PALAEONTOLOGICAL HERITAGE: COMBINED DESKTOP & FIELD-BASED REPORT

PROPOSED DEVELOPMENT OF THE BULSKOP PV CLUSTER AND ASSOCIATED GRID CONNECTION, BEAUFORT WEST MUNICPALITY (CENTRAL KAROO DISTRICT MUNICIPALITY), WESTERN CAPE

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EXECUTIVE SUMMARY

The Bulskop PV cluster project area on the Remaining Extent (Portion 0) of Farm 423 near Beaufort West, Central Karoo District Municipality, Western Cape Province is situated on the margins of the Aberdeen Vlaktes, an ancient land surface of possible Miocene age. The Lower Beaufort Group (Permian) bedrocks here are entirely covered by a thick calcrete hardpan and reworked sandy to gravelly alluvial deposits of low palaeosensitivity. The *c*. 17 km long grid connection corridor to the existing Droërivier MTS due SW of Beaufort West comprises more dissected terrain with low hills, colluvial slopes and alluvial *vlaktes* with limited exposure of potentially-fossiliferous bedrocks of the Late Permian Teekloof Formation (Lower Beaufort Group). A very sparse scatter of fossil sites of the Middle to Late Permian *Endothiodon* Assemblage Zone was recorded from these bedrocks during the site visit, comprising a few small dicynodont skulls within calcrete concretions weathering out from overbank mudrock facies, occasional robust fragments of rolled bone among ferruginous carbonate surface gravels and low diversity invertebrate trace fossil assemblages within channel sandstones. The only fossils recorded within the Late Caenozoic alluvial deposits are occasional calcretised termaria of possible Pleistocene or Holocene age. The Palaeozoic and Caenozoic fossil sites all lie on the margins of, or shortly outside, the project footprint (See satellite map A1 in Appendix 1), most of are modest scientific or conservation value and no mitigation in their regard is recommended here.

It is concluded that the Bulskop PV cluster and associated grid connection project areas are both of Low palaeontological sensitivity although the potential for isolated vertebrate fossil finds of high scientific interest - as recorded elsewhere in the Beaufort West region - cannot be completely discounted.

The proposed renewable energy developments are of Low impact significance and there are no objections on palaeontological heritage grounds to their authorisation. The appended Chance Fossil Finds Protocol should be included within the EMPr and implemented in full during the construction phase of the PV and grid connection developments.

1. INTRODUCTION

The company Bulskop PV (Pty) Ltd is proposing to develop a solar photovoltaic (PV) cluster on the Remaining Extent (Portion 0) of Farm 423 near Beaufort West in the Central Karoo District Municipality, Western Cape Province (Fig. 1). The PV project area is approximately 2 600 ha in size. The cluster is expected to comprise ~~five~~ PV facilities (each ~250 ha in extent) with a potential generating output capacity of 100 MW *per* PV facility. The study area falls within recently gazetted Beaufort West Renewable Energy Development Zone (REDZ). The grid connection to the existing Droërivier Main Transmission Substation (MTS), located approximately 7 km southwest of Beaufort West and *c*. 17 km west of the proposed PV facility, will comprise a 132 kV single/double circuit overhead powerline and falls within the Beaufort West REDZ as well as the Central Strategic Transmission Corridor. It traverses the following properties: Remaining Extent of Farm 423, Portion 4 of Farm 169, Portion 5 of Farm 169, Portion 1 of Farm Steenrotsfountain No 168 and Portion 10 of Farm Weltevreden No 170.

The present combined desktop and field-based palaeontological heritage report contributes to the separate consolidated Heritage Basic Assessment reports for the Bulskop PV cluster and associated grid connection that are being compiled by CTS Heritage, Cape Town (Contact details: Ms Jenna Lavin. CTS Heritage. 16 Edison Way, Century City, RSA. Tel: +27 (0)87 073 5739. Cell: +27 (0)83 619 0854. E-mail: info@ctsheritage.com).

2. INFORMATION SOURCES

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

1. A short project outline, maps and kmz files provided by CTS Heritage, Cape Town (See CTS Heritage Screening reports 2021a, 2021);

2. A review of the relevant scientific literature, including published geological maps (1: 250 000 geology sheet 3222 Beaufort West) and accompanying sheet explanations (*e.g.* Johnson & Keyser 1979) as well as several desktop and field-based palaeontological assessment studies in the broader Beaufort West region of the Western Cape by the author and others (See References);

3. Examination of relevant topographical maps (*e.g.* 1: 250 000 sheet 3222 Beaufort West, 1: 50 000 sheet 322BC Beaufort West) and Google Earth© satellite images;

4. A two-day palaeontological site visit by the author and an experienced assistant (4-5 September 2021) which focused on a representative sample of potentially-fossiliferous exposures of bedrock units (especially good mudrock exposures), calcrete pedocretes, as well as Late Caenozoic alluvial and eluvial deposits within the broader project area.

5. The author's previous field experience with the formations concerned and their palaeontological heritage (See also reviews of Western Cape fossil heritage by Almond & Pether 2008).

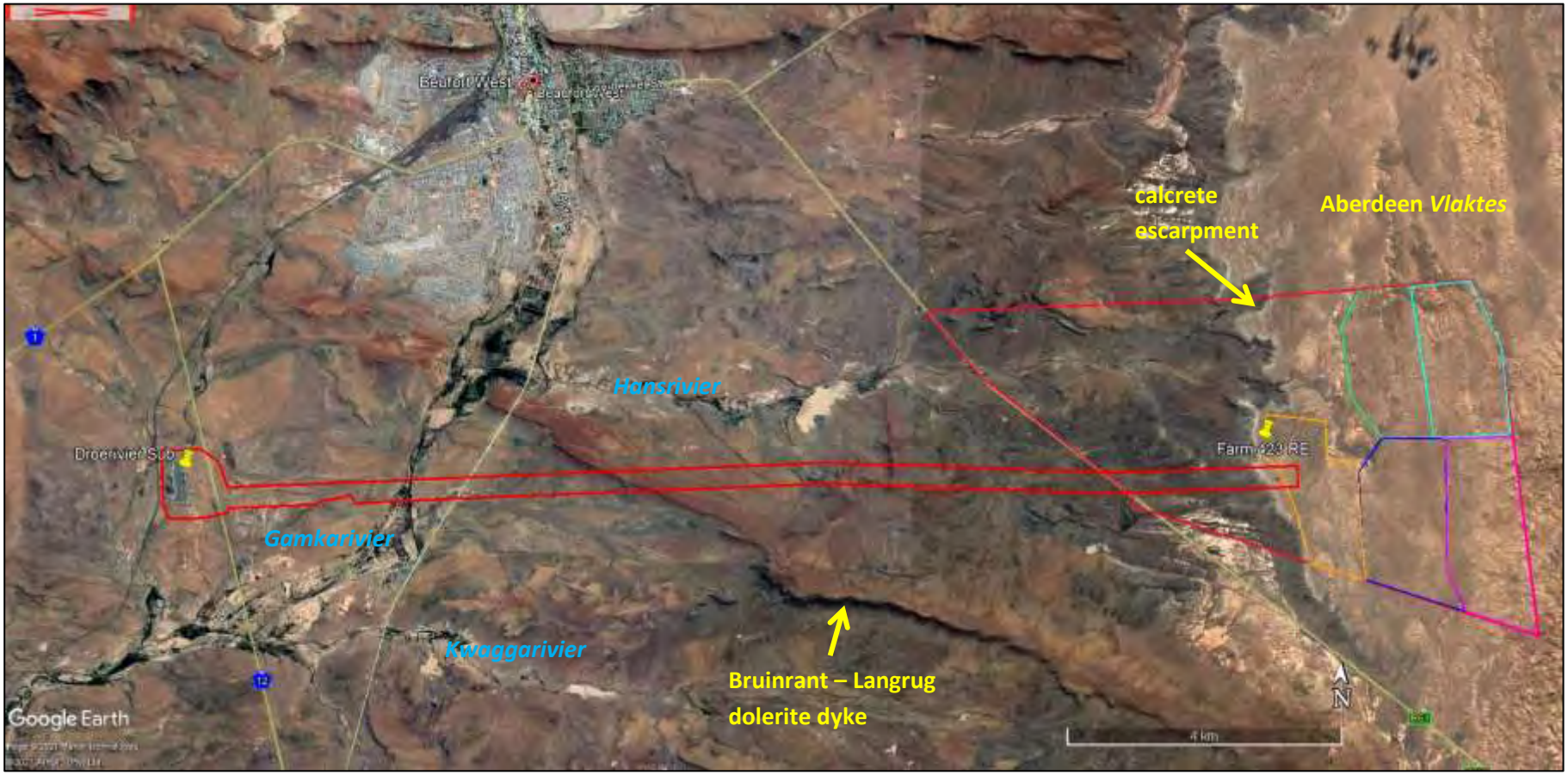

Figure 1: Google Earth© satellite image of the region south of Beaufort West in the Great Karoo region of the Western Cape, showing the five solar photovoltaic (PV) facility project areas of the Bulskop PV Cluster on the Remaining Extent (Portion 0) of Farm 423 (large red polygon) as well as the grid connection corridor to the existing Droërivier MTS to the southwest of Beaufort West (narrow red polygon).

3. GEOLOGICAL CONTEXT

The geology of the combined Bulskop PV cluster and grid connection project areas is covered by 1: 250 000 geology sheet 3222 Beaufort West (Council for Geoscience, Pretoria; Johnson & Keyser 1979) (Fig. 2). Parts of the grid connection corridor, as well as adjacent areas just to the north and south, have also been covered in previous PIA reports by the author for the Gamma-Omega 765 kV transmission line (Almond 2010a), a solar project on Farm Steenrotsfontein 168 (Almond 2011), the proposed Droërivier Solar Facility on Portion 55 of Farm 168 Steenrotsfontein and a portion of Portion 10 of Farm 170 Weltevreden, the grid connection corridor to Droërivier Substation for the proposed Nuweveld WEF (Almond 2020b) and a proposed solar project on Quaggas Fontein 166 (Almond, in prep.).

The entire PV cluster and grid connection project area is underlain at depth or at surface by Permian continental sediments of the **Teekloof Formation** (Lower Beaufort Group / Adelaide Subgroup, Karoo Supergroup) (Pa, grey-green in Fig. 2) (Johnson & Keyser 1979, Johnson *et al.* 2006). It is likely the majority of the bedrocks here can be assigned to the upper portion of the sandstone-dominated **Poortjie Member** situated towards the base of the very thick Teekloof Formation succession but this requires confirmation from detailed field mapping that is beyond the scope of the present PIA study. The age of the upper Poortjie beds as determined from volcanogenic tuff marker beds is *c*. 260 – 258 Ma (*i.e.* latest Capitanian to earliest Wuchiapingian), spanning the key stratigraphic boundary between the Middle and Late Permian Period (Day & Smith 2020). The sedimentology of the Abrahamskraal – Teekloof transition has been addressed recently by Paiva (2015).

The solar PV cluster project area on Farm 423 RE (Buls Kop 163 on 1: 250 000 maps) lies on the north-eastern side of the R61 Beaufort West to Aberdeen tar road in semi-arid, karroid terrain on the south-eastern outskirts of Beaufort West (Fig. 1). The adjoining PV sites are situated on a very level plateau at an elevation of around 890 m amsl which appears pale brown with a narrow white margin on satellite images reflecting a thick (few m) calcrete hardpan capping the bedrocks here (Figs. 25 to 27). The plateau is situated on the western edge of the Aberdeen *Vlaktes*, an ancient peneplanated land surface of possible Miocene age (Partridge & Maud 1987). It is separated by a low, incised scarp from lower-lying (*c*. 850-890 m amsl), more dissected terrain on the western portion of Farm 423 RE with low sandstone *koppies* and gravelly alluvial *vlaktes* showing darker brownish and grey hues on satellite imagery. Away from the plateau edge bedrock exposure is non-existent; a range of Late Caenozoic sandy and gravelly deposits carpeting the entire PV project area are illustrated in Figures 4, 5 and 27 to 33. The widely occurring cobbly sandstone gravels here are ultimately derived from a broad belt of coarse alluvial deposits related to ancient Caenozoic drainage systems draining the Great Escarpment, as reflected in the deep notch in the Escarpment due north of the site and the relict Platdoringrivier drainage line further to the east. Aeolian reworking of the finer-grained alluvium is suggested by the well-developed dune systems on the Aberdeen *Vlaktes* to the east.

The Late Palaeozoic Lower Beaufort Group sedimentary bedrocks within the grid connection corridor are locally intruded by the extensive WNW-ESE trending Bruinrant – Langrug dyke of the Early Jurassic **Karoo Dolerite Suite** (Jd, red in Fig. 2). The prominent-weathering dyke ridge, with a steeper SW scarp and gentler NE slopes mantled by doleritic colluvial gravels, stands out clearly as a rusty-brown strip on satellite images and is associated with local baking of the country rocks to pale quartzite and darker hornfels (Figs. 1, 8 & 24).

Bedrock exposure of the Beaufort Group sediments within the grid corridor is usually poor, especially in the case of the recessive-weathering, potentially fossiliferous mudrock facies which are mainly exposed along drainage lines (shallow streams, hillside gullies), on some gentle or steeper hillslopes as well as occasional small borrow pits in the wider region (Figs. 17 to 23). More resistant channel sandstone facies cap low ridges and *koppies* and are also well seen in section in the banks of the well-incised Gamka River. Thick basal or internal channel breccias composed of mudflake intraclasts and calcrete glaebules, sometimes cross-bedded, are locally well-developed (Figs. 13 to 16). Drainage within the grid corridor is largely *via* small stream tributaries of the Hansrivier in the north and the Kwaggarivier in the south, with the Bruinrant ridge acting as a local drainage divide. Towards the west these tributary systems feed into the major Gamkarivier which traverses the corridor due south of Beaufort West. Most low-lying areas within the grid corridor are mantled by extensive sheets of silty, sandy to gravelly alluvial, colluvial and eluvial (downwasted) deposits including a range of surface gravels (Figs. 34 to 38). Coarse, bouldery alluvium is encountered along the banks of the Gamkarivier with adjoining relict terraces of cobbly alluvial deposits.

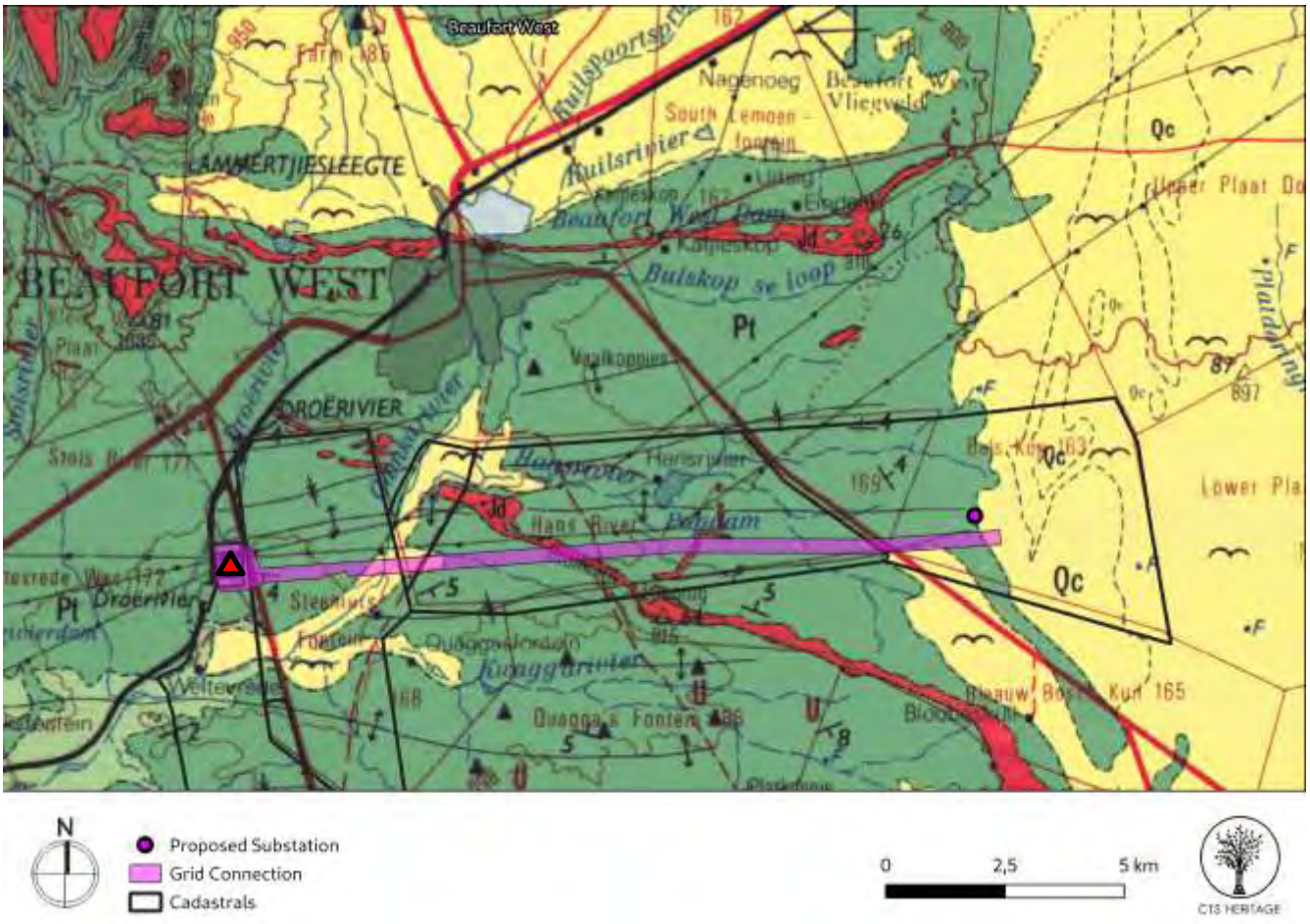

Figure 2: Geological map showing the location of the combined study areas for the Bulskop PV cluster on the Remaining Extent of Farm 423 (blue polygon) as well as the associated 132 kV grid line connection (purple corridor) traversing Portion 4 and Portion 5 of Farm 169 and Portion 1 of Farm Steenrotsfountain No 168 to the existing Droërivier Substation on Portion 10 of Farm Weltevreden No 170 to the SW of Beaufort West (red triangle) (Image prepared by CTS Heritage, Cape Town). Pt (dark green) = Teekloof Formation (mainly Poortjie Member within study region); Jd (red) = Karoo Dolerite Suite intrusions (*e.g.* major WNW-ESE Bruinrant – Langrug dyke); Qc (pale yellow) = Late Caenozoic calcrete; pale yellow with flying bird symbol = Late Caenozoic alluvium and downwasted alluvial deposits of the Aberdeen *vlaktes* and major drainage lines (*e.g.* Gamkarivier, Kwaggarivier, Hansrivier).

Figure 3: View eastwards towards the low, dissected, calcrete-capped escarpment bordering the Bulskop PV cluster project area on the eastern sector of the Remaining Extent of Farm 423. The flat, lower-lying terrain in the foreground is largely underlain by Lower Beaufort Group mudrocks mantled by eluvial gravels and finer-grained alluvial soils.

Figure 4: The Bulskop PV cluster project area features very flat terrain on the western margins of the Aberdeen *Vlaktes*, an ancient peneplanated land surface of possible Miocene age (Partridge & Maud 1987). Large parts of the surface are mantled by downwasted gravels and sandy to silty alluvium.

Figure 5: View across the PV cluster project area towards Great Escarpment to the north showing areas with sandy soil and low *bossieveld* but little or no surface gravels, Remaining Extent of Farm 423.

Figure 6: Flat terrain mantled by thin eluvial surface gravels and soils within the grid connection corridor in the western sector of Portion 4 of Farm 169 Hansrivier with low hills on the skyline to the south. Such areas may look palaeontologically promising on satellite images (dark hues, banded) but rarely yield useful fossil material.

Figure 7: Hilly terrain in the east-central sector of Portion 4 of Farm 169 Hansrivier that is traversed by the gird connection corridor, looking east. The hills are capped by Poortjie Member sandstone and locally also by dolerite with very little hillslope mudrock exposure due to sandstone / dolerite colluvium.

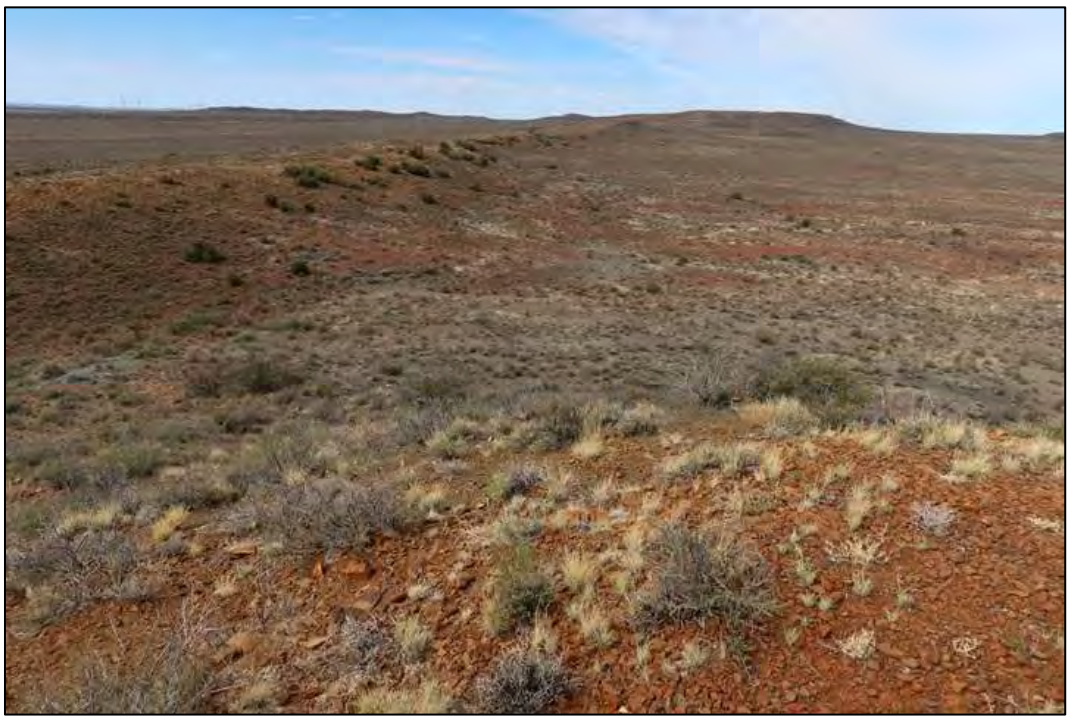

Figure 8: The low WNW-ESE trending Bruinrant – Langrug ridge reflecting a major dyke of resistant-weathering dolerite that crosses the grid connection corridor on Portion 4 of Farm 169 Hansrivier, here looking to the east. Note rusty-brown doleritic colluvial gravels in the foreground.

Figure 9: Flat terrain mantled by angular eluvial gravels of Beaufort Group sandstone, Portion 1 of Farm Steenrotsfountain No 168, looking due north.

Figure 10: Low hills and ridges capped by Poortjie Member sandstone in the western sector of the grid connection corridor near the N12 on Portion 1 of Farm Steenrotsfountain No 168. Recessive-weathering mudrocks in lower-lying areas are largely mantled by alluvial soils and fine sheetwash gravels (foreground).

Figure 11: Intermittent exposure of brown-weathering, cross-bedded channel sandstones of the Lower Beaufort Group (probably Poortjie Member) along the upper edge of the low escarpment bounding the Bulskop PV cluster project area on the Remaining Extent of Farm 423. The relict plateau here is underpinned by a subhorizontal channel sandstone package.

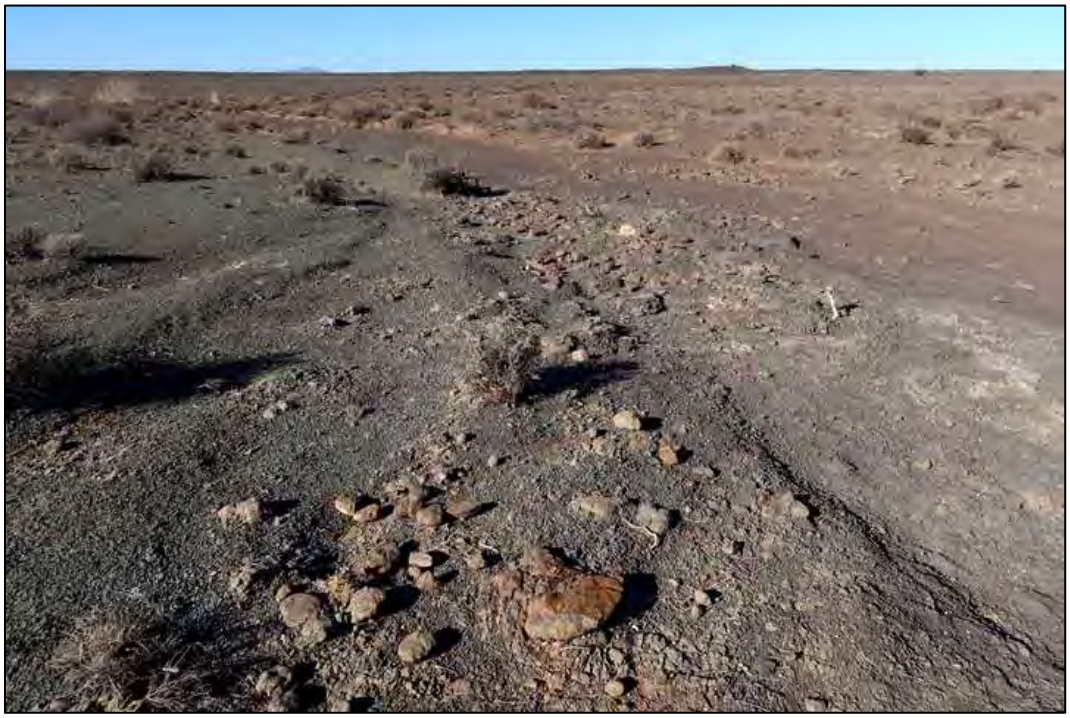

Figure 12: Limited exposure of Lower Beaufort Group purple-brown and grey-green overbank mudrocks with ferriginous calcrete concretions along a shallow stream bed traversing the low-lying eastern portion of the Remaining Extent of Farm 423.

Figure 13: Major channel sandstone body of the Poortjie Member exposed along the western bank of the Gamka River on Portion 1 of Farm Steenrotsfountain No 168.

Figure 14: Low, sandstone-caped *koppie* of the Poortjie Member close to the western bank of the Gamka River on Portion 1 of Farm Steenrotsfountain No 168. Note the typical lack of mudrock exposure on the lower hillslopes in this area.

Figure 15: Thick, dark grey-green basal channel breccias underlying the channel sandstone capping illustrated in the previous figure (Hammer = 30 cm). The breccias here are largely composed of mudflake intraclasts with no obvious reworked fossil bone.

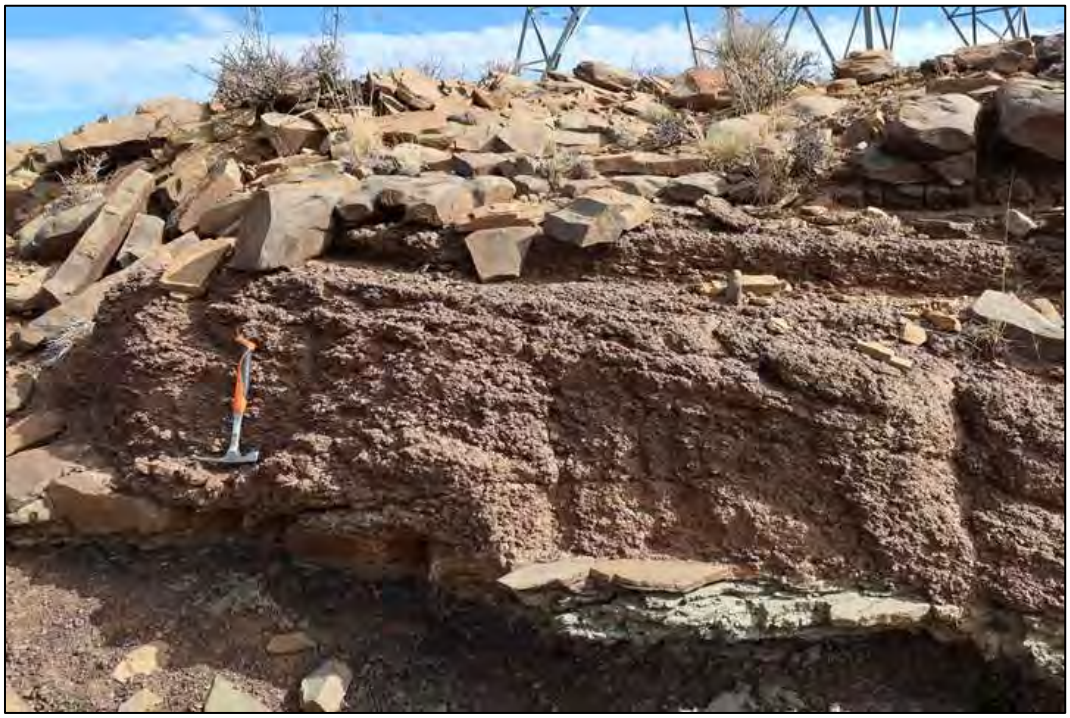

Figure 16: Reddish-brown, cross-bedded breccias exposed towards the base of a Poortjie Member channel sandstone on Portion 4 of Farm 169 Hansrivier (Hammer = 30 cm). The breccias here are composed of a mixture of reworked mudflakes and calcrete nodules with very sparse, small bone fragments (Loc. 358).

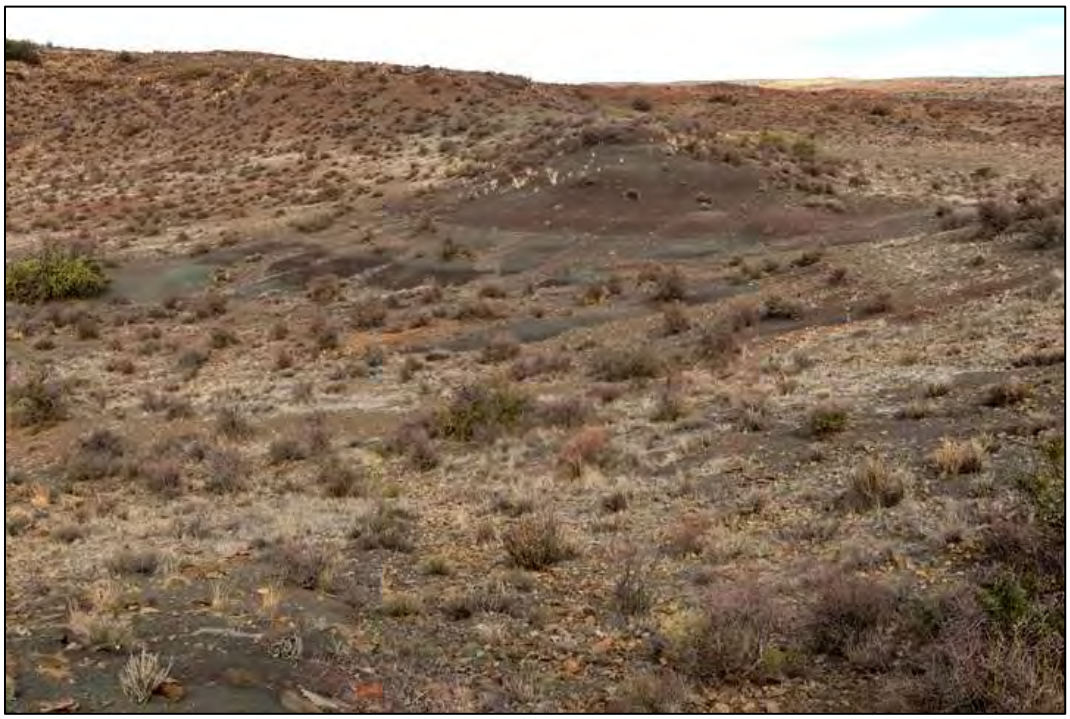

Figure 17: One of the few excellent hillslope exposures of Poortjie Member overbank mudrocks within the grid connection corridor, seen here on Portion 4 of Farm 169 Hansrivier due south of Pap Dam.

Figure 18: Closer view of the well-exposed Poortjie Member mudrocks seen in the previous illustration showing typical colour banding, thin crevasse-splay sandstones as well as lenticles or nodular horizons of pale grey pedogenic calcrete. These mudrocks with palaeosols are an important target for palaeontological recording but in this case no fossils were observed.

Figure 19: Dissected hilly terrain within the grid connection corridor on Portion 4 of Farm 169 Hansrivier showing grey-green overbank mudrocks exposed on gullied lower hillslopes and channel sandstones capping the flat-topped *koppie* on the horizon. The steeper upper hillslopes are mantled by scree gravels.

Figure 20: Stream gulley section through grey-green, thin-bedded distal floodplain mudrocks incised at the base of the succession shown in the previous figure, Portion 4 of Farm 169 Hansrivier (Hammer = 30 cm).

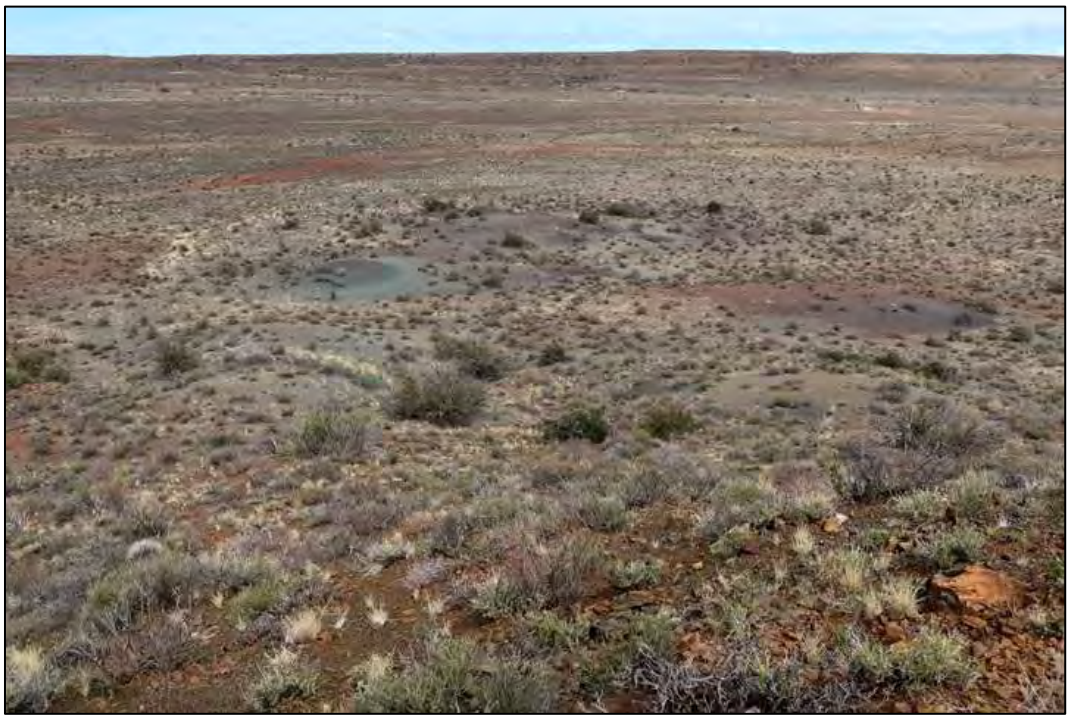

Figure 21: Multi-hued gentle hillslope exposures of Poortjie Member mudrocks situated at the foot of Bruinrant on the western sector of Portion 4 of Farm 169 Hansrivier, here looking south. These mudrock exposures have yielded several fossils of small-bodied dicynodonts (See Figures 45 & 46).

Figure 22: Stream bed and bank exposure of desiccation-cracked, purple-brown and grey-green overbank mudrocks of the Poortjie Member in the western sector of Portion 4 of Farm 169 Hansrivier. See also Figure 37 for overlying fine-grained alluvium.

Figure 23: Borrow pit excavation into a thick package of Poortjie Member overbank mudrocks close to the N12 on Portion 1 of Farm Steenrotsfountain No 168. This horizon has yielded several important vertebrate fossils of the *Lycosuchus* – *Eunotosaurus* Subzone less than 3 km further south.

Figure 24: Contact between brownish-weathering, well-jointed hornfels (baked mudrock) and rusty-brown intrusive dolerite along the margins of the Bruinrant dyke on Portion 4 of Farm 169 Hansrivier (See also Figure 8).

Figure 25: Section through thick Late Caenozoic calcrete capping along the escarpment edge just west of the Bulskop PV cluster on Remaining Extent of Farm 423 (Hammer = 30 cm). The unit is probably composite with a rubbly lower portion while the upper part comprises a dense hardpan with incorporated gravel clasts.

Figure 26: Close-up of a gravelly sector of the calcrete capping shown previously, here including numerous angular sandstone clasts, some of which may be anthropogenically flaked (to be confirmed) (Hammer = 30 cm). If so, at least the upper part of the hardpan must be Pleistocene or younger in age.

Figure 27: Calcrete hard pan exposure along the western margins of the plateau where the Bulskop PV cluster will be situated (pale rim seen in satellite images). The overlying sands and gravels have been removed in these areas, exposing the originally subsurface hardpan.

Figure 28: Unvegetated area on the plateau on Remaining Extent of Farm 423 carpeted with eluvial calcrete gravels and fine silty to sandy soils.

Figure 29: Grey areas seen on the plateau are veneered with fine pebbly gravels (clasts of mudrock, hornfels, patinated sandstone) and / or grey karroid *bossieveld* (Hammer = 30 cm). No clasts of silicified fossil wood were observed here.

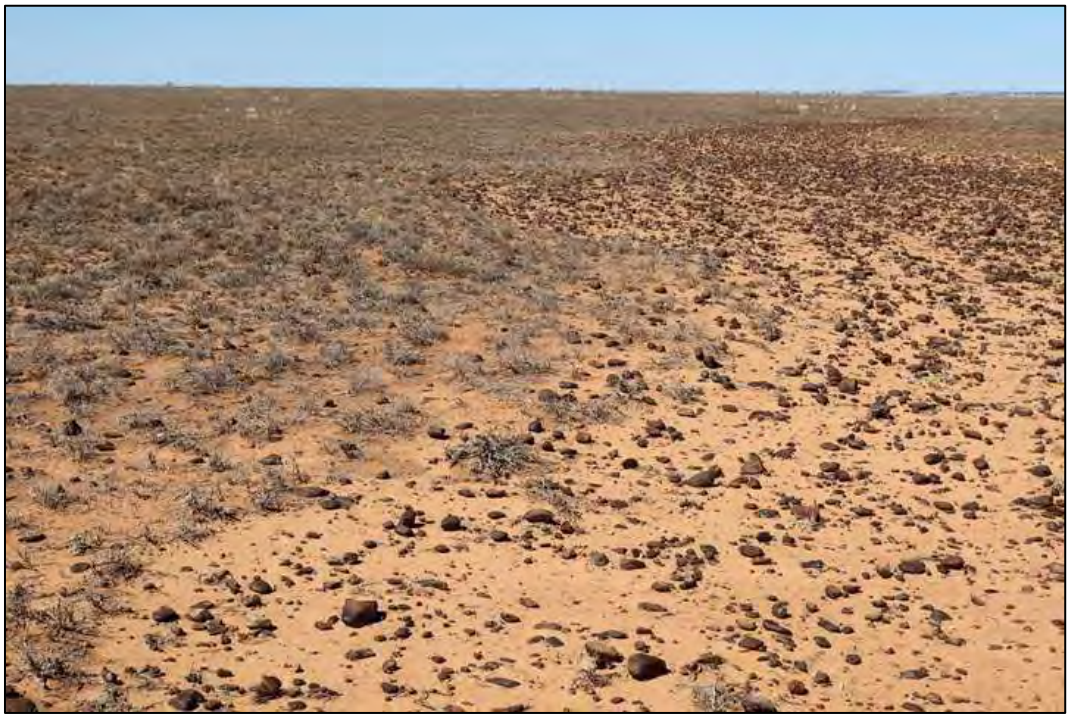

Figure 30: Sinuous, linear zones with higher concentrations of patinated cobbly gravels *might* reflect coarser alluvial sediments along defunct water courses subject to downwasting and deflation, Remaining Extent of Farm 423.

Figure 31: The extensive coarser sandstone surface gravels on the plateau have become subrounded and patinated over millennia of downwasting and surface exposure. Locally they include dispersed, barely recognisable flaked artefacts of ESA, MSA and younger provenance.

Figure 32: Several small pan areas occur on the plateau, characterised by bare, fine-grained silty to sandy sediment with oligomict coarser clasts (sandstone, hornfels, calcrete, mudrock) towards the pan margins.

Figure 33: Local thicker accumulations of semi-consolidated fine sediment on the plateau (often densely burrowed and vegetated with low shrubs, as here) may be relict alluvial sediments or, more likely, related to effaced aeolian dunes such as those developed along the western side of the Platdoringrivier drainage line which runs some 4 km to the east of the PV cluster project area.

Figure 34: Coarse, bouldery alluvium – with clasts mainly sandstone and dolerite - along the Gamka River on Portion 1 of Farm Steenrotsfountain No 168. This ancient river system has been draining the Great Karoo through most of the Caenozoic, and perhaps from Late Cretaceous times.

Figure 35: Disturbed relict, cobbly terrace gravel deposits along the eastern banks of the Gamka River on Portion 1 of Farm Steenrotsfountain No 168. The sandstone cobbles are often well-rounded and include occasional flaked stone artefacts.

Figure 36: Vertical section through thick, poorly-sorted gravelly to sandy alluvial deposits *c*. 1 km NW of the banks of the Gamka River on Portion 1 of Farm Steenrotsfountain No 168.

Figure 37: Fine-grained, sandy alluvial deposits mantling large portions of the low-lying *vlaktes* within the grid corridor are well-exposed along occasional incised streams which cut down to the Lower Beaufort Group bedrocks (foreground), seen here on Portion 4 of Farm 169 Hansrivier (Hammer = 30 cm).

Figure 38: Aprons of mixed colluvial and alluvial gravels mantle the Lower Beaufort Group bedrocks along the margins of Bruinrant – Langrug ridge. The gravels are dominated by rusty-brown dolerite but also contain paler clasts of baked quartzite, many of which have been anthropogenicaly flaked.

4. PALAEONTOLOGICAL HERITAGE CONTEXT

Preliminary palaeosensitivity mapping suggests that the Bulskop PV cluster project area is of Low to High sensitivity while most of the grid connection corridor is of Very High sensitivity except for narrow zones of Low to Zero sensitivity associated with major drainage lines and dolerite intrusions respectively (Fig. 39). No historical fossil sites are shown within the Bulskop project area to the south and south-east of Beaufort West in earlier sources such as the 1: 250 000 geology map (Fig. 2) or Keyser and Smith (1977-1978). However, the more recent compilation of Karoo vertebrate fossil sites by Nicolas (20007) highlights Beaufort West as a fossil-rich area and a number of academic publications have dealt with fossil vertebrate material from the region (*e.g.* Kitching 1977, Day *et al.* 2015a; see also refs. in CTS 2021a, 2021b).

Until recently fossil assemblages within the Poortjie Member of the Teekloof Formation were assigned to the *Pristerognathus* Assemblage Zone (AZ) (*e.g.* Smith and Keyser 1995, Smith *et al.* 2012). More recently, fossils within the upper portion of the Poortjie Member as well as the overlying mudrock-dominated Hoedemaker Member have been included within the newly-defined *Endothiodon* Assemblage Zone, and in particular to the *Lycosuchus-Eunotosaurus* Subzone (Day & Smith 2020; their Figure 2 assigns the most or all of present study area to this subzone) (Fig. 40). This fossil biota is characterised by the medium-sized, tuskless dicynodont *Endothiodon* (Fig. 41) with its highly-specialized herbivorous dentition (the first large-bodied herbivore to appear after the end-Capitanian extinction event) as well as a range of small-bodied dicynodonts with or without post-canine teeth (Fig. 42), palaeoniscoid bony fish, rhinesuchid temnospondyl amphibians, the small, tortoise-like reptile *Eunotosaurus* and carnivorous gorgonopsian and therocephalian therapsids. Large-bodied herbivores such as dinocephalian therapsids and pareiasaur reptiles have not been recorded at this level. The former were probably extinct by this stage while the latter may well have been present in small numbers since they occur within underlying and overlying beds in the Main Karoo Basin. Non-vertebrate fossils include non-marine bivalve molluscs, a limited range of trace fossils (*e.g.* vertebrate tracks, tetrapod burrows, including helical and inclined, more sinuous forms, invertebrate burrows and trackways) as well as plant remains of the Gondwanan *Glossopteris* Flora. The *Lycosuchus-Eunotosaurus* Subzone biota is of considerable palaeobiological interest in documenting the biotic recovery from the catastrophic end-Capitanian Mass Extinction Event of 260 Ma (*cf* Retallack *et al* 2006, Smith *et al.* 2012, Day *et al.* 2015a, 2015b, Day & Rubidge 2020, Day & Rubidge 2021, Marchetti *et al.* 2020) .

Numerous new records of Poortjie Members fossil assemblages belonging to the *Endothiodon* Assemblage Zone (previously the *Pristerognathus* AZ) in the vicinity of Beaufort West have been reported in recent field-based PIA reports by the author and others (*e.g.* Almond 2008, 2010a, 2010b, 2011, 2012, 2014, 2020a, 2020b and Almond in prep.). They include very rare rhinesuchid temnospondyls, locally abundant small-bodied dicynodonts (*e.g. Diictodon, Pristerodon, Robertia*), much less common larger-bodied dicynodonts (*Endothiodon*), medium-sized therocephalians ("*Pristerognathus"*) and rare gorgonopsians. Other fossil records include scratch-marked sandstone vertebrate burrow casts ("*Cruziana*"), helical burrow casts, meniscate back-filled invertebrate burrows (*Scoyenia*) and furrows, phosphatic tetrapod coprolites (fossil droppings), fish swimming trails, small-scale invertebrate tracks, microbial mat biosedimentary structures, locally abundant equisetalean fern compressions and petrified wood. Diverse trace fossil assemblages are associated with sandstone palaeosurfaces (Smith 1993). Despite the long history of palaeontological collecting, it is apparent that scientifically valuable fossil material continues to come to light here and the high palaeontological sensitivity of the Beaufort West area is well-established.

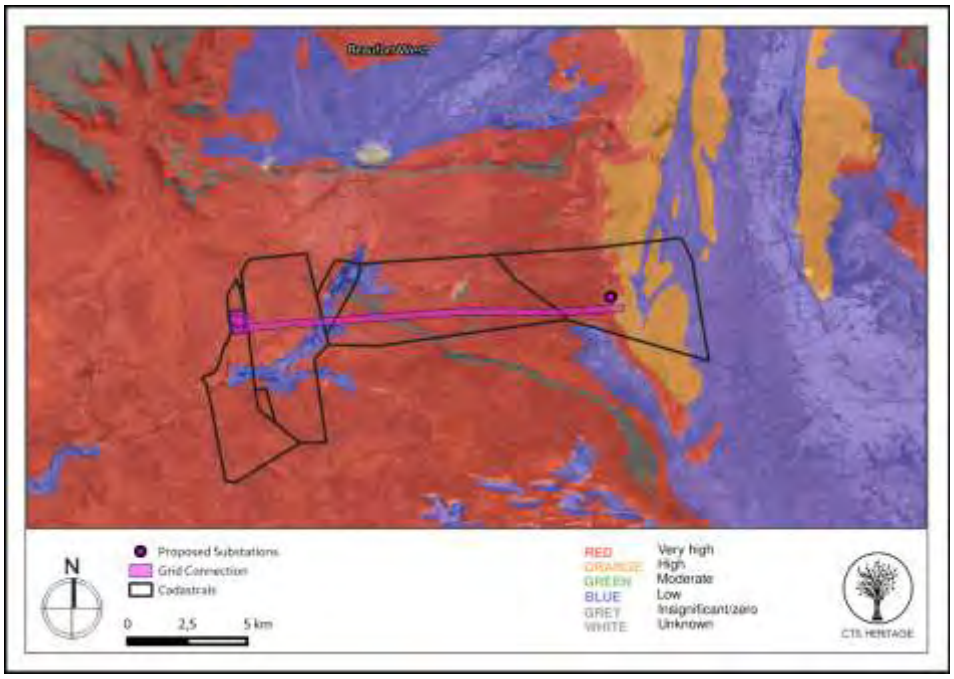

Figure 39: Provisional palaeosensitivity map for the Bulskop PV solar cluster and grid connection project areas (black polygons) (Image abstracted from Screening Report by CTS 2021b). The sensitivity mapping shown here is *contested* in the present report (See Section 5.3).

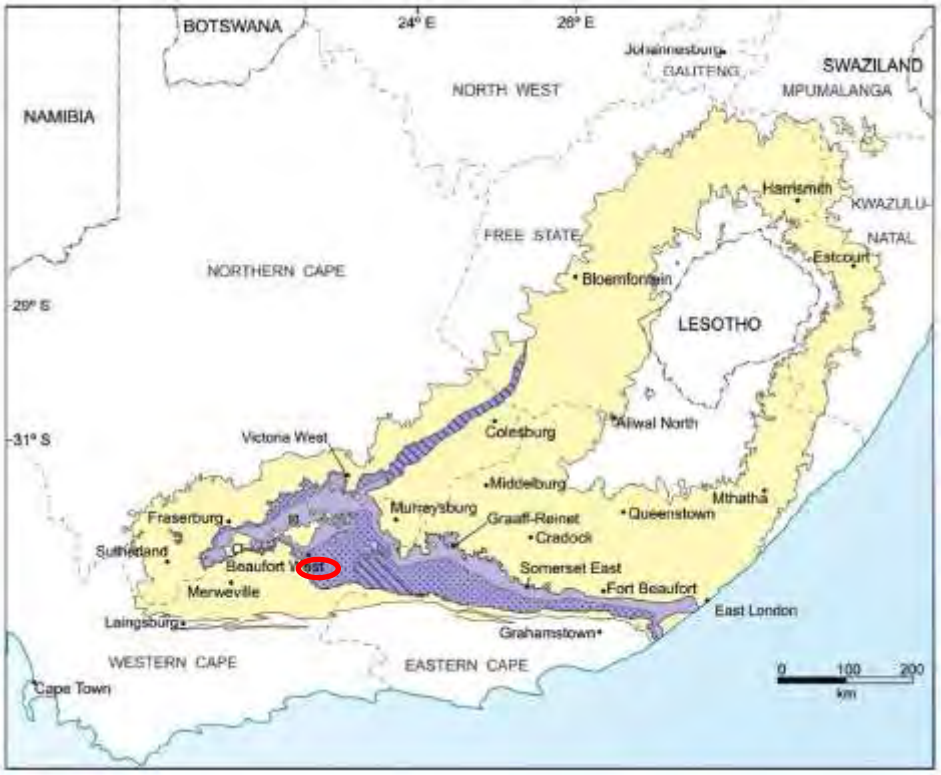

Figure 40: Distribution of the *Endothiodon* Assemblage Zone (AZ) within the Main Karoo Basin of the RSA (Day & Smith 2020). The project area south of Beaufort West (red ellipse) falls largely or entirely within the *Lycosuchus – Eunotosaurus* Subzone (stippled lilac area).

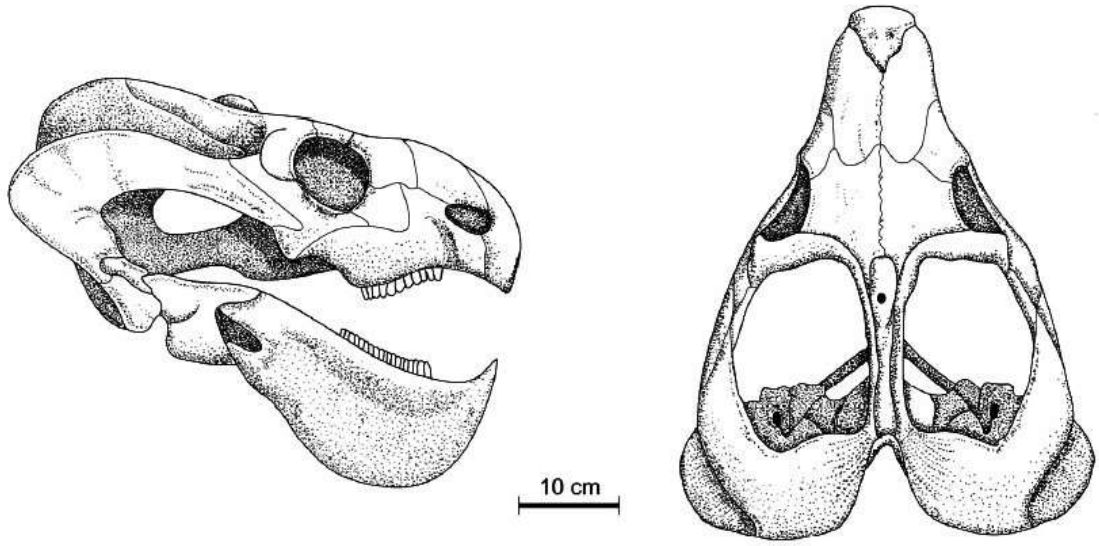

Figure 41: Robust skull of the medium-sized dicynodont therapsid *Endothiodon*. This key index fossil for the *Endothiodon* AZ has been recorded close to and south of the grid connection project area. It was a highly specialized herbivore with batteries of continuously replaced cheek teeth but usually lacked the large canine tusks characteristic of most dicynodonts. *Endothiodon* was among the first substantial-sized herbivores to appear in the Main Karoo Basin after the extinction or almost complete disappearance of the dinocephalians and pareiasaurs during the end-Capitanian Mass Extinction Event around 260 Ma.

Figure 42: Dorsal and lateral views of the skull of *Diictodon feliceps*, the commonest small-bodied dicynodont from the *Endiothiodon* AZ (From Kammerer *et al.* 2020). Numerous skulls as well as distinctive helical burrow casts of this animal have been recorded in the region to the south of Beaufort West.

5. RESULTS FROM PALAEONTOLOGICAL SITE VISIT, CONCLUSIONS & RECOMMENDATIONS FOR EMPR

GPS locality details of fossil material recorded during the recent site visit (Figs. 43 to 49 and satellite map Figure A1) are tabulated in Appendix 1 with a short description and indication of its palaeontological heritage significance (Provisional Field Rating).

5.1. Bulskop PV cluster project area

Lower Beaufort Group sedimetary bedrocks are not exposed at all within the project areas for the PV facilities due to the thick capping of Late Caenozoic calcrete and overlying sandy to gravelly deposits associated with the ancient (possibly Miocene) land surface of the Aberdeen *Vlaktes*. No fossils of any sort- including the most likely candidates, blocks or resistant-weathering silicified wood reworked into surface gravels - were recorded within the PV cluster project area. Vertical sections through the calcrete hard pan along the escarpment edge to the west of the PV cluster project area also yielded no fossil remains. Fossils which might be anticipated here include calcretised termitaria, rhizoliths (plant root casts) and gastropod shells. Cross-bedded Lower Beaufort Group channel sandstone exposed intermittently along the escarpment edge contain low-diversity trace fossil assemblages (horizontal and oblique burrows) of the *Scoyenia* Ichnofacies – possibly attributable to burrowing insects in damp substrates – and possible vertical casts of reedy plant stems (unconfirmed) (Fig. 47). None of these fossils are of high scientific or conservation value (Proposed Field Rating IIIC Local Resource) and the known fossil site lies just outside the project area so no mitigation is required here.

It is concluded that the Bulskop PV cluster project area is of LOW palaeosensitivity. There are no fatal flaws or objections to authorisation of the proposed projects on palaeontological heritage grounds. No further specialist palaeontological studies or mitigation are recommended for these renewable energy projects. The Chance Fossil Finds Protocol appended to this report should be included in the EMPr for the developments.

5.2. Grid connection corridor

Many sectors of the the grid connection corridor to the Droerivier Substation look palaeontologically promising on satellite imagery (Figure 1). However, in practice Beaufort Group bedrock exposure here - especially of less resistant mudrock facies that are the principal focus for palaeontological surveying - is very limited due to extensive cover by colluvial and alluvial sediments.

A few gentle hillslope exposures of Poortjie Member mudrocks on Portion 4 of Farm 169 Hansrivier have yielded several skull and post-cranial remains of small-bodied dicynodonts (Figs. 45 & 46). These are probably *Diictodon*, the commonest tetrapod in the *Lycosuchus* – *Eunotosaurus* Subzone (Day & Smith 2020). In contrast, other excellent exposures appear to be palaeontologically barren (Figs. 17 & 18). Several reworked ("rolled") blocks of robust tetrapod bone are recorded among surface gravels on the margins of the grid connection corridor, especially in areas rich in ferruginous carbonate pedocrete concretions (Figs. 43 & 44) - and doubtless additional, unrecorded specimens occur elsewhere within the corridor. The reworked fossil material is probably unidentifiable – the robustly-built dicynodont *Endothiodon* is one likely candidate - and of limited scientific or conservation value. The only fossils recorded within Late Caenozoic superficial sediments within or close to the grid corridor comprise occasional calcretised termitaria (termite nests) within younger alluvial sediments of

Pleistocene or Holocene age (Figs. 48 & 49). The fossil material recorded all lies close to but *outside* the grid connection corridor (See satellite map Fig. A1).

Given the very sparse occurrence of recorded fossils in the region, and their unpredictable occurrence, it is concluded that the Bulskop PV cluster grid connection project area is of LOW palaeosensitivity. No further specialist palaeontological studies or mitigation are recommended for this electrical infrastructure project. The Chance Fossil Finds Protocol appended to this report should be included in the EMPr for the developments.

5.3. Site Sensitivity Verification

As motivated above, the provisional palaeosensitivity mapping for the Bulskop PV Cluster and associated grid connection corridor (Fig. 39), based on the DFFE Screening Tool and SAHRIS website, is *contested* here. Potentially-fossiliferous Lower Beaufort Group sediments are not exposed in the PV cluster project area while the surface cover of Late Caenozoic calcretes, surface gravels and finer-grained soils are generally of low palaeosensitivity in the Great Karoo region. Beaufort Group bedrocks are likewise poorly exposed along much of the grid connection corridor and conservation-worthy fossils here are very sparse indeed. An overall LOW palaeosensitivity for the combined PV cluster and grid connection project areas is inferred here, although the potential for isolated vertebrate fossil finds of high scientific interest – as recorded elsewhere in the Beaufort West region - cannot be completely discounted.

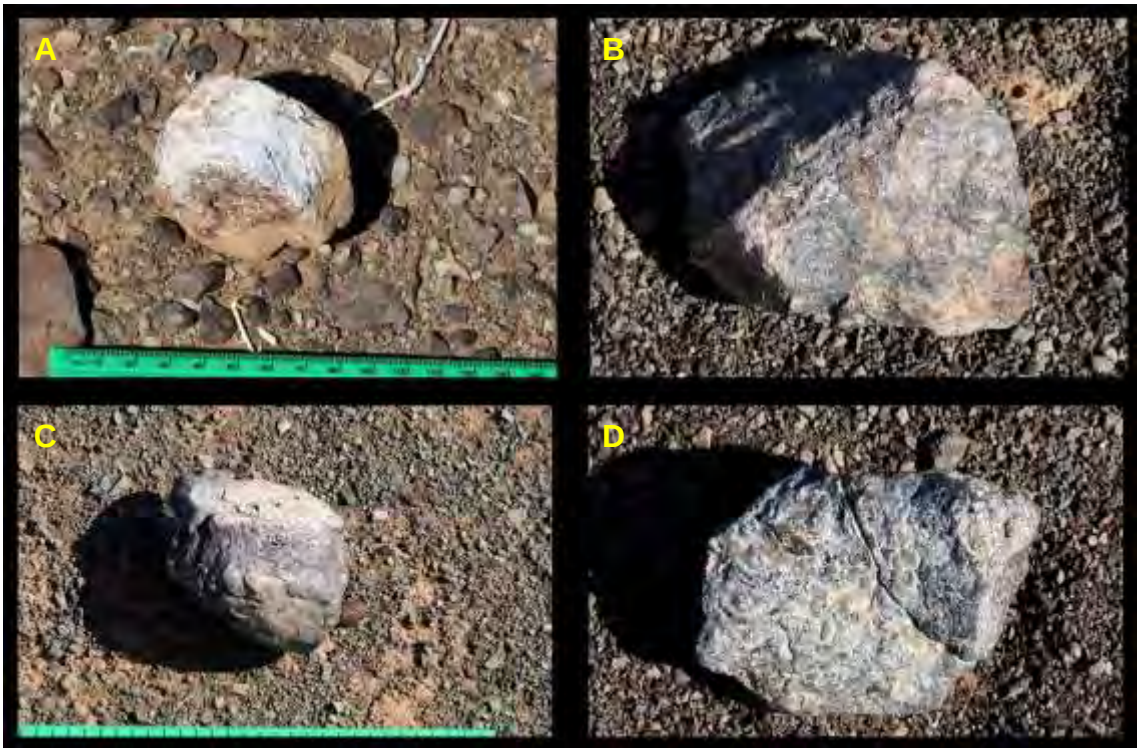

Figure 43: Fragments of robust rolled bones of sizeable-bodied tetrapods found among surface gravels dominated by ferruginous carbonate pedogenic concretions. A: Portion 4 of Farm 169 Hansrivier (Loc. 345). B – D: Portion 1 of Farm Steenrotsfountain No 168 (Locs. 340, 341) (Specimens B, D are *c.* 7 cm across).

Figure 44: Surface scatters of ferruginous calcrete concretions within the Poortjie Member occasionally yield vertebrate fossil remains, such as the rolled tetrapod bone indicated by the yellow arrow (Scale = 15 cm). The specimen is shown above in Figure 43A. The other pale clasts seen here are covered by grey lichen.

Figure 45: Small pedogenic calcrete concretions weathering out from grey overbank mudrocks of the Lower Beaufort Group and containing skulls of small-bodied dicynodonts (probably *Diictodon*) and disarticulated postcranial remains, Portion 4 of Farm 169 Hansrivier (Loc. 354). Specimen on lower RHS is *c*. 4 cm across (see following figure).

Figure 46: Close-up of the snout of a small dicynodont (probably *Diictodon;* compare Fig. 42), showing the toothless, boat-shaped lower jaw and upper jaw with large canine tusk (arrowed) - possibly a sexually dimorphic character. Portion 4 of Farm 169 Hansrivier (Loc. 354). Specimen is *c*. 4 cm across in this view.

Figure 47: Lower Beaufort Group ripple cross-laminated channel sandstones of the Lower Beaufort Group with small scale invertebrate burrows (*Scoyenia* ichnofacies), perhaps accompanied by reedy plant stem casts, Remaining Extent of Farm 423 (Loc. 322) (Scale in cm and mm).

Figure 48: Poorly-preserved, calcretised termitarium (arrowed) weathering-out from within sandy to fine gravelly stream alluvium, probably Pleistocene to Holocene in age, on Portion 4 of Farm 169 Hansrivier (Loc. 351) (See following figure for more detail).

Figure 49: Close-up of calcified subfossil termitarium shown in the previous figure (Scale is *c*. 15 cm long).

6. KEY REFERENCES

ALMOND, J.E. 2006. Karoo National Park, Beaufort West: palaeontological scoping of proposed tourist route, 27 pp plus plates. *Natura Viva* cc, Cape Town.

ALMOND, J.E. 2008. Damkoppie housing development, Beaufort West: palaeontological impact assessment, 12 pp. Natura Viva cc, Cape Town.

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

ALMOND, J.E. 2010b. Proposed wind farm development, Beaufort West Municipality, Western Cape, 34pp. Natura Viva cc.

ALMOND, J.E. 2010c. Palaeontological impact assessment: pre-scoping desktop study. Proposed Mainstream wind farm to the south of Beaufort West, Western Cape, 19 pp. Natura Viva cc., Cape Town.

ALMOND, J.E. 2010d. Areas proposed for low-cost housing, Beaufort West, Western Cape Province. Palaeontological impact assessment: combined desktop & scoping study, 19 pp. Natura Viva cc, Cape Town.

ALMOND, J.E. 2011a. Proposed Photovoltaic Power Facility, Farm Steenrotsfontein 168, Beaufort West Municipality, Western Cape Province. Palaeontological impact assessment: desktop study, 23 pp. Natura Viva cc, Cape Town.

ALMOND, J.E. 2011b. Proposed windfarm development, Beaufort West Municipality, Western Cape. Palaeontological specialist study: combined desktop & field-based assessment, 27 pp. Natura Viva cc, Cape Town.

ALMOND, J.E. 2012. Proposed Photovoltaic Solar Plant, Erf 7388, Beaufort West Municipality, Western Cape. Palaeontological assessment: combined desktop & field study, 29 pp. Natura Viva cc.

ALMOND, J.E. 2014. Proposed Droërivier Solar Facility, Portion 55 of Farm 168 Steenrotsfontein and a portion of Portion 10 of Farm 170 Weltevreden, Beaufort West Municipality, Western Cape. Palaeontological impact assessment: combined desktop & field-based study, 53 pp. Natura Viva cc, Cape Town.

ALMOND, J.E. 2015g. Proposed Gunstfontein Wind Energy Facility near Sutherland, Karoo Hoogland Local Municipality, Northern Cape Province. Palaeontological heritage assessment: combined desktop & field-based study, 62 pp. Natura Viva cc, Cape Town.

ALMOND, J.E. 2018. Proposed Trakas and Beaufort West 140 MW Wind Farms and associated electrical infrastructure near Beaufort West, Central Karoo District, Western Cape. Combined desktop and field-based study, 61 pp. Natura Viva cc, Cape Town.

ALMOND, J.E. 2020a. Lombardskraal Renewable Energy Facility project area, Beaufort West, Western Cape. Palaeontological heritage site sensitivity assessment: combined desktop & field-based study, 22 pp. Natura Viva cc, Cape Town.

ALMOND, J.E. 2020b. Grid connection for the proposed Redcap Nuweveld Wind Farms, Beaufort West Local Municipality, Central Karoo District Municipality, Western Cape. Palaeontological heritage assessment: desktop and field-based report, 101 pp. Natura Viva cc Cape Town.

ALMOND, J.E. 2021a. Proposed Development of the Kwagga 1 Wind Energy Facility near Beaufort West in the Central Karoo District, Western Cape. Palaeontological heritage: combined desktop & field-based screening study & site sensitivity verification, 18 pp. Natura Viva cc, Cape Town.

ALMOND, J.E. 2021b. Proposed Development of the Kwagga 2 Wind Energy Facility near Beaufort West in the Central Karoo District, Western Cape. Palaeontological heritage: combined desktop & field-based screening study & site sensitivity verification, 17 pp. Natura Viva cc, Cape Town.

ALMOND, J.E. 2021c. Proposed Development of the Kwagga 3 Wind Energy Facility near Beaufort West in the Central Karoo District, Western Cape. Palaeontological heritage: combined desktop & field-based screening study & site sensitivity verification, 18 pp. Natura Viva cc, Cape Town.

ALMOND, J.E. & PETHER, J. 2008. Palaeontological heritage of the Western Cape. Interim SAHRA technical report, 20 pp. Natura Viva cc., Cape Town.

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

BENDER, P.A. 2004. Late Permian actinopterygian (palaeoniscid) fishes from the Beaufort Group, South Africa: biostratigraphic and biogeographic implications. Council for Geoscience Bulletin 135, 84 pp.

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

BLACKWELL, L., STEININGER, C., NEVELING, J. ABDALA, F., PEREIRA, L., MAYER, E., ROSSOUW, L., DE LA PEÑA P. & BRINK, J. 2017. Holocene large mammal mass death assemblage from South Africa. Quaternary International xxx (2017), p1-15.

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

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

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

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

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

COLE, D.I. AND WIPPLINGER, P.E. 2001, Sedimentology and molybdenum potential of the Beaufort Group in the main Karoo Basin, South Africa, Council for Geoscience Memoir, South Africa 80, 225 pp.

CTS 2021a. Proposed development of the Bulskop PV Cluster and associated infrastructure on Remaining Extent (Portion 0) of Farm 423 near Beaufort West, Western Cape. Heritage Screener, 25 pp. CTS Heritage, Cape Town.

CTS 2021b. Proposed development of grid connection infrastructure for the Bulskop PV Cluster near Beaufort West, Western Cape. Heritage Screener, 28 pp. CTS Heritage, Cape Town.

DAY, M.O., GÜVEN, S., ABDALA, F., JIRAH, S., RUBIDGE, B. & ALMOND, J. 2015a. Youngest dinocephalian fossils extend the *Tapinocephalus* Zone, Karoo Basin, South Africa Research Letter, South African Journal of Science 111, 5 pp.

DAY, M.O., RAMEZANI, J., BOWRING, S.A., SADLER, P.M., ERWIN, D.H., ABDALA, F. & RUBIDGE, B.S. 2015b. When and how did the terrestrial mid-Permian mass extinction occur? Evidence from the tetrapod record of the Karoo Basin, South Africa. Proc. R. Soc. B 282: 20150834. http://dx.doi.org/10.1098/rspb.2015.0834

DAY, M.O. & SMITH, R.M.S. 2020. Biostratigraphy of the *Endothiodon* Assemblage Zone (Beaufort Group, Karoo Supergroup), South Africa. South African Journal of Geology 123, 164 - 180.

DAY, M.O. & RUBIDGE, B.S. 2021. The Late Capitanian mass extinction of terrestrial vertebrates in the Karoo Basin of South Africa. Froniers in Earth Science 9, article 631198, 15 pp.

DE RUITER, D.J., BROPHY, J.K., LEWIS, P.J., KENNEDY, A.M., STIDHAM, T.A., CARLSON, K.B. & HANCOX, P.J. 2010. Preliminary investigation of Matjhabeng, a Pliocene fossil locality in the Free State of South Africa. Palaeontologia Africana 45, 11-22.

HERITAGE WESTERN CAPE 2016. Guide for minimum standards for archaeology and palaeontology reports submitted to Heritage Western Cape, 4 pp.

HERITAGE WESTERN CAPE 2021. Guide for minimum standards for archaeology and palaeontology reports submitted to Heritage Western Cape - June 2021, 6 pp.

JOHNSON, M.R. & KEYSER, A.W. 1979. The geology of the Beaufort West area. Explanation of geological Sheet 3222, 14 pp. Council for Geoscience, Pretoria.

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

KAMMERER C.F., DEUTSCH M., LUNGMUS J.K. & ANGIELCZYK KD. 2020. Effects of taphonomic deformation on geometric morphometric analysis of fossils: a study using the dicynodont *Diictodon feliceps* (Therapsida, Anomodontia). PeerJ 8:e9925 DOI 10.7717/peerj.9925

KEYSER, A. W. 1966. Some indications of arid climate during the deposition of the Beaufort Series. Annals of the Geological Survey of South Africa 5,77–79.

KEYSER, A.W. & SMITH, R.M.H. 1977-78. Vertebrate biozonation of the Beaufort Group with special reference to the Western Karoo Basin. Annals of the Geological Survey of South Africa 12: 1-36.

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

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

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

MARCHETTI L. et al. 2019. Permian-Triassic vertebrate footprints from South Africa: Ichnotaxonomy, producers and biostratigraphy through two major faunal crises. Gondwana Research 72, 139-168.

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

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

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

PAIVA, F., 2015. Fluvial facies architecture and provenance history of the Abrahamskraal-Teekloof Formation transition (Lower Beaufort Group) in the main Karoo Basin. Unpublished M.Sc. dissertation, University of Cape Town, Cape Town, 98pp.

PARTRIDGE, T.C. & MAUD, R.R. 1987. Geomorphic evolution of southern Africa since the Mesozoic. South African Journal of Geology 90: 179-208.

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

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

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

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

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

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

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

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

SMITH, R.M.H. & KEYSER, A.W. 1995b. Biostratigraphy of the *Pristerognathus* Assemblage Zone. Pp. 13-17 in Rubidge, B.S. (ed.) Biostratigraphy of the Beaufort Group (Karoo Supergroup). South African Committee for Stratigraphy, Biostratigraphic Series No. 1. Council for Geoscience, Pretoria.

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

SMITH, R.M.S. *et al.* 2020. Introduction to the tetrapod biozonation of the Karoo Supergroup. South African Journal of Geology 123, 131-140 • doi:10.25131/sajg.123.0009.

VAN DER WALT, J. 2019. Phase 2 Strategic Environmental Assessment for Wind and Solar Photovoltaic Energy Development in South Africa. Appendix A3. Heritage Scoping Assessment Report, 65 pp. CSIR.

7. ACKNOWLEDGEMENTS

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8. 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: BULSKOP PV SOLAR CLUSTER & GRID CONNECTION FOSSIL SITE DATA – SEPTEMBER 2021

All GPS readings were taken in the field using a hand-held Garmin GPSmap 64s 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 only those sites recorded during the field survey. The absence of recorded fossil sites in any area therefore does *not* mean that no fossils are present there.
- The detailed stratigraphic data for each site is provisional and has yet to be confirmed.

Loc.	GPS data	Comments
322	32°23'31.87"S 22°41'52.17"E	Remaining Extent of Farm 423. Lower Beaufort Group ripple cross-laminated channel sandstones with small scale invertebrate burrows (*Scoyenia* ichnofacies), perhaps accompanied by reedy plant stem casts. Proposed Field Rating IIIC Local Resource. No mitigation necessary since fossil site lies outside project footprint.
340	32°24'16.60"S 22°33'51.36"E	Portion 1 of Farm Steenrotsfountain No 168. Pebble-sized, well-rounded fragment of rolled bone of sizeable Permian tetrapod among surface gravels dominated by ferruginous carbonate concretions. Proposed Field Rating IIIC Local Resource. No mitigation necessary since fossil site lies outside project footprint.
341	32°24'16.12"S 22°33'50.26"E	Portion 1 of Farm Steenrotsfountain No 168. Two subrounded fragments of rolled bone of sizeable Permian tetrapod (possibly same individual as above) among surface gravels dominated by ferruginous carbonate concretions. Proposed Field Rating IIIC Local Resource. No mitigation necessary since fossil site lies outside project footprint.
345	32°24'14.34"S 22°34'37.34"E	Portion 4 of Farm 169 Hansrivier. Pebble-sized, well-rounded fragment of rolled bone of sizeable Permian tetrapod among surface gravels dominated by ferruginous carbonate concretions. Proposed Field Rating IIIC Local Resource. No mitigation necessary since fossil site lies outside project footprint.
351	22°35'21.46"E 22°35'21.46"E	Portion 4 of Farm 169 Hansrivier. Poorly-preserved, calcretised termitarium weathering-out from within sandy to fine gravelly stream alluvium. Probably Pleistocene to Holocene in age. Proposed Field Rating IIIC Local Resource. No mitigation necessary since fossil site lies outside project footprint.
354	32°24'20.75"S 22°36'0.73" E	Portion 4 of Farm 169 Hansrivier. Small pedogenic calcrete concretions weathering out from grey overbank mudrocks of the Lower Beaufort Group and containing skulls of small-bodied dicynodonts (probably *Diictodon*) and disarticulated postcranial remains. Proposed Field Rating IIIB Local Resource. No mitigation necessary since fossil site lies outside project footprint.
358	32°24'3.07"S 22°37'16.15"E	Portion 4 of Farm 169 Hansrivier. Well-developed, reddish-brown Lower Beaufort Group channel breccias composed of reworked mudflake intraclasts as well as calcrete nodules with occasional interspersed small fragments of reworked bone (unidentifiable). Proposed Field Rating IIIC Local Resource. No mitigation necessary.

Figure A1: Google Earth© satellite image of the region south of Beaufort West in the Great Karoo region of the Western Cape, showing the five solar photovoltaic (PV) facility project areas of the Bulskop PV Cluster on the Remaining Extent (Portion 0) of Farm 423 (large red polygon) as well as the grid connection corridor to the existing Droërivier MTS to the southwest of Beaufort West (narrow red polygon). The sparse fossil sites recorded during the palaeontological site visit are indicated by the yellow numbered circles (See table above for details). The sites all lie on the margins of, or shortly outside, the project footprint and no mitigation in their regard is recommended here.

APPENDIX 2: CHANCE FOSSIL FINDS PROTOCOL

<table>
<tr><th colspan="3">Bulskop PV Solar Cluster and associated 132 kV grid connection to Droërivier MTS Substation near Beaufort West</th></tr>
<tr><td>Province & region:</td><td colspan="2">Western Cape (Central Karoo District): Beaufort West Municipality</td></tr>
<tr><td>Responsible Heritage Resources Agency</td><td colspan="2">Heritage Western Cape (Contact details: Heritage Western Cape. 3rd Floor Protea Assurance Building, 142 Longmarket Street, Green Market Square, Cape Town 8000. Private Bag X9067, Cape Town 8001. Tel: 021 483 5959 Email: ceoheritage@westerncape.gov.za)</td></tr>
<tr><td>Rock unit(s)</td><td colspan="2">Teekloof Formation / Poortjie Member (Lower Beaufort Group), Late Caenozoic alluvium, colluvium, calcrete pedocretes, surface gravels & soils</td></tr>
<tr><td>Potential fossils</td><td colspan="2">Fossil vertebrate bones, teeth, trace fossils (e.g. vertebrate 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. termiytaria, 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 fo 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>