEF project area is collected by a suitably qualified palaeontologist for curation in an approved fossil collection (*e.g.* Evolutionary Studies institute, Wits University, Johannesburg) once the development is authorized and before the Construction Phase.

Most of the low-relief WEF Cluster project area is covered by a blanket of Late Caenozoic superficial deposits, including alluvial gravels and sands, eluvial and colluvial surface gravels, calcrete hard pans, pan sediments and gravelly to sandy soils. Apart from the abundant reworked fossil wood blocks and very rare bones reworked from the Permian bedrocks, no fossils of Caenozoic age have been recorded within these younger sediments.

Given the rarity of significant vertebrate and other fossil finds, the overall palaeosensitivity of the Aberdeen WEF Cluster project area is assessed as LOW. The provisional Medium to Very High Palaeosensitivity mapped here by the DFFE Screening Tool is accordingly *contested*. The potential for occasional fossil vertebrate sites of Very High palaeosensitivity cannot be entirely excluded, however. The distribution of such sites is largely unpredictable and they are best mitigated through a Chance Fossil Finds protocol (Appendix 2).

The impact significance of the proposed Aberdeen Wind Energy Facility Cluster is assessed as LOW since fossils of significant scientific and conservation value are so rare here. None of the recorded fossil sites lies directly within the provisional project footprint. The project is not fatally flawed and there are no objections on palaeontological heritage grounds to its authorization. This assessment applies equally to all infrastructure components and layout options currently under consideration.

The Environmental Control Officer (ECO) / Environmental Site Officer (ESO) responsible for the WEF developments should be made aware of the possibility of important fossil remains (vertebrate bones, teeth, burrows, petrified wood, plant-rich horizons *etc.*) being found or unearthed during the construction phase of the development. Monitoring for fossil material of all major surface clearance and deeper (>1m) excavations by the ECO/ESO on an on-going basis during the construction phase is therefore recommended. Significant fossil finds such as vertebrate bones, teeth and well-preserved petrified logs should be safeguarded and reported at the earliest opportunity to the Eastern Cape Provincial Heritage Resources Authority (ECPHRA. Contact details: Mr Sello Mokhanya, 74 Alexander Road, King Williams Town 5600; Email: smokhanya@ecphra.org.za). This is so that appropriate mitigation (*e.g.* recording, sampling or collection) can be taken by a professional palaeontologist (See tabulated Chance Fossil Finds Procedure in Appendix 2 to this report). The specialist involved would require a fossil collection permit from ECPHRA. Fossil material must be curated in an approved repository (*e.g.* museum or university collection) and all fieldwork and reports should meet the minimum standards for palaeontological impact studies developed by SAHRA (2013). These recommendations must be included in the EMPr for the proposed renewable energy development.

1. PROJECT OUTLINE & BRIEF

The company Atlantic Energy Partners (Pty) Ltd is proposing to develop a cluster of 4 x 170MW wind farms *plus* grid connection infrastructure comprising a 132/400kV collector switching station and a 132/400kV overhead power line (within a 100km long and 300m wide corridor) on a site near Aberdeen in the Eastern Cape Province (Fig. 1). The project site is located within the Beaufort West Renewable Energy Development Zone (REDZ) and the grid connection corridor falls within the Central and Eastern Corridors of the Strategic Transmission Corridors. The Applications for Authorisation for the 4x 170MW wind farms and grid connection infrastructure will therefore follow a Basic Assessment (BA) process.

The WEF cluster project area is situated between15 and 45 km west of the small town Aberdeen in Sarah Baartman District (Dr Beyers Naude Local Municipality), Eastern Cape Province. It is located on the farms Koppies Kraal 157, RE of Farm 91, Doornpoort 93, Farm 94, Kraanvogel Kuil 154, Kraanvogel Kuil 55, Kraay Rivier Outspan 150, Farm 153 and Kraai Rivier 149, situated for the most part in the Aberdeen *Vlaktes* subregion of the Great Karoo between the R61 (Aberdeen – Beaufort West) and N9 (Aberdeen – Willowmore) tar roads (Fig. 1).

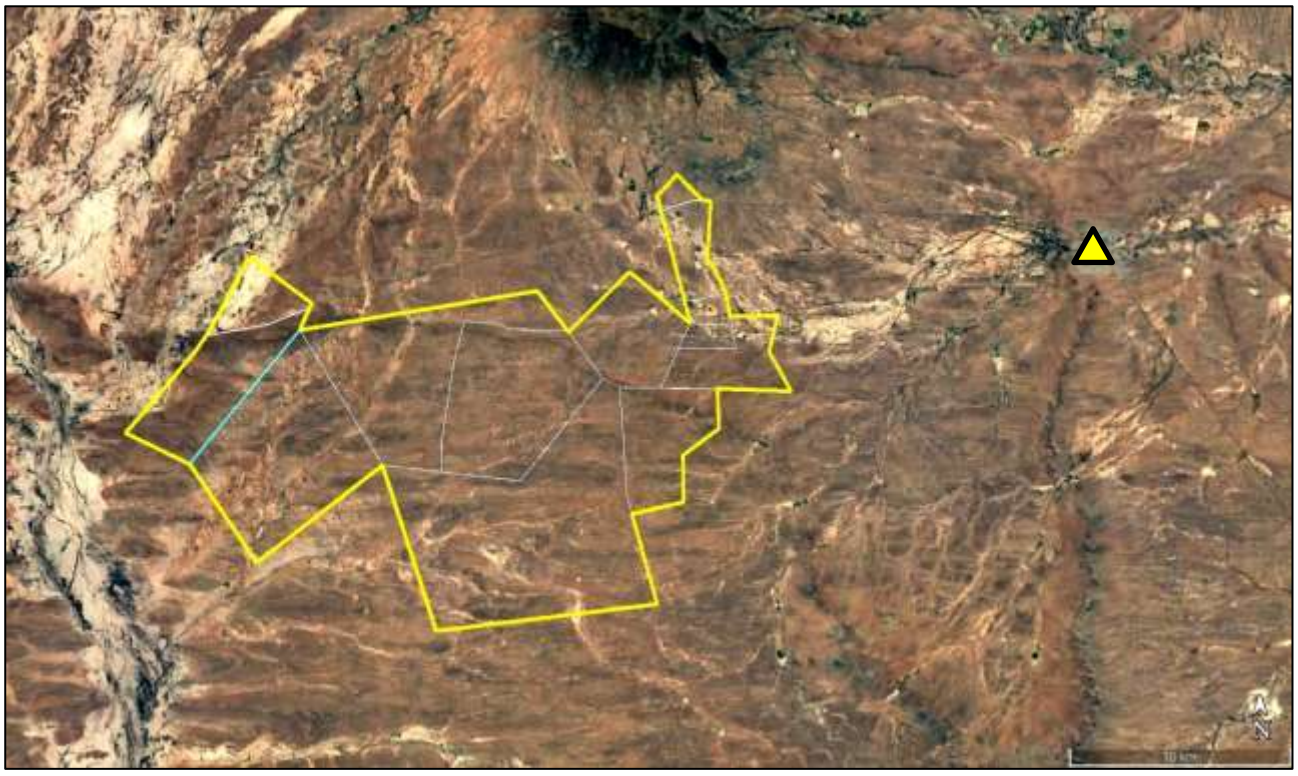

Figure 1: Google Earth© satellite image showing the location of the Aberdeen WEF Cluster project area (yellow polygon) situated in the low-relief Aberdeen *Vlaktes* region of the Great Karoo, *c*. 15 to 45 km west of Aberdeen (yellow triangle) and east of the main Kariega River drainage system.

Provisional sensitivity mapping (SAHRIS palaeosensitivity map, DFFE Screening Tool) suggests that much or most of the site is of High to Very High Palaeosensitivity based on the presence here of potentially fossiliferous continental sediments of the Lower Beaufort Group (Karoo Supergroup) of Permian age. The present combined desktop and field-based palaeontological heritage report contributes palaeontological heritage data to the overarching Heritage Impact Assessment (HIA)

and EMPR that are being compiled for the Aberdeen WEF Cluster by CTS Heritage, Cape Town (Contact details: Ms Jenna Lavin, CTS Heritage. 16 Edison Way, Century City, Cape Town. Tel: +27 (0)87 073 5739. Cell: +27 (0)83 619 0854. E-mail: info@ctsheritage.com). The independent EAP for this renewable energy project is Savannah Environmental (Pty) Ltd.

2. INFORMATION SOURCES

This combined desktop and field-based palaeontological heritage study of the Aberdeen WEF Cluster project area is based on the following information resources:

1. Short project outlines, kmz files, screening reports and maps provided by CTS Heritage, Cape Town;

2. A desktop review of:

(a) the relevant 1:50 000 scale topographic maps (3223BD Kamdeboo, 3223BC Kunna, 3223DB Kaapsepoortjie and 3223DA Kiwietskuil) as well as the 1:250 000 scale topographic map 3222 Beaufort West;
(b) Google Earth© satellite imagery;
(c) published geological and palaeontological literature, including the 1:250 000 geological map (3222 Beaufort West) and relevant sheet explanation (Johnson & Keyser 1979) as well as
(d) previous fossil heritage (PIA) assessments for mining and renewable energy projects in the Aberdeen *Vlaktes* subregion by Rubidge & Abdala (2008) and Almond (2014);
(e) Palaeontological data from the Karoo Fossil Database and additional unpublished information kindly provided by Dr Mike Day (Natural History Museum, London) and Professor Bruce Rubidge (Evolutionary Studies Institute, Wits University, Johannesburg);

3. The author's field experience with the formations concerned and their palaeontological heritage (*cf* Almond & Pether 2008 and PIA reports listed in the References); and

4. A four-day field assessment of the WEF Cluster project area by the author and an experienced field assistant (Ms Madelon Tusenius, *Natura Viva* cc), during the period 30 July to 2 August 2022. Given the generally extremely poor levels of bedrock exposure in the Aberdeen *Vlaktes*, fieldwork mainly focussed on examination of a representative selection of potentially fossiliferous bedrock exposures identified on the basis of Google Earth satellite imagery (many of which proved misleading in practice), especially those close to farm tracks. Given time constraints, it was not practicable to survey all parts of the huge project area, most of which is likely to be palaeontologically barren on the basis of satellite imagery.

The season in which the site visit took place has no critical bearing on the palaeontological study.

Figure 2: View southwards across the WEF Cluster project area from a dolerite dyke ridge near the farmstead on Kraanvogel Kuil 55 showing the limited relief and low W-E trending ridges in this sector of the Aberdeen *Vlaktes*.

Figure 3: View eastwards across the SW sector of the WEF Cluster project area from the dolerite ridge with the communication mast and trigonometrical survey beacon on Farm 91 with highly jointed, baked quartzites in the foreground.

Figure 4: A wide, shallow, sandy tributary of the Kraairivier on Farm Kraai Rivier 149, one of the few sizeable drainage courses within the WEF Cluster project area. Note the lack of bedrock exposure here due to thick alluvial deposits.

Figure 5: View north-westwards towards the eastern margins of WEF Cluster project area from Mon Repos 154 showing part of the extensive, broadly E-W trending dolerite dyke that builds a low ridge across the northern part of the area.

Figure 6: Large areas of the WEF Cluster project area are covered with sparse to dense, karroid *bossieveld* and sandy to gravelly soils, as seen here on Kraanvogel Kuil 155.

Figure 7: Darker grey areas on satellite images of the Aberdeen *Vlaktes* often reflect thin surface gravels of siltstone overlying alluvial and pan sediments rather than bedrock, as seen here just outside the project area on Mon Repos 154.

3. GEOLOGICAL CONTEXT

The Aberdeen WEF Cluster project area features low-relief, undulating to gently hilly, terrain of the Aberdeen *Vlaktes* of the Eastern Cape (Figs. 1 to 7). Much of the area is clothed in sparse to dense karroid *bossieveld* with numerous unvegetated pans and open alluvial plains; woody vegetation dominated by thorn trees is mainly restricted to larger drainage lines. This portion of the Great Karoo region is located due south of the Kamdebooberge – a sector of the Great Escarpment - some 15 to 45 km west of the small town Aberdeen. It is characterized by semi-arid, karroid vegetation, extensive sandy to gravelly alluvial plains (*c*. 800-850m amsl), numerous shallow pans (*brak-kolle*), a few low E-W trending rocky ridges or *bulte* (*c*. 850-880m amsl) built of dolerite and baked metasediments and, for the most part very shallow, sandy drainage lines. These last (*e.g.* Gannaleegte system) mainly feed westwards into the wide, N-S trending Kariega River running to the west of the WEF Cluster project area while the NE sector is drained by the Kraairivier which flows eastwards towards Aberdeen. The Aberdeen *Vlaktes* represent an ancient peneplanated land surface of possible Miocene age (Partridge & Maud 1987). As a result of protracted denudation, the regularly folded bedrocks have been planed down and extensively blanketed by colluvial, eluvial and alluvial sediments with extensive subsurface bedrock weathering and development of calcrete pedocretes. Due to the pervasive superficial sediment cover, levels of good, fresh bedrock exposure are generally rare to very rare in the Aberdeen *Vlaktes* region with occasional low projecting channel sandstone beds in the lowlands and quartzitic baked sandstones and dolerite along the ridges. Only a handful of – mainly small – mudrock exposures are encountered here, mainly comprising gullied areas on gentle to steep hillslopes as well as occasional “windows: through superficial sediments along active drainage lines. There are also several large borrow pit exposures – highly disturbed – as well as occasional low road cuttings along the R61 and elsewhere.

The geology of the Great Karoo to the west of Aberdeen is depicted in 1: 250 000 geology sheet 3222 Beaufort West (Council for Geoscience, Pretoria; Johnson & Keyser 1979) (Fig. 8). The bedrocks underlying the study area are *mapped* within the lower portion of the **Teekloof Formation** (**Pt**) of the **Lower Beaufort Group** (Adelaide Subgroup, Karoo Supergroup) that is predominantly fluvial in origin (Johnson *et al.* 2006). The Lower Beaufort beds here were erroneously assigned by Almond (2014) in a previous PIA report to the mudrock-dominated **Hoedemaker Member** of Late Permian (Wuchiapingian) age (*c.* 260 Ma) (Smith & Keyser 1995, Rubidge 2005, Rubidge *et al.* 2013) while the thin, closely-spaced, prominent-weathering sandstones seen on the lower slopes of the Kamdebooberg escarpment to the northeast were assigned to the overlying **Oukloof Member** (*cf* stratigraphic table in Fig. 39). However, subsequent biostratigraphic data based on more recent fossil tetrapod finds indicates that the somewhat older (Middle Permian) Abrahamskraal Formation occurs in the footslopes of the Great Escarpment (Oorlogspoortberge) *c*. 20 km to the NW of the WEF Cluster project area and further to the north (Dr Mike Day, Professor B. Rubidge, pers. comm., 2022). This suggests that the Aberdeen *Vlakes* in the WEF Cluster project area are also underlain by the Abrahamskraal Formation; the south-facing slopes of the Kamdebooberge to the north feature younger strata of the Poortjie, Hoedemaker and Oukloof Members of the Teekloof Formation. The Beaufort Group bedrocks in the project area are extensively folded along E-W axes into low, open folds; this region accordingly lies within the northern margins of the Permo-Triassic Cape Fold Belt. Folding is associated with numerous joints and fractures, quartz veining with mineral lineation and mapped bedding dips up to *c*. 22°. Mudrock facies are locally cleaved. In many areas the bedrock folds can be readily picked out on satellite images (Fig. 1), showing that the superficial deposits here are often not, in fact, always very thick.

The **Abrahamskraal Formation** is a very thick (*c*. 2.4 km) succession of fluvial deposits laid down in the Main Karoo Basin by meandering rivers on an extensive, low-relief floodplain during the Middle Permian Period, some 268-261 million years ago (Smith & Keyser 1995a, Loock *et al*., 1994, McCarthy & Rubidge 2005, Johnson *et al*., 2006, Day & Rubidge 2014, Jirah & Rubidge 2014, Wilson *et al.* 2014, Cole *et al.* 2016). These sediments include (a) lenticular to sheet-like channel sandstones, often associated with occasional thin, impersistent intraformational breccio-conglomerates (larger clasts mainly of reworked mudflakes, calcrete nodules, *plus* sparse rolled bones, teeth, petrified wood), (b) well-bedded to laminated, grey-green to purple-brown floodplain mudrocks with common greyish to rusty brown pedocrete horizons (pebble to cobble-sized, sphaeroidal calcrete concretions formed in ancient soils), (c) thin, sheet-like crevasse-splay sandstones, as well as more (d) localized playa lake deposits (*e.g.* wave-rippled sandstones, laminated mudrocks, limestones, evaporates (Figs. 9 to 25). Most of the sandstones within the present study area are fine- to medium-grained, grey-green wackes, occasionally with fine heavy mineral lamination. A few channel sandstones are coarser, massive to cross-bedded with a speckled, biscuit-like texture and common *koffieklip* lenses. Lenses and zones of dark brown, ferruginous *koffieklip* are common within some mudrock packages as well as within channel sandstone bodies where they contain sphaeroidal calcrete concretions (possibly transported) and may be loosely associated with weathered-out petrified wood which has also been transported within river channels. A number of yellowish-green to reddish-weathering, silica-rich “chert” horizons are also found within the Abrahamskraal Formation, especially towards the top of the succession. Some of these appear to be secondarily silicified mudrocks or limestones of possible lacustrine origin but at least some contain high levels of reworked volcanic ash (tuffs and tuffites). Greenish-yellow, cobble-sized sphaeroidal cherty bodies embedded in baked mudrock are seen in the vicinity of a dolerite dyke just south of Pretoriuskuil homestead and are of uncertain origin – perhaps related to loading and boudinage of a lacustrine tuffite horizon (Fig. 25).

In contrast to pluvial episodes characterised by extensive lakes, a wide range of sedimentological and palaeontological observations also point to periods of deposition under seasonally arid climates in the Middle Permian Period. These include, for example, the abundance of calcretes and evaporites (silicified gypsum pseudomorphs or “desert roses”, reddened mudrocks, sun-cracked muds, “flashy” river systems, sun-cracked fossil bones, well-developed seasonal growth rings in fossil wood, rarity of fauna, common burrowing behavior by tetrapods *plus* little evidence for substantial bioturbation or vegetation cover (*e.g.* root casts) on floodplains away from the river banks.

The Lower Beaufort Group country rocks are locally intruded by the **Karoo Dolerite Suite** of Early Jurassic age (Duncan & Marsh 2006). A laterally persistent, broadly W-E trending dyke of resistant-weathering dolerite runs across the wind farm project area where it is expressed as a low rocky ridge just to the south of the R61 (870 m amsl) with additional extensions towards the west of the area (Figs. 5 & 26. Major, columnar-jointed dolerite sills are also visible further to the northeast in the upper slopes of the Kamdebooberg Escarpment (*e.g.* Sleeping Giant). Beaufort Group mudrocks and channel sandstones in the vicinity of the igneous intrusions have been baked to form dark hornfels and splintery, pale blue-green metaquartzite respectively; these tough lithologies form important raw materials for local Stone Age artefacts.

A range of **Late Caenozoic superficial deposits** – mostly Quaternary or younger in age – overlies the Beaufort Group and Karoo dolerite bedrocks within the project area (Figs. 27 to 36). Angular, blocky colluvial rubble of baked quartzite and dolerite mantles the ridge slopes. Locally the rock

rubble has been incorporated on lower hillslopes into thin debris flow diamictites with a chaotic fabric and gritty to fine-gravelly matrix. Low wacke (impure sandstone) ridges in low-lying terrain are often highly jointed and locally weather to form blocky eluvial gravels or well-rounded corestones. Extensive zones of relict, downwasted alluvial “High Level Gravels” margin the larger water courses (*e.g.* Gannaleegte); the clasts here include moderately to well-rounded pebbles and cobbles of brownish-orange patinated wacke, pale blue-grey, fine-grained quartzite, very dark hornfels, dolerite, vein quartz, calcrete, pedocrete concretions, greenish tuffite and locally common petrified wood reworked from the Permian bedrocks. Some of this tough-weathering material may have been transported downstream from the Escarpment Zone. Thin alluvial and eluvial (downwasted) gravels of angular wacke and vein quartz mantle large parts of the project area; grey areas on satellite images often feature fine, flaky to crumbly mudrock clasts and / or pedocrete concretions overlying sands rather than fine-grained bedrocks. Well-developed calcrete pedocretes are mainly developed along major drainage lines such as the Gannaleegte. Here older, orange-brown, polygonally veined, massive calcretes with sparse gravel clasts are overlain by younger, pale cream-hued calcrete which also penetrates underlying mudrocks as veins along fractures. Most of the younger alluvium consists of fine-grained sands and silts (locally reworked by wind) with lenses of coarser gravels (clasts of dolerite, wacke, hornfels *etc*) at the base. Well-developed coarse gravelly alluvial deposits are rare. Numerous, extensive pan areas (*brak-kolle*) are devoid of vegetation with floors of fine sand or silt which often underlain by a calcrete *dorbank*. The pan margins usually possess a sparse veneer of sheet-washed, pebbly to cobbly gravels of resistant rock-types (*e.g.* wacke, silicified wood, hornfels, quartzite) that are commonly anthropogenically flaked. Scattered bush clumps are associated with low mounds or *heuweltjies* of unusually thick silty to sandy soil. These areas are typically densely burrowed by mammals (aardvark, porcupines), often feature scattered modern bones, and may be associated with calcrete glaebules.

Representative exposures of the various bedrock and superficial sediment rock units present within the Aberdeen WEF Cluster project area are illustrated in Figures 9 to 36 below.

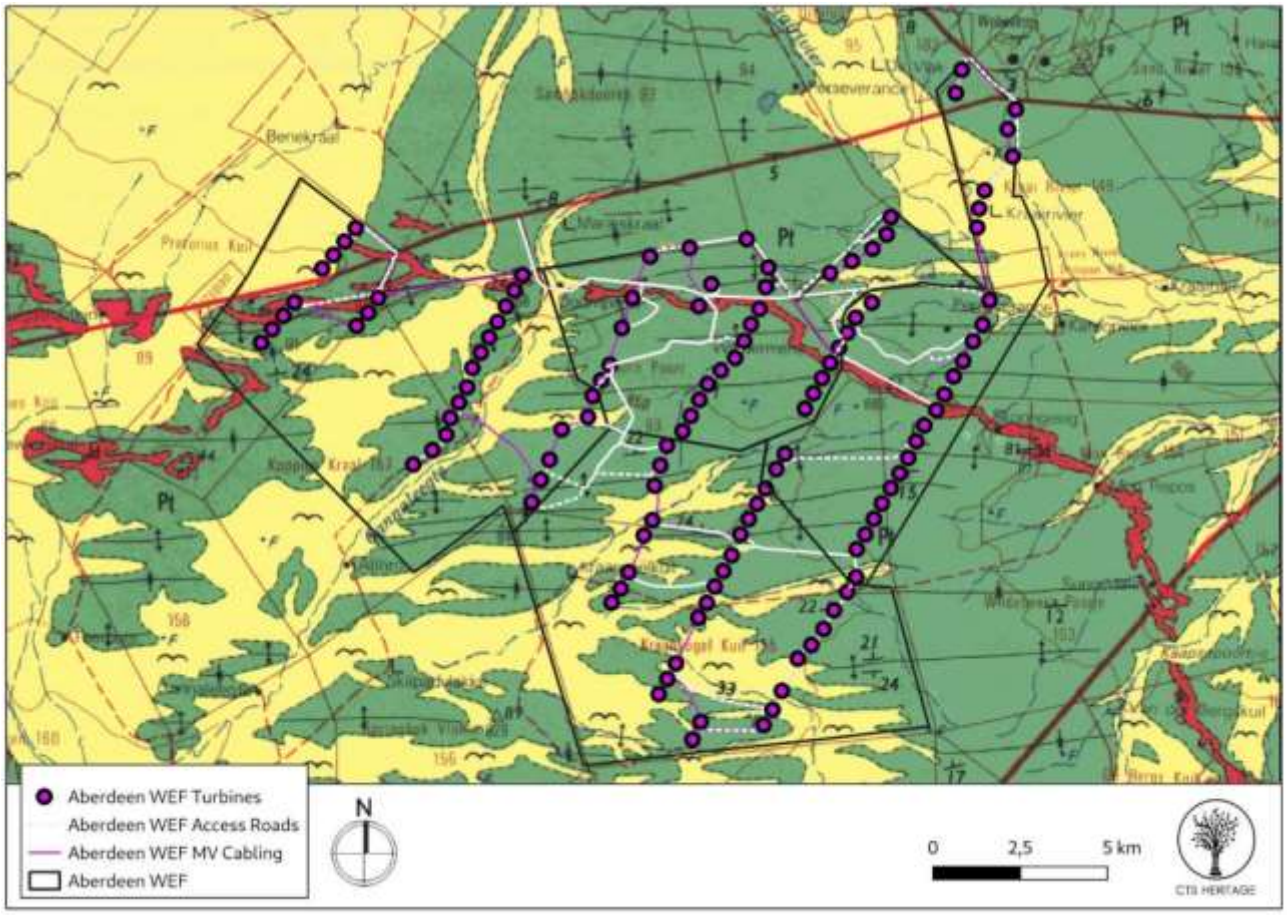

Figure 8: Extract from 1: 250 000 geology sheet 3222 Beaufort West (Council for Geoscience, Pretoria) showing the approximate boundaries of the Aberdeen Wind Farm Cluster project study area *c.* 15-45 km west of Aberdeen (black polygons). Provisional wind turbine positions are shown by the purple circles and internal access roads by red lines. The main rock units mapped here within the study area include: Pt (green) = Late Permian Teekloof Formation (Lower Beaufort Group / Adelaide Subgroup, Lower Beaufort Group). Note the numerous W-E trending fold axes indicated in this area. New biostratigraphic data suggests that the Lower Beaufort Group bedrocks in the project area probably belong to the Middle Permian Abrahamskraal Formation. Jd (red) = Early Jurassic intrusions of the Karoo Dolerite Suite. Yellow with flying bird symbol = Quaternary superficial sediments, including alluvium, sheet wash, colluvium, soils, locally cemented by pedocretes such as calcrete. Older alluvial terrace gravels ("High Level Gravels") are not mapped within the study area. No historical fossil sites are mapped here.

Figure 9: Thin channel sandstone package composed of tabular-bedded, fine-grained wacke, Kraay River Outspan 158.

Figure 10: Float block of ferruginised basal channel breccio-conglomerate composed of mudflake intraclasts and reworked pedocrete concretions, Kraanvogel Kuil 155 (*c*. 20 cm wide). Fragments of transported bone and teeth may sometimes be found within this facies.

Figure 11: Prominent-weathering bed of channel wacke on Koppies Kraal 157 showing gentle dips and dense jointing typical for this marginal region of the Cape Fold Belt.

Figure 12: Unusually extensive bedding plane exposures of gently dipping channel wackes in a dam overflow channel on Farm 94. Note elliptical pod of diagenetic ferruginous *koffieklip* in the foreground (hammer = 30 cm).

Figure 13: Pale greyish, well-rounded clasts within a *koffieklip* lens on Farm 94 (scale in mm and cm). These may be reworked calcrete concretions eroded out of floodplain deposits and transported as pebbly lags (as also inferred for logs of wood found in the wider region) or perhaps represent exotic, extra-basinal pebbles.

Figure 14: Prominent-weathering, highly jointed lens of dark brown *koffieklip*, seen here on Mon Repos 154 just east of the WEF Cluster project area (hammer = 30 cm). Abundant blocks of fossil wood are sometimes found in the vicinity of such *koffieklip* bodies and probably stem from the same channel sandstone bodies.

Figure 15: Distinctive, yellow-weathering, speckled, medium-grained channel sandstone facies building low ridges on Farm 94. This facies occurs commonly within the upper Abrahamskraal Formation and overlying Poortjie Member of the Teekloof Formation.

Figure 16: Extensive exposure of grey-green, fine-grained channel wacke on Farm 94 showing blocky jointing and angular eluvial gravels.

Figure 17: Rare gulley exposure of purple-brown overbank siltstones overlying a wave-rippled greenish-grey sandstone bed, Farm 91.

Figure 18: Extensive exposure of cleaved, grey-green and purple-brown overbank mudrocks in a riverine area on Kraay River Outspan 158.

Figure 19: Isolated exposure of grey-green, crumbly overbank mudrocks on Koppies Kraal 157 – ideal for palaeontological surveying, but rare in the Aberdeen *Vlaktes* region.

Figure 20: Detail of the exposure seen above showing common lenses of ferruginous carbonate which are probably of diagenetic or pedogenic origin, perhaps reflecting episodes of high water tables on the ancient Karoo floodplain, Koppies Kraal 157.

Figure 21: Gullied hillslope on Kraanvogel Kuil 55 exposing baked and weathered, grey-green overbank mudrocks and thin crevasse-splay sandstones.

Figure 22: Isolated window exposing highly cleaved, grey-green overbank mudrocks on Kraanvogel Kuil 155 (hammer = 30 cm). These readily-weathered and easily-eroded bedrocks are usually obscured by superficial deposits on the Aberdeen *Vlaktes*.

Figure 23: Good exposure of a pedocrete (ancient soil) horizon marked by pebble-sized sphaeroidal calcrete concretions, Kraay River Outspan 158 (hammer = 30 cm). Such horizons are an important target for vertebrate fossil prospecting.

Figure 24: Extensive surface scatter of ferruginous calcrete concretions on Farm 94. Areas like this have potential for recording fossil tetrapod remains.

Figure 25: Horizon of cobble-sized, rounded, greenish-yellow siliceous bodies of uncertain origin (possibly tuffitic) within a dark siltstone matrix shortly below a dolerite intrusion on Farm RE/91 (hammer = 30 cm).

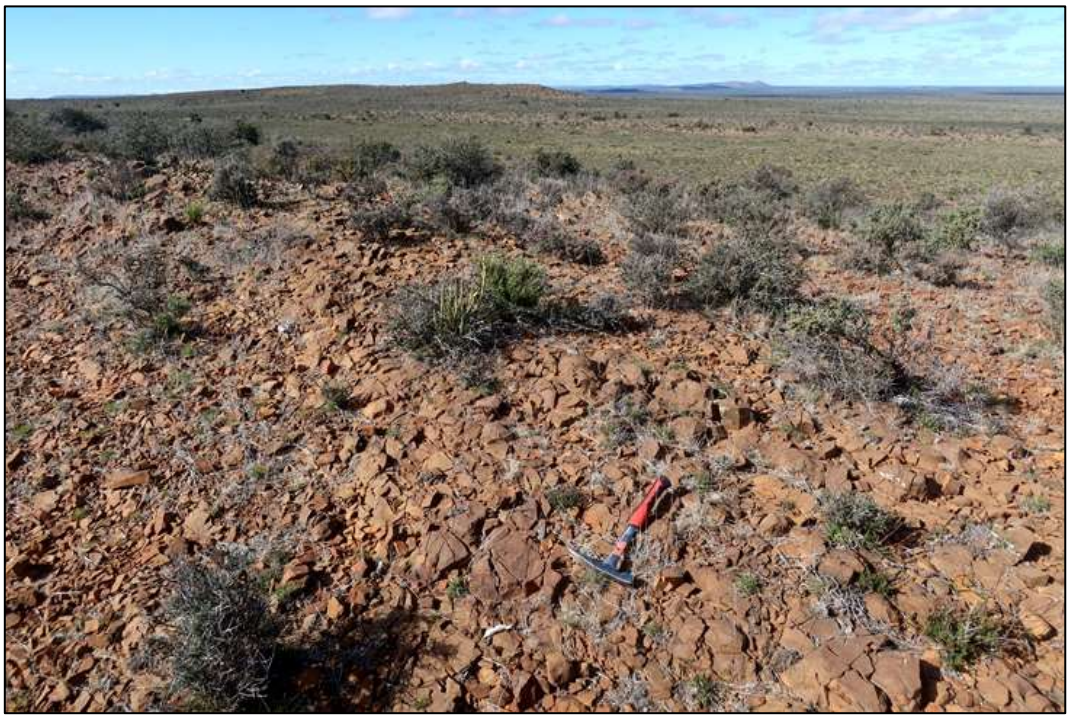

Figure 26: Highly jointed, blocky weathering dolerite dyke exposed along a ridge crest near the farmstead on Kraanvogel Kuil 55 (hammer = 30 cm).

Figure 27: Lobe of rubbly diamictite with chaotic fabric of floating wacke and dolerite blocks within a gritty matrix, probably of debris flow origin, Farm 91 (hammer = 30 cm).

Figure 28: Massive, calcretised, orange-brown older alluvial deposits exposed along the edge of the Gannaleegte on Doorn Poort 93 (hammer = 30 cm).

Figure 29: Pale, creamy, calcretised younger alluvium exposed in a borrow pit along the Gannaleegte on Doorn Poort 93. The underlying fractured siltstone bedrocks are also extensively veined by calcrete.

Figure 30: Rubbly alluvial basal gravels overlain by thicker sandy alluvium with gravel lenses, tributary of the Kraairivier on Kraai Rivier 149.

Figure 31: Shallow incised stream on Farm 94 with sandy banks and coarser gravels along its bed.

Figure 32: Reworked pebbly alluvial gravels associated with the Gannaleegte drainage system on Koppies Kraal 157 (hammer = 30 cm). These resistant weathering gravels contain abundant, subrounded to well-rounded clasts of dark hornfels, angular blocks of petrified wood (arrowed) as well as numerous MSA and LSA stone tools.

Figure 33: Alluvial *vlaktes* on Kraanvogel Kuil 155 mantled by thick, orange or yelllow sandy alluvium with a network of shallow drainage lines. Aeolian reworking of sands during the dry season, with polishing and faceting of pebbly clasts (ventifacts) is common.

Figure 34: Large areas of the Aberdeen *Vlaktes* comprise gravelly plains dominated by angular to well-rounded clasts of brownish channel wacke, seen here on Farm 94. Many of the well-rounded clasts are weathered corestones rather than water-worn cobles.

Figure 35: Open, shallow pan areas (*brak-kolle*) on the Aberdeen *Vlaktes*, seen here on Kraanvogel Kuil 155, often feature a dense to sparse veneer of surface gravels, among which reworked blocks of petrified wood are commonly found.

Figure 36: Typical raised *heuweltjie* characterised by thick, sandy soils, bush clumps, impersistent calcretisation at depth, modern bones and intense mammalian burrowing, as seen here on Farm RE/91.

4. PALAEONTOLOGICAL HERITAGE CONTEXT

The Aberdeen *Vlaktes* are largely *Terra Incognita* in palaeontological terms due to the exceedingly poor levels of bedrock exposure in the region (See fossil vertebrate site maps presented by Keyser & Smith (1977-1978) (Fig. 37), Nicolas (2007) as well as the 1: 250 000 geological map in Figure 8 which shows no historical sites within the WEF Cluster project area). Rubidge and Abdala (1988) recorded a modest number of small dicynodonts, large therocephalian postcranial remains and fossil wood from a series of farms extending across the Karoo *vlaktes* to the south-west of Oorlogspoortberge, due west of the present study area. The fossils were provisionally assigned to the formerly recognised *Pristerognathus* AZ (but might belong, at least in part, to the upper *Tapinocephalus* AZ. A more recent PIA report by Almond (2014) for a 200MW WEF project area adjoining the present Aberdeen WEF Cluster project area on the northern side recorded locally abundant petrified wood within surface gravels but no fossil vertebrate remains. No PIA reports were submitted for the proposed Biotherm Aberdeen PV/CPV Solar Energy Facility on Portion 1 of The Farm Wildebeest Poortje near Aberdeen, Camdeboo Municipality, Eastern Cape or the proposed Camdeboo Wind Energy Facility near Aberdeen Eastern Cape (CTS, pers. com., 2022).

As discussed above, recent fossil collection from better bedrock exposures within the Great Escarpment Zone (Oorlogspoortberge, foothills of the Kamdebooberge) to the north suggests that the Lower Beaufort Group bedrocks in the present project area belong to the upper part of the Abrahamskraal Formation and *not* the Teekloof Formation as mapped (*cf* Fig. 8). Fossil assemblages of the Middle Permian ***Tapinocephalus* Assemblage Zone** may therefore be expected here but supporting material is exceedingly scarce. This revised mapping is reflected, albeit provisionally, in the most recent biozonation mapping of the Main Karoo Basin by Day & Rubidge (2020a) which shows an unconfirmed tongue of “Tap Zone” outcrop extending into the Aberdeen Vlaktes region from the south (Fig. 38) (contrast the earlier account by Almond 2014, now outdated).

Continental (terrestrial / lacustrine / fluvial) fossil biotas within the upper part of the Abrahamskraal Formation (Moordenaars and Karelskraal Members) as well as within the lowermost portion of the Poortjie Member of the Teekloof Formation are now assigned to the ***Diictodon* – *Styracocephalus* Subzone** of the revised ***Tapinocephalus* Assemblage Zone** (AZ) that is of Late Capitanian age (*c*. 262-260 Ma) (Day & Rubidge 2020a) (Fig. 39). The highly impoverished, post-extinction vertebrate fauna represented in the uppermost part of the *Diictodon* – *Styracocephalus* Subzone (lowermost Poortjie Member) includes – or is inferred to include – only a few representatives of several tetrapod subgroups. These include amphibians, parareptiles (pareiasaurs, *Eunotosaurus*), dinocephalians (*e.g. Criocephalosaurus,* perhaps also *Styracocephalus*), dicynodonts (*e.g. Diictodon*), therocephalians (*e.g. Pristerognathus*) and gorgonopsians (Retallack *et al* 2006, Smith *et al.* 2012, Day *et al.* 2015a, 2015b, Day & Rubidge 2020a).

The fossil record of the Abrahamskraal – Teekloof contact zone is of special scientific interest because of its record of environmental and palaeobiological events related to the major **Middle Permian Mass Extinction Event** of 262-260 million years ago (= Capitanian or Guadalupian Mass Extinction Event) (Day *et al.* 2015b). Since vertebrate fossils are generally rare within this interval, any new records of well-preserved, identifiable material here are of considerable scientific value (*cf* ongoing research project on this extinction event conducted by Professor Bruce Rubidge of Wits University and colleagues elsewhere).

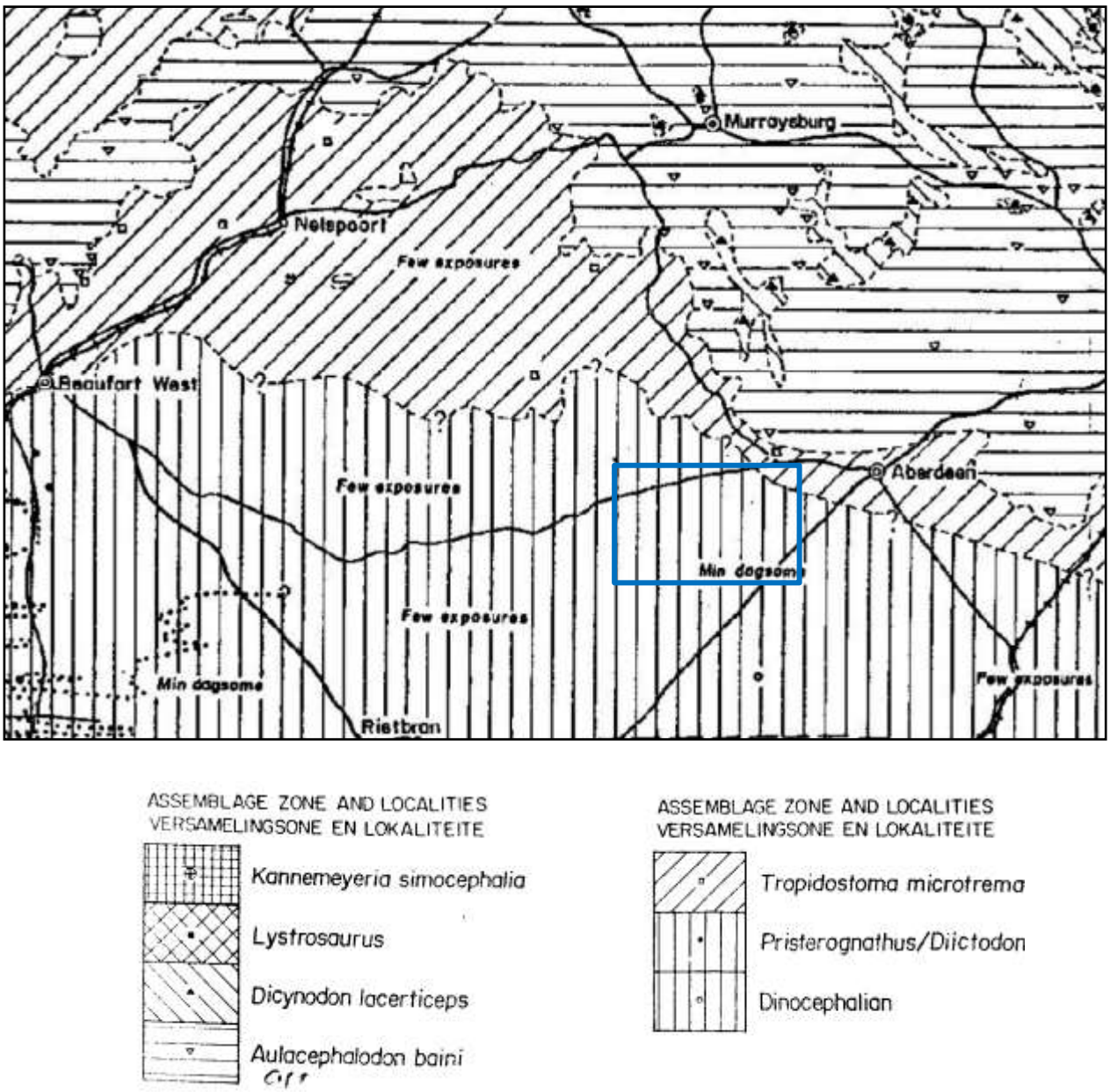

Figure 37: Early, and now outdated, biostratigraphical map of the Lower Beaufort Group in the Great Karoo between Beaufort West and Aberdeen showing the distribution of the various palaeontological Assemblage Zones, mainly based on tetrapod fossils (Keyser & Smith 1977-78). According to this map the Aberdeen WEF Cluster project area *c*. 15-45 km west of Aberdeen (*approximately* indicated by the blue rectangle) lies in a region of limited bedrock exposure (*min dagsome*) within which no tetrapod fossils have been recorded. *Tapinocephalus* AZ fossils ("Dinocephalian) are known to the south of the N9. *Endothiodon* AZ fossils (previously *Tropidostoma* AZ) as well as *Cistecephalus* AZ fossils are recorded in the Kamdebooberge Escarpment to the north of the WEF Cluster project area, associated with the Hoedemaker and Oukloof Members of the Teekloof Formation respectively.

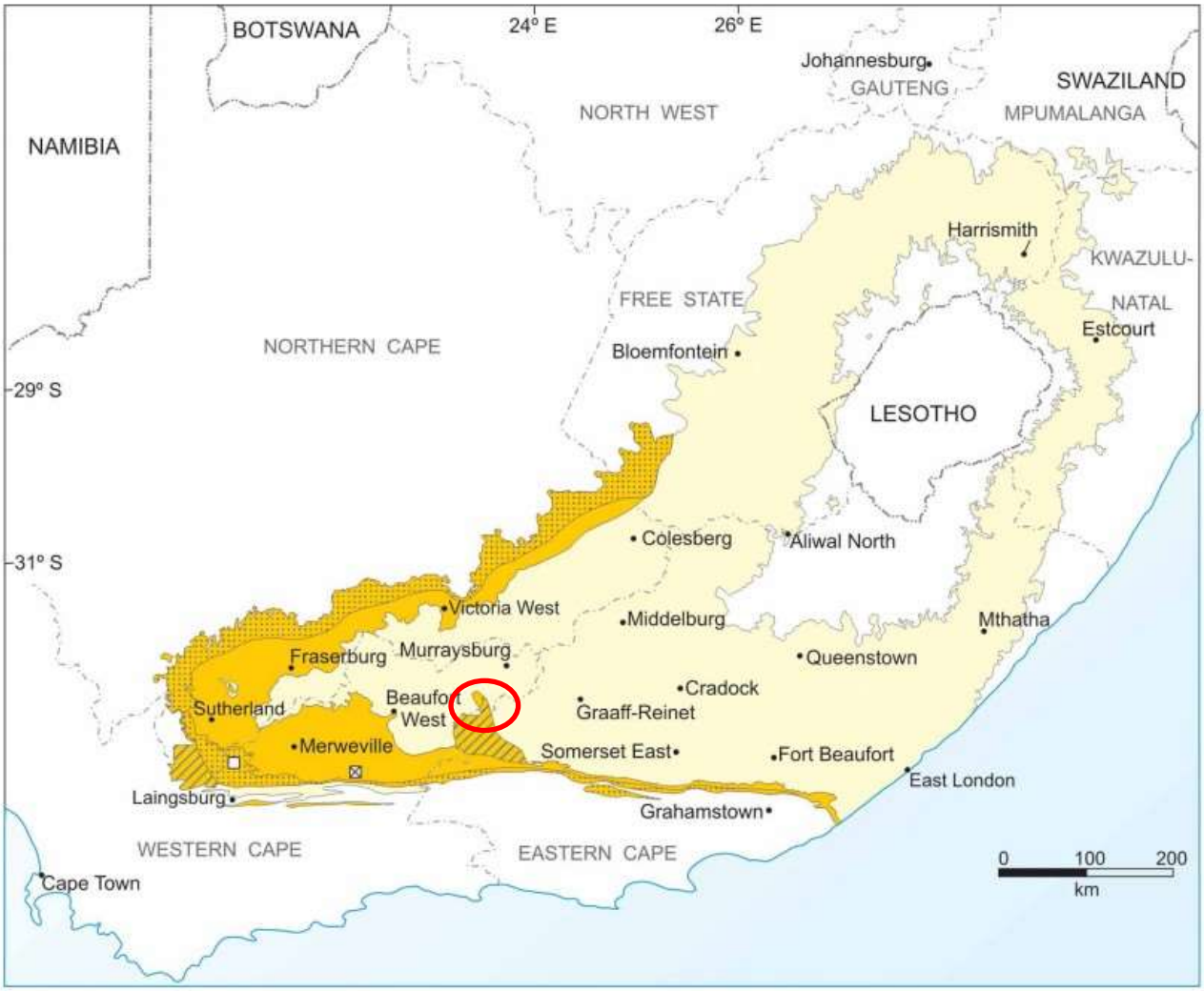

Figure 2. *Distribution of the* Tapinocephalus *Assemblage Zone (dark yellow) in the Beaufort Group (yellow), showing the distribution of the* Eosimops – Glanosuchus *Subzone (dotted),* Diictodon – Styracocephalus *Subzone (not dotted), and uncertain presence (diagonal hatched). Positions of Type localities for the* Eosimops – Glanosuchus *Subzone (empty square) and* Diictodon – Styracocephalus *Subzone (crossed square) are indicated.*

Figure 38: The most recent fossil biozonation mapping of the *Tapinocephalus* Assemblage Zone in the Main Karoo Basin by Day and Rubidge (2020a) indicates a region of the Onder Karoo between Beaufort West and Aberdeen where the presence of this AZ is uncertain (red ellipse). Any identifiable new tetrapod (and possibly also woody) fossil material from the Aberdeen *Vlaktes* may help clarify these biostratigraphic ambiguities.

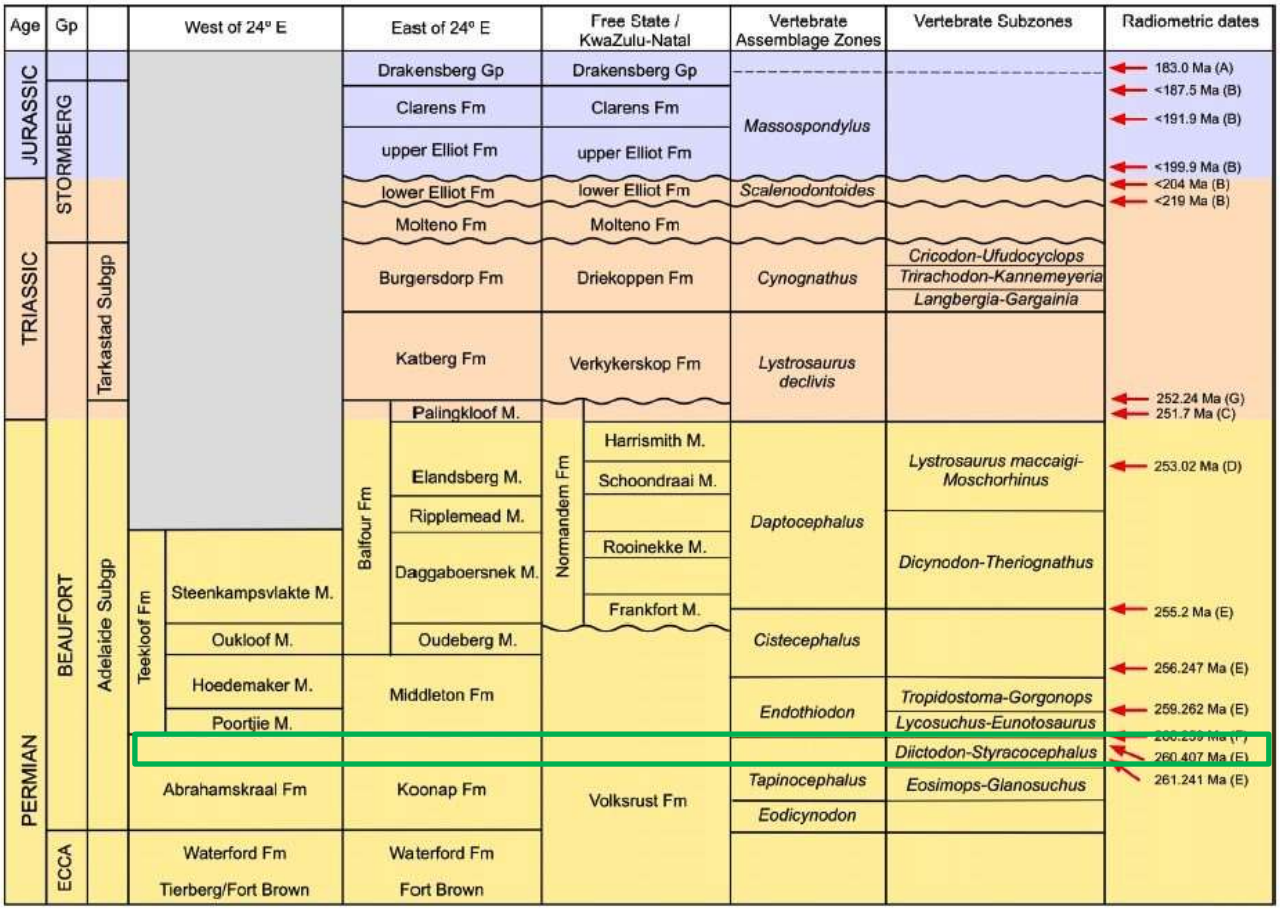

Figure 39: Stratigraphic subdivision of the Karoo Supergroup with the rock units and fossil biozones most relevant to the present PIA study outlined in green (Modified from Smith *et al.* 2020). Recent Karoo fossil biozonation mapping suggests that Lower Beaufort Group bedrocks underlying the Aberdeen WEF Cluster project area contain fossil assemblages within the Abrahamskraal Formation assigned to – probably the upper part of - the *Tapinocephalus* Assemblage Zone (green rectangle). Previous geological mapping suggested a high stratigraphic placement within the Teekloof Formation associated with *Endothiodon* Assemblage Zone fossil assemblages (previously assigned to the *Pristerognathus* AZ). The Poortjie, Hoedemaker and Oukloof Members of the Teekloof Formation are represented in the slopes of the Kamdebooberge Escarpment to the northeast of the WEF Cluster project area.

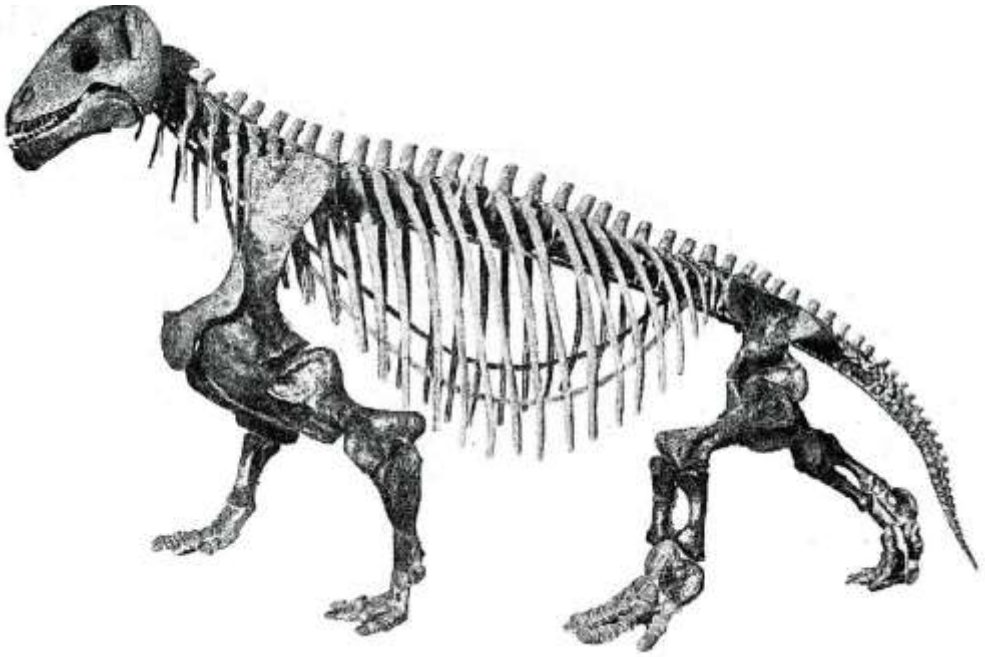

Figure 40: Skeleton of the tapinocephalid (thick-skulled) dinocephalian *Moschops*, a rhino-sized herbivorous therapsid that reached lengths of 2.5 to 3 m and may have lived in small herds. Possible cranial fragments of a tapinocephalid dinocephalian have now been recorded within the Abderdeen WEF Cluster project area.

4. RESULTS FROM PALAEONTOLOGICAL SITE VISIT

Most of the palaeontological fieldwork for the present site visit focussed on sporadic, darker, greyish areas seen on satellite images which, in some cases at least, are associated with local exposures of Lower Beaufort Group mudrocks (many only feature loose shaley surface gravels or sandstone, however). Areas with abundant pale grey or rusty-brown pedocrete concretions, as well as *koffieklip* lenses, were also intensively searched. Less attention was paid to sandstone exposures, although these may also contain valuable reworked fossil vertebrate material in the Abrahamskraal Formation.

The only significant Karoo fossil vertebrate site recorded during the palaeontological site visit comprises a scatter of *ex situ* fragmentary bone material of a large-bodied tetrapod on Farm RE/91 (Locs. 215-216; Figs. 41 to 44). The bones were recorded at surface or embedded within gravelly sands overlying a channel sandstone body which is exposed in the vicinity, as is a narrow dolerite dyke. They include several probable cranial fragments, probably but not certainly from a single individual, one of which shows dense pachyostosis 12 cm or more thick with sparse radial canals. Another small jaw fragment contains the conical roots of several small teeth. A tapinocephalid dinocephalian identification therefore seems to be most likely (*cf* Fig. 40), supporting the re-assignation of the bedrocks here to the *Tapinocephalus* Assemblage Zone, *i.e.* Abrahamskraal Formation or, at most but less likely, lower Poortjie Member (*cf* Day *et al.* 2015a). The fossil material has been partially sampled for the collections of the Evolutionary Studies Institute (Wits University, Johannesburg) under the Fossil Collection Permit of Professor Bruce Rubidge who is currently reviewing the “Tap Zone” biotas of the Main Karoo Basin. Additional bone material remains buried on site.

Trace fossils, including tetrapod burrows, are not widely recorded within the project area, Small-scale, meandering invertebrate burrows associated with wave-rippled pond palaeosurfaces on top of thin, tabular crevasse splay sandstones may be attributable to undermat miners such as insects (Fig. 46).

A background scatter of reworked blocks of petrified (silicified) wood in many different hues (pale grey to black, pearly, orange-brown, pale brown *etc*, in part reflecting different iron and manganese content) occurs widely within alluvial and eluvial surface gravels and sands across the WEF Cluster project area (*N.B.* The sites noted in Appendix 1 and on satellite map Figure A1 represent only a *small fraction* of all fossil wood occurrences within the WEF Cluster project area). Fossil wood may be concentrated in remanié / eluvial gravels at the contact between superficial sands and bedrock as well as in stream gravels. A large proportion of the wood blocks show partially or poorly-preserved xylem fabrics which may reflect different levels of microbial decomposition before or at the time of diagenetic silicification (Figs. 52 to 54). However, some of the blocks show well-developed seasonal growth rings and excellent preservation of xylem tissue. Occasional elongate subcylindical hollows might reflect insect borings (Fig. 49). Such material is potentially identifiable to genus or species level on the basis of the woody microstructure, and may help refine the local biostratigraphy; unfortunately many Permian wood taxa have long stratigraphic ranges (*cf* Bamford 1999, 2000). Day and Rubidge (2020a) list the genera *Australoxylon* and *Prototaxoxylon* from the Middle Permian Tap Zone beds (Fossil wood taxa for the overlying *Endothiodon* AZ are not listed by Day & Smith (2020). Bamford (1999) notes that *Australoxylon* also occur within the lowermost Teekloof Formation / Poortjie Member at Stellenboschvlei, north of the Oorlogskloofberge, but recent dinocephalian finds here suggest this area might also lie within the Abrahamskraal Formation (or perhaps the lower Poortjie Member).

Many of the fossil wood blocks recorded within the Aberdeen WEF Cluster project area, including those within alluvial gravels, are subangular to angular and do not appear to have suffered extensive transport, which some small blocks are well-rounded. Such material is extremely tough-weathering and can potentially be transported far from source by vigorous streams. Denser scatters of fossil wood may occur preferentially in the vicinity of channel-hosted *koffieklip* bodies. At one site, south of and outside the WEF Cluster project area, numerous sizeable blocks of silicified wood occur incorporated within superficial sands just downslope of an extensive *koffieklip* lens or zone developed within a channel sandstone. The fact that the blocks apparently do not occur upslope of the sandstone / *koffieklip* horizon suggests that this last may be the source of the fossil log material, although none has been observed *in situ* here. The marked decrease in reworked fossil wood material on farms to the north of the present project area, underlain by Poortjie Member beds, supports an Abrahamskraal Formation provenance for the super-abundant material recorded here.

Good sections through Late Caenozoic superficial deposits suitable for palaeontological prospecting are rare in the Aberdeen *Vlaktes* region. No fossil material was observed within deposits such as thicker alluvial sands and calcretes (as also found by Almond 2014). Reworked blocks of petrified wood are common, and locally abundant within surface gravels and even sands, as discussed above. The single, small rounded clast of fossil bone recorded from surface gravels on Farm 94 has probably been transported some distance. In contrast, the local concentration of fossil tetrapod bone recorded on Farm RE/91 described above has probably been weathered-out from local sandstone bedrocks seen in the area, broken up and then incorporated into overlying gravelly sands.

Figure 41: Assemblage of robust bone blocks from a large-bodied tetrapod collected from a small area of surface gravels on Farm RE/91 (Loc. 215) (scale = 15 cm). See following two figures for more detail. This material, key elements of which have now been sampled, *may* belong to a tapinocephalid dinocephalian (to be confirmed), indicative of the *Tapincephalus* Assemblage Zone.

Figure 42: Block of bone *c*. 11 cm long from Loc. 215 on Farm RE/91 showing very thick, dense pachyostosis and sparse canals – possibly part of the cranial roof of a tapinocephalid dinocephalian.

Figure 43: Two, robust bone fragments from Loc. 215 on Farm RE/91, possibly adjoining parts of the skull. The large block is *c*. 11 cm long.

Figure 44: Fractured curved bone (*c*. 20 cm long) of a large-bodied tetrapod embedded in sandy superficial sediments, Loc, 216 on Farm RE/91 – possibly part of the same individual seen at Loc. 215 nearby.

Figure 45: Isolated chunk of "rolled bone" (*c*. 4 cm long) from a medium- to large-bodied tetrapod found among surface gravels on Farm 94 (Loc. 182). Such material is rarely identifiable and of very limited scientific value.

Figure 46: Crevasse splay sandstone bed top featuring small, meandering burrows of probable undermat miners (possibly insects) foraging beneath microbial mats on damp pond margins (scale in cm), Kraai Rivier 149 (Loc. 180).

Figure 47: Several blocks of well-preserved, cherty fossil wood from among surface gravels on Farm 153 (Loc. 170). The largest block seen here is *c*. 6 cm wide.

Figure 48: Varied appearance of angular petrified wood blocks – in part due to differences in secondary iron mineralisation – found among surface gravels on Farm 153 (Loc. 138) (scale in cm and mm).

Figure 49: Well-preserved block of silicified wood (*c*. 7 cm across) from Mon Repos 154 (Loc. 136), just outside the WEF Cluster project area, showing well-developed seasonal growth banding and *possible* insect borings (elongate reddish areas).

Figure 50: Sizeable, angular block of petrified wood (*c*. 25 cm across) embedded within gravelly sands on Farm Kraanvogel Kuil 155 (Loc. 139). Several large blocks found within a small area suggest that a substantial fossil log may have broken-up locally.

Figure 51: Large block of seasonally banded fossil wood at surface on Farm Kraanvogel Kuil 155 (Loc. 139) (scale in cm).

Figure 52: Highly variable preservation styles shown by fossil wood blocks from the same area on Farm Kraanvogel Kuil 155 (Loc. 156). The longest, palest block seen here is *c*. 15 cm long.

Figure 53: Abundant silicified wood blocks among alluvial gravels on Farm Koppies Kraal 157 (Loc. 197) showing a range of preservation styles (scale in cm).

Figure 54: Attractive block of petrified wood from Farm Koppies Kraal 157 (Loc. 197) showing possible silicification of partially decomposed woody tissue.

5. SITE SENSITIVITY VERIFICATION

Preliminary palaeosensitivity mapping of the Aberdeen WEF Cluster project area based on the DFFE Screening Tool is shown below in map Figure 55. Outcrop areas of Lower Beaufort Group bedrocks shown on the 1: 250 000 geology map (Fig. 8) are assigned a Very High palaeosensitivity, mapped alluvial areas a Low palaeosensitivity and major dolerite intrusions an Insignificant / Zero palaeosensitivity.

Historically almost no vertebrate fossil sites have been recorded within the wider Aberdeen *Vlaktes* subregion (Fig. 37). Based on the recent 4-day palaeontological site visit, the great majority of the WEF Cluster project area is mantled by thin to thick (several m) superficial deposits (alluvium, colluvium / eluvium, calcrete, pan sediments, soils) of low palaeosensitivity (Section 4). In addition to very occasional invertebrate trace fossils of limited scientific interest, the only tetrapod fossils recorded from Lower Beaufort Group bedrocks here comprise an isolated, reworked bone fragment as well as a single concentration of robust bones of a large-bodied tetrapod weathered-out into surface gravels. Given the general rarity of vertebrate fossil finds, the latter site is of some scientific interest, while there is potential for sporadic occurrences of comparable or better material occurring at or beneath the surface elsewhere within this vast project area. Blocks of fossil wood occur widely as a background scatter across most of the WEF Cluster project area, locally in abundance; a minority of the material is well-preserved and of scientific interest and most occurrences are rated as of low heritage significance. No fossils have been recorded within the Late Caenozoic superficial deposits (alluvium, colluvium, surface gravels, soils, calcretes *etc*).

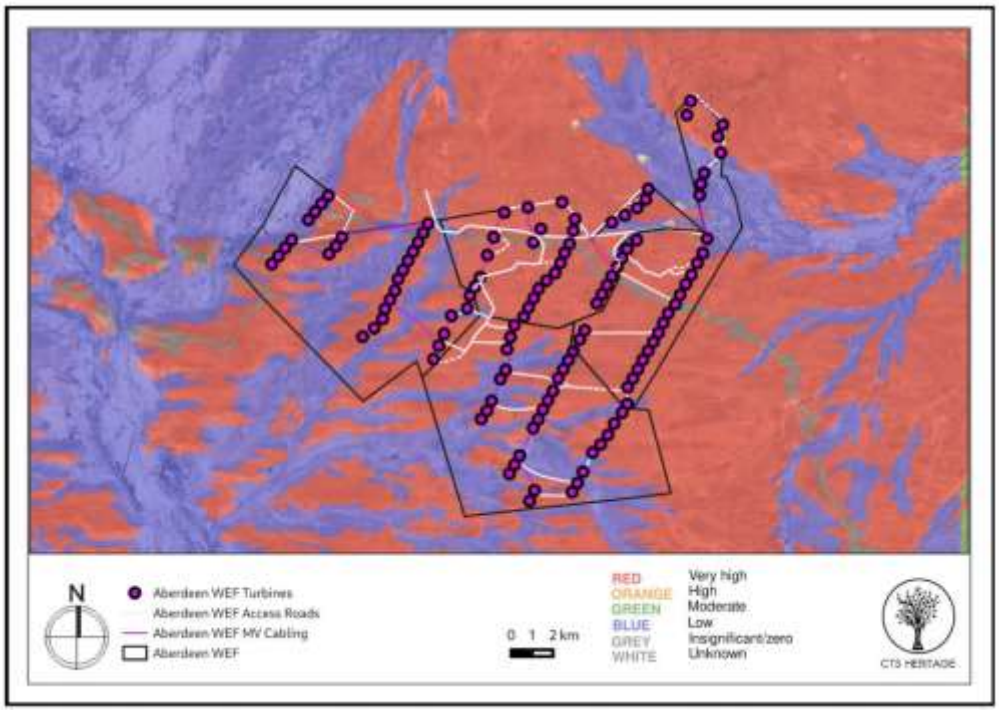

Figure 55: Provisional palaeosensitivity mapping for the Aberdeen WEF Cluster project area (black polygons) (Image based on the DFFE Screening Tool and provided by CTS 2022). The Very High Palaeosensitivity shown here for outcrop areas of the Lower Beaufort Group is *contested* in the present report since bedrock exposure levels are generally very low and very few vertebrate fossils of scientific and conservation value have been recorded here. Areas featuring substantial alluvial deposits are rated as of Low Palaeosensitivity and this particular assessment is upheld by this report.

It is concluded that the Aberdeen WEF Cluster project area is in practice of Low Palaeosensitivity overall, so the preliminary DFFE site sensitivity mapping shown in Figure 55 is *contested* here.

6. CONCLUSIONS & RECOMMENDATIONS

The Aberdeen WEF Cluster project area is underlain at depth by potentially fossiliferous continental (fluvial / lacustrine) bedrocks of the Lower Beaufort Group (Adelaide Subgroup). They probably belong to the Middle Permian Abrahamskraal Formation rather than the Late Permian Teekloof Formation as currently mapped. There are no historical records of fossil vertebrates from this area; this is largely due to the extremely poor levels of bedrock exposure found here. During the recent 4-day palaeontological field assessment only two occurrences of fossil vertebrates were recorded, both from superficial gravels rather than *in situ*. They include an unidentifiable fragment of rolled bone (Farm 94) as well as a concentration of bone chunks of a large-bodied tetrapod on Farm RE/91 which is provisionally interpreted to include cranial fragments (with a few teeth) of a tapinocephalid dinocephalian. The latter would support recent re-assignment of the bedrocks here to the *Tapinocephalus* Assemblage Zone. Both fossil vertebrate sites have been adequately sampled and do not require further mitigation. Occasional trace fossil assemblages comprise low diversity, small-scale invertebrate burrows of limited scientific interest.

A background scatter of petrified (silicified) wood blocks reworked from the Lower Beaufort Group bedrocks occurs within surface gravels and sands of eluvial and alluvial origin throughout most of the project area; only a small sample of occurrences have been recorded here. Much of the fossil wood material is poorly preserved and of limited scientific value. However, a small minority of blocks show well-developed seasonal growth rings and excellent preservation of the original woody fabric; these are potentially identifiable and may be of biostratigraphic and palaeoecological interest. Mitigation of the recorded fossil wood sites in particular is not recommended here, given the abundance and widespread occurrence of the material. However, it is recommended that a representative sample of well-preserved fossil wood material from the WEF Cluster project area is collected by a suitably qualified palaeontologist for curation in an approved fossil collection (*e.g.* Evolutionary Studies institute, Wits University, Johannesburg) once the development is authorized and before the Construction Phase.

Most of the low-relief WEF Cluster project area is covered by a blanket of Late Caenozoic superficial deposits, including alluvial gravels and sands, eluvial and colluvial surface gravels, calcrete hard pans, pan sediments and gravelly to sandy soils. Apart from the abundant reworked fossil wood blocks and very rare bones, no fossils of Caenozoic age have been recorded within these younger sediments.

Given the rarity of significant vertebrate and other fossil finds, the overall palaeosensitivity of the Aberdeen WEF Cluster project area is assessed as LOW. The provisional Medium to Very High Palaeosensitivity mapped here by the DFFE Screening Tool is accordingly *contested*. The potential for occasional fossil vertebrate sites of Very High palaeosensitivity cannot be entirely excluded, however. The distribution of such sites is largely unpredictable and they are best mitigated through a Chance Fossil Finds protocol.

The impact significance of the proposed Aberdeen WEF Cluster is assessed as LOW. None of the recorded fossil sites lies directly within the provisional project footprint. The project is not fatally flawed and there are no objections on palaeontological heritage grounds to its authorization. This

assessment applies equally to all infrastructure components and layout options currently under consideration.

The Environmental Control Officer (ECO) / Environmental Site Officer (ESO) responsible for the developments should be made aware of the possibility of important fossil remains (vertebrate bones, teeth, burrows, petrified wood, plant-rich horizons *etc.*) being found or unearthed during the construction phase of the development. Monitoring for fossil material of all major surface clearance and deeper (>1m) excavations by the ECO/ESO on an on-going basis during the construction phase is therefore recommended. Significant fossil finds such as vertebrate bones, teeth and well-preserved petrified logs should be safeguarded and reported at the earliest opportunity to the Eastern Cape Provincial Heritage Resources Authority (ECPHRA. Contact details: Mr Sello Mokhanya, 74 Alexander Road, King Williams Town 5600; Email: smokhanya@ecphra.org.za). This is so that appropriate mitigation (*e.g.* recording, sampling or collection) can be taken by a professional palaeontologist (See tabulated Chance Fossil Finds Procedure in Appendix 2 to this report). The specialist involved would require a fossil collection permit from ECPHRA. Fossil material must be curated in an approved repository (*e.g.* museum or university collection) and all fieldwork and reports should meet the minimum standards for palaeontological impact studies developed by SAHRA (2013). These recommendations must be included in the EMPr for the proposed renewable energy development.

7. ACKNOWLEDGEMENTS

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9. SHORT CV OF 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 the University of Tübingen in Germany, and has carried out palaeontological research in Europe, North America, the Middle East as well as North and South Africa and Madagascar. 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 numerous palaeontological impact assessments for developments and conservation areas in the Western, Eastern and Northern Cape, Limpopo, Northwest Province, Mpumalanga, Gauteng, KwaZulu-Natal and the Free State under the aegis of his Cape Town-based company *Natura Viva* cc. He has served as a 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, 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 1: ABERDEEN WEF CLUSTER PROJECT AREA NEAR ABERDEEN - FOSSIL SITE DATA – MARCH 2022

All GPS readings were taken in the field using a hand-held Garmin GPSmap 65s instrument. The datum used is WGS 84.

Please note that:

- Locality data for South African fossil sites in *not* for public release, due to conservation concerns.
- The table does *not* represent all potential fossil sites within the project area but those sites recorded during the field survey (*N.B.* many background scatter occurrences of petrified wood are *not* included here since the material is very widespread and common with surface gravels). The absence of recorded fossil sites in any area therefore does *not* mean that no fossils are present there.
- The stratigraphic data for each site has yet to be confirmed (probably Abrahamskraal Formation – member uncertain – but some fossil wood may be worked from higher stratigraphic levels within the GreatEscarpment zone).

The recorded fossil sites are mapped in satellite image Figures A1 below and in relation to the provisional infrastructure layout in Figure A2.

LOC	GPS DATA	COMMENTS
136	-32.576024° 23.880584°	Mon Repos 154. Blocks of silicified fossil wood among surface gravels. Proposed Field Rating IIIC Local Resource. No mitigation recommended (*outside* project area).
138	-32.583672° 23.842179°	Farm 153, southern edge. Blocks of silicified wood among surface gravels possibly associated with lenses of *koffieklip*. Proposed Field Rating IIIC Local Resource. No mitigation recommended.
139	-32.584027° 23.832259°	Farm Kraanvogel Kuil 155, northern boundary. Concentration of well-preserved petrified wood blocks up to 30 cm across among surface gravels along farm track. Proposed Field Rating IIIC Local Resource. No mitigation recommended.
140	-32.590942° 23.824339°	Farm Kraanvogel Kuil 155. Blocks of petrified wood among surface gravels. Proposed Field Rating IIIC Local Resource. No mitigation recommended.
149	-32.622460° 23.778256°	Farm Kraanvogel Kuil 155. Blocks of petrified wood among surface gravels. Proposed Field Rating IIIC Local Resource. No mitigation recommended..
156	-32.601308° 23.751004°	Farm Kraanvogel Kuil 155. Blocks of petrified wood with very variable quality of preservation among surface gravels. Proposed Field Rating IIIC Local Resource. No mitigation recommended.
160	-32.584051° 23.760231°	Farm Kraanvogel Kuil 155. Blocks of petrified wood among surface gravels. Proposed Field Rating IIIC Local Resource. No mitigation recommended.
161	-32.587424° 23.767689°	Farm Kraanvogel Kuil 155. Abundant blocks of petrified wood, some substantial and well-preserved, among surface gravels. Proposed Field Rating IIIC Local Resource. No mitigation recommended.
164	-32.566510° 23.881011°	Mon Repos 154. Abundant blocks of fossil wood among surface gravels, possibly associated with nearby lenses of channel-hosted koffieklip. Proposed Field Rating IIIC Local Resource. No mitigation recommended

		(*outside* project area).
168	-32.569428° 23.858666°	Farm 153. Ridge crest with blocks of petrified wood among surface gravels. Proposed Field Rating IIIC Local Resource. No mitigation recommended.
169	-32.558420° 23.865376°	Farm 153. Heuweltjie with blocks of petrified wood among surrounding surface gravels. Proposed Field Rating IIIC Local Resource. No mitigation recommended.
170	-32.549473° 23.869668°	Farm 153. Gullied area with abundant blocks of petrified wood among surface gravels. Proposed Field Rating IIIC Local Resource. No mitigation recommended..
178	-32.510876° 23.879795°	Kraairivier 149. Extensive, low riverine exposure of purple-brown and grey-green mudrocks with pedocrete concretions, sparse blocks of petrified wood in surface gravels. Proposed Field Rating IIIC Local Resource. No mitigation recommended.
180	-32.514674° 23.893096°	Kraairivier 149. Extensive, low riverine exposure of purple-brown and grey-green mudrocks, thin, tabular crevasse splay sandstones with wave-rippled upper bed palaeosurfaces, local concentrations of small-scale meandering invertebrate traces – possibly undermat miners. Proposed Field Rating IIIC Local Resource. No mitigation recommended.
182	-32.513246° 23.857518°	Farm 94. Small pebble-sized, rounded clast of pale grey, reworked “rolled bone” as well as silicified wood blocks among surface gravels in shallow pan area. Proposed Field Rating IIIC Local Resource. Specimen collected. No mitigation required.
183	-32.513435° 23.857041°	Farm 94. Locally abundant blocks of silicified wood among surface gravels. Proposed Field Rating IIIC Local Resource. No mitigation recommended.
187	-32.524892° 23.835069°	Farm 94. Low ridges of yellowish-weathering, medium-grained, crumbly speckled sandstone with sparse scatter of fossil wood blocks among overlying eluvial gravels. Proposed Field Rating IIIC Local Resource. No mitigation recommended.
193	-32.520628° 23.726627°	Farm Doornpoort 93. Abundant reworked blocks of fossil wood among alluvial gravels bordering Gannaleegte drainage line. Proposed Field Rating IIIC Local Resource. No mitigation recommended.
196	-32.553682° 23.710204°	Farm Koppies Kraal 157. Blocks of fossil wood among eluvial gravels. Proposed Field Rating IIIC Local Resource. No mitigation recommended.
197	-32.568231° 23.685375°	Farm Koppies Kraal 157. Abundant blocks of fossil wood with variable quality of preservation among surface gravels. Proposed Field Rating IIIC Local Resource. No mitigation recommended.
215	-32.544215° 23.609752°	Farm RE/91. Concentration among surface gravels and sands of small to medium-sized (dm scale) bone blocks of a large-bodied tetrapod – possibly a tapinocephalid dinocephalian, including probable cranial material (e.g. jaw with embedded conical tooth roots). Proposed Field Rating IIIB. Site has been sampled. No mitigation recommended.
216	-32.544325° 23.609804°	Farm RE/91. Curved bone of large tetrapod (*possibly* dentary / lower jaw) embedded within surface sands and gravels (probably same individual as at Loc. 215). Proposed Field Rating IIIC. No mitigation recommended.

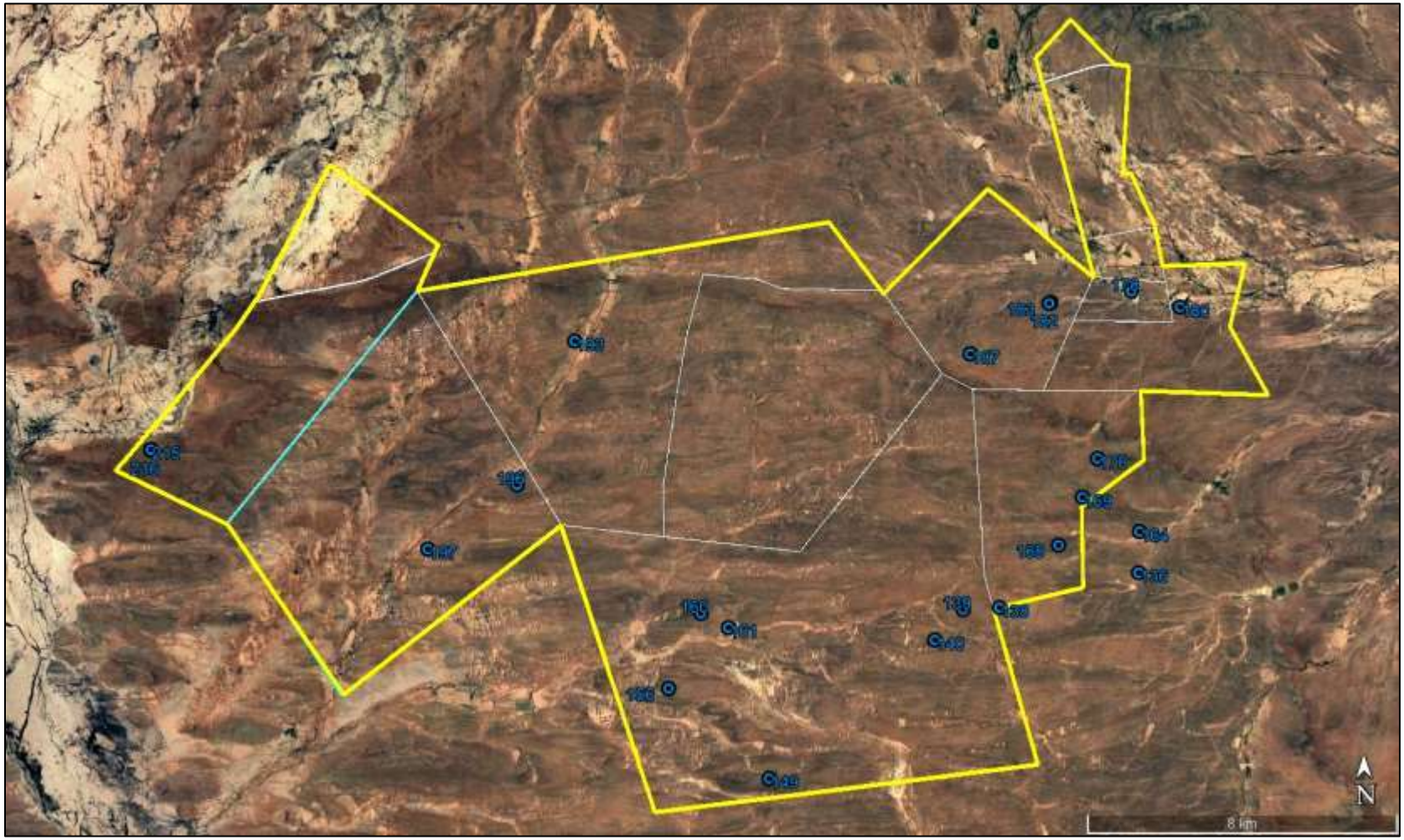

Figure A1: Google Earth© satellite image of the Aberdeen WEF Cluster project area (yellow polygon) showing the location of the recorded fossil sites - numbered in blue - that are tabulated above (*N.B.* The widespread background scatter of fossil wood encountered within surface deposits has not been recorded here).

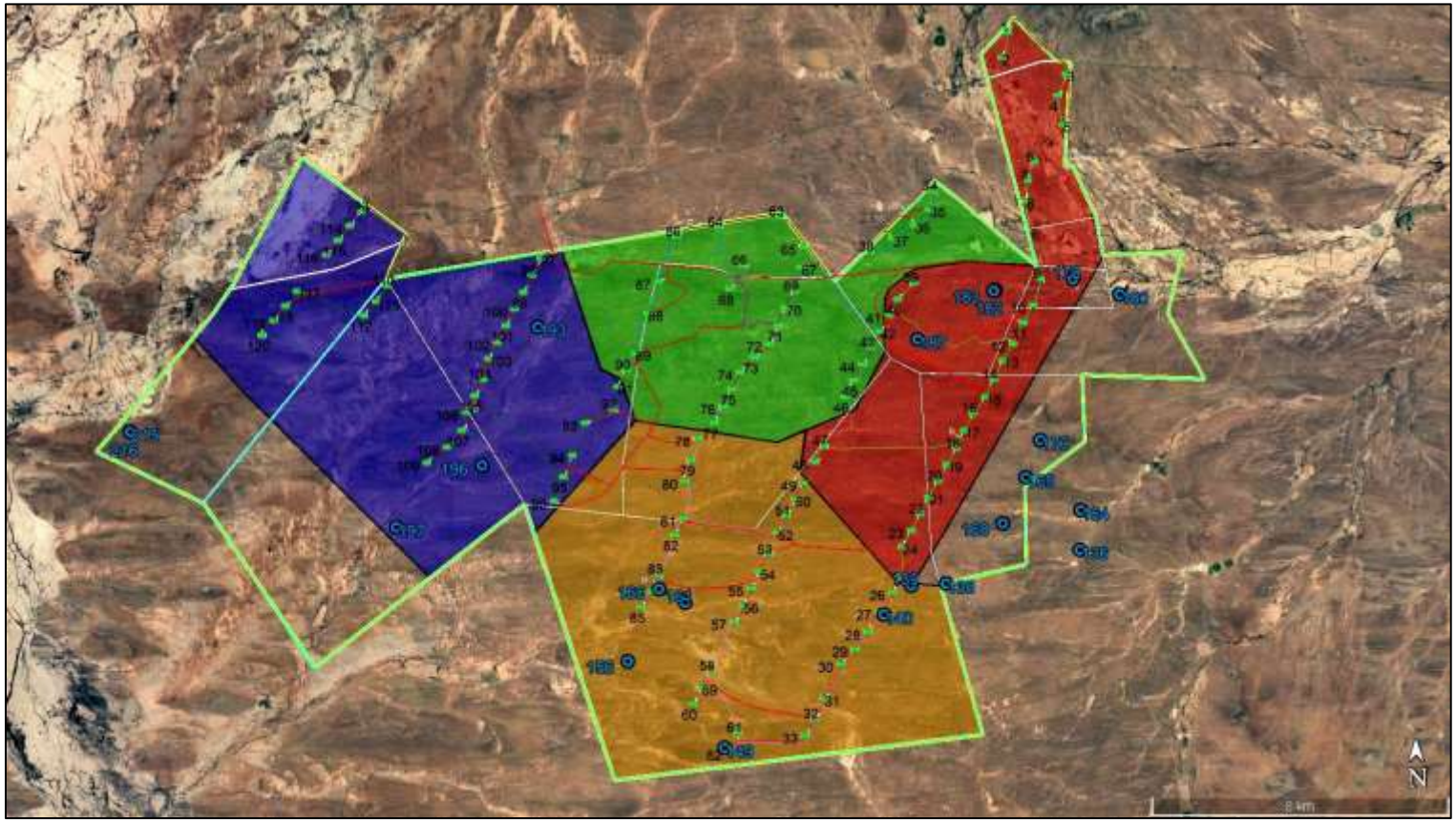

Figure A2: Google Earth© satellite image of the Aberdeen WEF Cluster project area showing the recorded fossil sites – numbered in blue - in the context of the provisional infrastructure layouts of the WEFs (wind turbine positions in green, access roads in red). None of the recorded sites lies within the provisional infrastructure footprint and palaeontological mitigation is not recommended for any of these sites.

APPENDIX 2: CHANCE FOSSIL FINDS PROTOCOL

<table>
<tr><td colspan="3">ABERDEEN WEF CLUSTER NEAR ABERDEEN</td></tr>
<tr><td>Province & region:</td><td colspan="2">Eastern Cape Cape; Sarah Baartman District , Dr Beyers Naude Local Municipality</td></tr>
<tr><td>Responsible Heritage Resources Agency</td><td colspan="2">ECPHRA. Contact details: Mr Sello Mokhanya, 74 Alexander Road, King Williams Town 5600; Email: smokhanya@ecphra.org.za</td></tr>
<tr><td>Rock unit(s)</td><td colspan="2">Abrahamskraal Formation (Lower Beaufort Group), Late Caenozoic alluvium, colluvium, calcrete pedocretes, pan sediments, surface gravels & soils</td></tr>
<tr><td>Potential fossils</td><td colspan="2">Fossil vertebrate bones, teeth, trace fossils (e.g. vertebrate and invertebrate burrows), trackways, petrified wood, plant-rich beds in the Lower Beaufort Group bedrocks.
Fossil mammal bones, teeth, horn cores, freshwater molluscs, calcretised trace fossils (e.g. termitaria, rhizoliths), plant material in Late Caenozoic alluvium, calcretes.</td></tr>
<tr><td rowspan="5">ECO protocol</td><td colspan="2">1. Once alerted to fossil occurrence(s): alert site foreman, stop work in area immediately (N.B. safety first!), safeguard site with security tape / fence / sand bags if necessary.</td></tr>
<tr><td colspan="2">2. Record key data while fossil remains are still in situ:
Accurate geographic location – describe and mark on site map / 1: 50 000 map / satellite image / aerial photo
Context – describe position of fossils within stratigraphy (rock layering), depth below surface
Photograph fossil(s) in situ with scale, from different angles, including images showing context (e.g. rock layering)</td></tr>
<tr><td>3. If feasible to leave fossils in situ:
Alert Heritage Resources Agency and project palaeontologist (if any) who will advise on any necessary mitigation
Ensure fossil site remains safeguarded until clearance is given by the Heritage Resources Agency for work to resume</td><td>3. If not feasible to leave fossils in situ (emergency procedure only):
Carefully remove fossils, as far as possible still enclosed within the original sedimentary matrix (e.g. entire block of fossiliferous rock)
Photograph fossils against a plain, level background, with scale
Carefully wrap fossils in several layers of newspaper / tissue paper / plastic bags
Safeguard fossils together with locality and collection data (including collector and date) in a box in a safe place for examination by a palaeontologist
Alert Heritage Resources Agency and project palaeontologist (if any) who will advise on any necessary mitigation</td></tr>
<tr><td colspan="2">4. If required by Heritage Resources Agency, ensure that a suitably-qualified specialist palaeontologist is appointed as soon as possible by the developer.</td></tr>
<tr><td colspan="2">5. Implement any further mitigation measures proposed by the palaeontologist and Heritage Resources Agency</td></tr>
<tr><td>Specialist palaeontologist</td><td colspan="2">Record, describe and judiciously sample fossil remains together with relevant contextual data (stratigraphy / sedimentology / taphonomy). Ensure that fossils are curated in an approved repository (e.g. museum / university / Council for Geoscience collection) together with full collection data. Submit Palaeontological Mitigation report to Heritage Resources Agency. Adhere to best international practice for palaeontological fieldwork and Heritage Resources Agency minimum standards.</td></tr>
</table>