SiVEST SA (PTY) LTD

PROPOSED CONSTRUCTION OF THE PATATSKLOOF WIND ENERGY FACILITY, BATTERY ENERGY STORAGE SYSTEM (BESS) AND ASSOCIATED GRID INFRASTRUCTURE, NEAR CERES, WESTERN CAPE PROVINCE, SOUTH AFRICA

Palaeontological Heritage Report

DFFE Reference:	**TBA**
Report Prepared by:	**Dr John E. Almond**
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PALAEONTOLOGICAL HERITAGE REPORT

EXECUTIVE SUMMARY

South Africa Mainstream Renewable Power Developments (Pty) Ltd is proposing to develop the Patatskloof Wind Energy Facility (WEF), Battery Energy Storage System (BESS) and associated grid infrastructure on a site in the Ceres Karoo located approximately 20km northeast of Touwsrivier in the Cape Winelands District Municipality, Western Cape Province. The WEF will comprise up to thirty-five wind turbines with a maximum total energy generation capacity of up to approximately 250MWac. The electricity generated will be fed into the national grid *via* a 132kV overhead power line to either Kappa Substation or Adamskraal substation in the Ceres Karoo. The Patatskloof WEF, BESS and grid connection project areas lie within the Komsberg Renewable Energy Development Zone (REDZ 2).

The Patatskloof WEF, BESS and grid connection project areas are underlain by several basinal to shallow marine sedimentary formations of the Witteberg Group (Cape Supergroup), Dwyka Group and Ecca Group (Karoo Supergroup) of Palaeozoic age. All these units are potentially fossiliferous but only two – the Early Carboniferous Waaipoort Formation and the Early Permian Whitehill Formation – are generally regarded as of high palaeosensitivty due to their record of well-preserved fish, mesosaurid reptiles, crustaceans and plant fossils in the Tanqua - Ceres Karoo region and elsewhere. A recent 2-day palaeontological field survey shows that the Waaipoort Formation is very poorly exposed within the WEF project area, although potentially fossiliferous phosphatic carbonate concretions do occur here, while the uppermost several meters of the Whitehill Formation are intensely weathered. The only fossil remains recorded during the site visit comprise (a) occasional stromatolitic carbonate erratics within the Dwyka Group and (2) low-diversity, poorly-preserved trace fossil assemblages in the Floriskraal and Collingham Formations. These fossils occur widely within the outcrop areas of the formations concerned and are not of high scientific interest or conservation value. Desktop reviews of several previous palaeontological assessment reports relevant to the grid connection project area show that the bedrocks here are likewise of low palaeosensitivity with no significant fossil sites recorded within the various grid corridors under consideration.

As a consequence of (1) the paucity of irreplaceable, unique or rare fossil remains within the WEF and grid connection project areas, as well as (2) the extensive superficial sediment cover overlying most potentially-fossiliferous bedrocks here, the overall impact significance of the construction phase of the

proposed Patatskloof WEF, BESS and grid connection regarding legally-protected palaeontological heritage resources is assessed as ***LOW*** (*negative status*), with and without mitigation. This assessment applies equally to all layout alternatives and grid connection options under consideration. There is therefore no preference on palaeontological heritage grounds for any specific layout (*e.g.* location of on-site substation, construction laydown area, grid connection corridor) among those under consideration. No significant further impacts on fossil heritage are anticipated during the operational and decommissioning phases of the renewable energy developments. The No-Go alternative (*i.e.* no WEF / grid development) would probably have a neutral impact on palaeontological heritage.

No palaeontological High Sensitivity or No-Go areas have been identified within the WEF, BESS and grid connection project areas. None of the recorded fossil sites lies within the development footprint as currently defined. Pending the potential discovery of significant new fossil material here during the construction phase, no specialist palaeontological monitoring or mitigation is recommended for these developments.

Inevitable loss of some fossil heritage during the construction phase may be - at least partially - offset by an improved understanding of local palaeontological heritage through professional recording and mitigation of any significant new fossil finds (This may be considered as a *positive* impact).

Due to the generally low palaeosensitivity of the Ceres Karoo as a whole, anticipated cumulative impacts of the known renewable energy projects proposed or authorised in the region are assessed as ***LOW*** *(negative)* with and without mitigation. It is concluded that, as far as fossil heritage resources are concerned, the proposed Patatskloof WEF, BESS and grid connection projects, whether considered individually or together, will not result in any unacceptable loss or impact considering all the renewable energy projects proposed in the area. This analysis only applies *provided that* all the proposed monitoring and mitigation recommendations made for the other renewable energy projects proposed or authorised in the Ceres Karoo are fully and consistently implemented.

Recommended mitigation comprises:

(1) The Environmental Site Officer (ESO) should be made aware of the possibility of important fossil remains (bones, teeth, fish, petrified wood, plant-rich horizons *etc*) being found or unearthed during the construction phase of the development.

(2) Monitoring for fossil material of all major surface clearance and deeper (> 1m) excavations by the Environmental Site Officer on an on-going basis during the construction phase is therefore recommended.

(3) Significant fossil finds should be safeguarded and reported at the earliest opportunity to Heritage Western Cape for recording and sampling by a professional palaeontologist.

(4) A protocol for Chance Fossil Finds is appended to this report (Appendix 2). These recommendations must be included within the Environmental Management Programmes (EMPrs) for the Patatskloof WEF, BESS and grid connection developments.

Conclusion

There are no fatal flaws in the Patatskloof WEF, BESS and grid development proposals as far as fossil heritage is concerned. Provided that these monitoring and mitigation measures are followed through, residual impacts for the Patatskloof WEF, BESS and grid projects are rated as **LOW**. There are no objections on palaeontological heritage grounds to authorization of the proposed Patatskloof WEF, BESS and the associated grid connection.

This palaeontological impact assessment - including the tables provided in Sections 6 and 7 of the report – together with recommendations for the Environmental Management Programme apply to the final proposed layouts of the Patatskloof WEF (with refined buildable areas as shown in **Figure *60*** at the end of this report) and the associated Grid Connection.

NATIONAL ENVIRONMENTAL MANAGEMENT ACT, 1998 (ACT NO. 107 OF 1998) AND ENVIRONMENTAL IMPACT REGULATIONS, 2014 (AS AMENDED) - REQUIREMENTS FOR SPECIALIST REPORTS (APPENDIX 6)

Regulation GNR 326 of 4 December 2014, as amended 7 April 2017, Appendix 6	**Section of Report**
1. (1) A specialist report prepared in terms of these Regulations must contain- a) details of- i. the specialist who prepared the report; and ii. the expertise of that specialist to compile a specialist report including a curriculum vitae;	**1.2 & Appendix 1**
b) a declaration that the specialist is independent in a form as may be specified by the competent authority;	**Appendix 5**
c) an indication of the scope of, and the purpose for which, the report was prepared;	**1.1**
(cA) an indication of the quality and age of base data used for the specialist report;	**1.3.1.**
(cB) a description of existing impacts on the site, cumulative impacts of the proposed development and levels of acceptable change;	**5**
d) the date and season of the site investigation and the relevance of the season to the outcome of the assessment;	**1.3.1.**
e) a description of the methodology adopted in preparing the report or carrying out the specialised process inclusive of equipment and modelling used;	**1.3.1.**
f) details of an assessment of the specific identified sensitivity of the site related to the proposed activity or activities and its associated structures and infrastructure, inclusive of a site plan identifying site alternatives;	**3.2 & 6**
g) an identification of any areas to be avoided, including buffers;	N/A
h) a map superimposing the activity including the associated structures and infrastructure on the environmental sensitivities of the site including areas to be avoided, including buffers;	**Figure *61***
i) a description of any assumptions made and any uncertainties or gaps in knowledge;	**2**
j) a description of the findings and potential implications of such findings on the impact of the proposed activity, (including identified alternatives on the environment) or activities;	**5,6, & 7**

k) any mitigation measures for inclusion in the EMPr;	**8 & Appendix 4**
l) any conditions for inclusion in the environmental authorisation;	**8**
m) any monitoring requirements for inclusion in the EMPr or environmental authorisation;	**8 & Appendix 4**
n) a reasoned opinion- i. (as to) whether the proposed activity, activities or portions thereof should be authorised; (iA) regarding the acceptability of the proposed activity or activities; and ii. if the opinion is that the proposed activity, activities or portions thereof should be authorised, any avoidance, management and mitigation measures that should be included in the EMPr, and where applicable, the closure plan;	**9**
o) a description of any consultation process that was undertaken during the course of preparing the specialist report;	**n/a**
p) a summary and copies of any comments received during any consultation process and where applicable all responses thereto; and	**n/a**
q) any other information requested by the competent authority.	None to date
2) Where a government notice *gazetted* by the Minister provides for any protocol or minimum information requirement to be applied to a specialist report, the requirements as indicated in such notice will apply.	-

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List of Abbreviations

amsl	above mean sea level
BESS	Battery Energy Storage System
DFFE	Department of Forestry, Fisheries and the Environment
ECO	Environmental Control Officer
EMPr	Environmental Management Programme
ESO	Environmental Site Officer
GPS	Global Positioning System
HWC	Heritage Western Cape
Ma	millions of years ago
Mainstream	South Africa Mainstream Renewable Power Developments (Pty) Ltd
NEMA	National Environmental Management Act
O&M	Operation and Maintenance
PGS	PGS Heritage (Pty) Ltd
PIA	palaeontological heritage impact assessment
REIPPPP	Renewable Energy Independent Power Producer Procurement Programme
SAHRA	South African Heritage Resources Agency
SAHRIS	South African Heritage Resources Information System
SiVEST	SiVEST (PTY) Ltd
WEF	Wind Energy Facility

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PALAEONTOLOGICAL HERITAGE REPORT

1. INTRODUCTION

South Africa Mainstream Renewable Power Developments (Pty) Ltd (hereafter referred to as “Mainstream”), has appointed SiVEST SA (Pty) Ltd (hereafter referred to as “SiVEST”) to undertake the required Basic Assessment (BA) Processes for the proposed construction of the 250MWac Patatskloof WEF, Battery Energy Storage System (BESS) and associated grid infrastructure near Touwsrivier in the Western Cape Province. PGS Heritage (Pty) Ltd (PGS) was appointed by SiVEST to undertake the specialist studies for the development of the Patatskloof WEF, and John Almond was appointed by PGS to conduct the Palaeontological Impact Assessment (PIA).

The overall objective of the development is to generate electricity by means of renewable energy technology capturing wind energy to feed into the National Grid.

It is anticipated that the proposed Patatskloof WEF will comprise thirty-five (35) wind turbines with a maximum total energy generation capacity of up to approximately 250MWac. The electricity generated by the proposed WEF development will be fed into the national grid via a 132kV overhead power line.

In terms of the Environmental Impact Assessment (EIA) Regulations, which were published on 04 December 2014 [GNR 982, 983, 984 and 985) and amended on 07 April 2017 [promulgated in Government Gazette 40772 and Government Notice (GN) R326, R327, R325 and R324 on 7 April 2017], various aspects of the proposed development are considered listed activities under GNR 327 and GNR 324 which may have an impact on the environment and therefore require authorisation from the National Competent Authority (CA), namely the Department of Forestry, Fisheries and the Environment, (DFFE), prior to the commencement of such activities. Specialist studies have been commissioned to assess and verify the project under the new Gazetted specialist protocols.

The proposed WEF, BESS and associated grid infrastructure is located within the Komsberg Renewable Energy Development Zone (REDZ 2), as published in terms of Section 24(5) of the National Environmental Management Act, 1998 (NEMA) in GN R114 of 16 February 2018. A BA process as contemplated in terms of regulation 19 and 20 of the EIA Regulations, 2014, is required for the authorization of this large scale WEF.

Accordingly, a BA process as contemplated in terms of the EIA Regulations (2014, as amended) is being undertaken in respect of the proposed WEF project.

Grid connection infrastructure for the WEF will be subject to a separate BA Process as contemplated in terms of regulation 19 and 20 of the Environmental Impact Assessment Regulations, 2014, which is currently being undertaken in parallel to the WEF BA process.

1.1 Terms of Reference

The present combined desktop and field-based Palaeontological Impact Assessment (PIA) report assesses potential impacts to palaeontological heritage resources that may result from the proposed Patatskloof WEF, BESS and its associated grid connection. It will contribute to the over-arching Heritage Impact Assessments, co-ordinated by PGS Heritage and SiVEST Environmental Division, as part of the two separate BA processes that are being conducted for these developments as well as to the relevant Environmental Management Programmes (EMPrs).

1.2 Specialist Credentials

The author, Dr John Almond, is a specialist palaeontologist who has over 40 years of experience in palaeontological research and teaching in Europe, South Africa and elsewhere. He also has more than 20 years of experience in the palaeontological heritage impact assessment world in the RSA and has been involved with numerous PIAs in the Ceres Karoo region and elsewhere (Please see Appendix 1 for a short Specialist CV).

1.3 Assessment Methodology

1.3.1 Information sources

The desktop and field-based palaeontological heritage study of the Patatskloof WEF, BESS and grid connection project areas was based on the following information resources:

1. A detailed project outline, kmz files, screening report and maps provided by SiVEST Environmental Division and PGS Heritage;

2. A desktop review of:

a) the relevant 1:50 000 scale topographic maps (3320AA Brewelsfontein, 3319BB Inverdoorn) and the 1:250 000 scale topographic maps 3220 Ladismith and 3319 Worcester),

b) Google Earth© satellite imagery,

c) published geological and palaeontological literature, including 1:250 000 geological maps (3220 Ladismith, 3319 Worcester) and relevant sheet explanations (Theron et al. 1991, Gresse & Theron 1992) as well as

d) several previous and fossil heritage (PIA) assessments for renewable energy and transmission line projects in the Ceres Karoo region near Touwsrivier by the author and colleagues (*e.g.* Almond 2010a-c, 2015, 2016a-b, 2018, 2020a-d, Almond 2022, Butler 2018);

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 two-day field assessment of the Patatskloof WEF project area, including portions of all land parcels involved, by the author and an experienced field assistant (Ms Madelon Tusenius, Natura Viva cc), during the period 5 and 6 December 2020. Sectors of the Grid Connection project area lying outside the WEF project area itself were *not* re-surveyed but are treated here on a desktop level. This is because the areas concerned have already been well-covered by previous field-based palaeontological heritage studies for earlier renewable energy and transmission line projects (see References under Almond and Butler) and are therefore considered to be well-understood as well as generally of low palaeosensitivity.

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

1.3.2 Study approach

In preparing a palaeontological desktop study the potentially fossiliferous rock units (groups, formations, members etc.) represented within the study area are determined from geological maps and satellite images. The known fossil heritage within each rock unit is inventoried from the published scientific literature, previous palaeontological impact studies in the same region, and the author's field experience (consultation with professional colleagues as well as examination of institutional fossil collections may play a role here, or later following scoping during the compilation of the final report). This data is then used to assess the palaeontological sensitivity of each rock unit to development (provisional tabulations of palaeontological sensitivity of all formations in the Western Cape have already been compiled by J. Almond and colleagues; e.g. Almond & Pether 2008) and are shown on the palaeosensitivity map on the SAHRIS (South African Heritage Resources Information System) website. The likely impact of the development on local fossil heritage is then determined on the basis of (1) the palaeontological sensitivity of the rock units concerned and (2) the nature and scale of the development itself, most notably the extent of fresh bedrock excavation and ground clearance envisaged. When rock units of moderate to high palaeontological sensitivity are present within the development footprint, a field assessment study by a professional palaeontologist is usually warranted.

The focus of palaeontological field assessment is not simply to survey the development footprint or even the development area as a whole (e.g. farms or other parcels of land concerned in the development). Rather, the palaeontologist seeks to assess or predict the diversity, density and distribution of fossils within and beneath the study area, as well as their heritage or scientific interest. This is primarily achieved through a careful field examination of one or more representative exposures of all the sedimentary rock units present (N.B. Metamorphic and igneous rocks rarely contain fossils). The best rock exposures are generally those that are easily accessible, extensive, fresh (*i.e.* unweathered) and include a large fraction of the stratigraphic unit concerned (e.g. formation). These exposures may be natural or artificial and include, for example, rocky outcrops in stream or river banks, cliffs, quarries, dams, dongas, open building excavations or road and railway cuttings. Consolidated as well as uncemented superficial deposits, such as alluvium, scree or wind-blown sands, may occasionally contain fossils and should also be included in the field study where they are well-represented in the study area. It is occasional practice for impact palaeontologists to collect representative, well-localised (*e.g.* GPS and stratigraphic data) samples of fossil material during field assessment studies. In order to do so, a fossil collection permit from Heritage Western Cape (HWC) is required and all fossil material collected must be properly curated within an approved repository (usually a museum or university collection).

Note that while fossil localities recorded during field work within the study area itself are obviously highly relevant, most fossil heritage here is embedded within rocks beneath the land surface or obscured by surface deposits (soil, alluvium, *etc*.) and by vegetation cover. In many cases where levels of fresh (i.e. unweathered) bedrock exposure are low, the hidden fossil resources have to be inferred from palaeontological observations made from better exposures of the same formations elsewhere in the region but outside the immediate study area. Therefore a palaeontologist might reasonably spend far more time examining road cuts and borrow pits close to, but outside, the study area / project footprint than within the study area / project footprint itself. Field data from localities even further afield (e.g. an adjacent province) may also be adduced to build up a realistic picture of the likely fossil heritage within the study area.

Given 1) the large project areas concerned with the Patatskloof WEF project and (2) the extensive superficial sediment cover in this region of the Ceres Karoo, the palaeontological heritage field study largely entailed the examination of selected, representative, potentially fossiliferous sites with good bedrock exposure – especially along drainage lines as well as steeper hillslopes and erosion gullies. A representative selection of good exposures and sections through Late Caenozoic alluvial deposits were also examined. It is emphasised that it is simply not practicable to record all, or even a major portion, of fossil sites within such a large area within the course of a few days' fieldwork, and that the occurrence of fossils at surface in the Ceres Karoo has a large element of unpredictability. Several fossil sites were discovered simply by chance. It is therefore inevitable that the recent site visit can only hope to locate a representative subsample of surface fossil sites present within the WEF project areas. The absence of recorded sites within an area does *not* therefore mean that palaeontologically significant material is not present there, either on or beneath the ground surface.

2. ASSUMPTIONS AND LIMITATIONS

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

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

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

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

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

5. Absence of a comprehensive computerised database of fossil collections in major RSA institutions which can be consulted for impact studies.

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

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

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

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

In the case of the Patatskloof WEF project area bedrock exposure may be good in highly-dissected, hilly regions (mostly outside and south of the project footprint, *e.g.* Bontberg range) but is highly constrained by extensive superficial deposits in the areas of low relief that make up most of the project area, as well as, to a lesser extent, by shrubby karroid vegetation. The project area is very extensive (*c*. 6612 ha) and with comparatively few access roads. Unavoidably, only a small fraction of the entire project area could be surveyed on foot within the time available (2 days).

Nevertheless, sufficient bedrock exposures – including a few of excellent quality - were examined during the course of the two-day field study to assess the palaeontological heritage sensitivity of the main rock units represented within the Patatskloof WEF, BESS and grid connection study area. As previously noted, sectors of the grid connection project area lying outside the WEF project area are treated at a desktop level in the present report since this area and the rock units concerned have already been well-covered by previous PIA reports by the author and colleagues (See References). Confidence levels for this impact assessment are accordingly rated as *medium*.

3. TECHNICAL DESCRIPTION

3.1 Project Location

The proposed Patatskloof WEF and associated grid infrastructure project areas are located approximately 18km and 25km northeast respectively of Touwsrivier in the Western Cape Province and lie within the Witzenberg Local Municipality, in the Cape Winelands District Municipality (**Figure *1***).

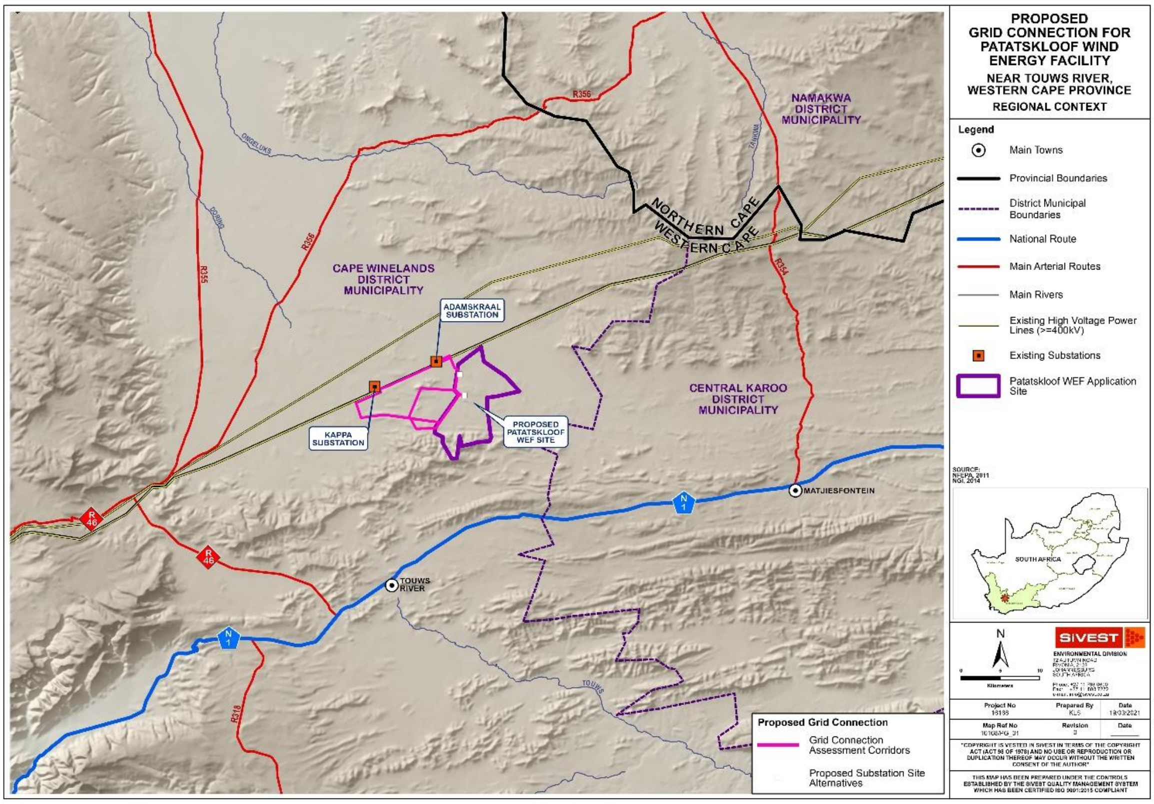

Figure 1: Regional Context Map.

3.1.1 WEF

The WEF application site as shown on the locality map below (**Figure *2***) is approximately 6 612 hectares (ha) in extent and incorporates the following farm portions:

- Remainder of the Farm Upper Stinkfontein No 246
- Remainder of the Farm Upper Melkbosch Kraal No 250; and
- Portion 1 of the Farm Drinkwaters Kloof No 251.

A smaller buildable area (2 905.4 ha) has, however, been identified as a result of a preliminary suitability assessment undertaken by Mainstream and this area is likely to be further refined with the exclusion of sensitive areas determined through various specialist studies being conducted as part of the BA process.

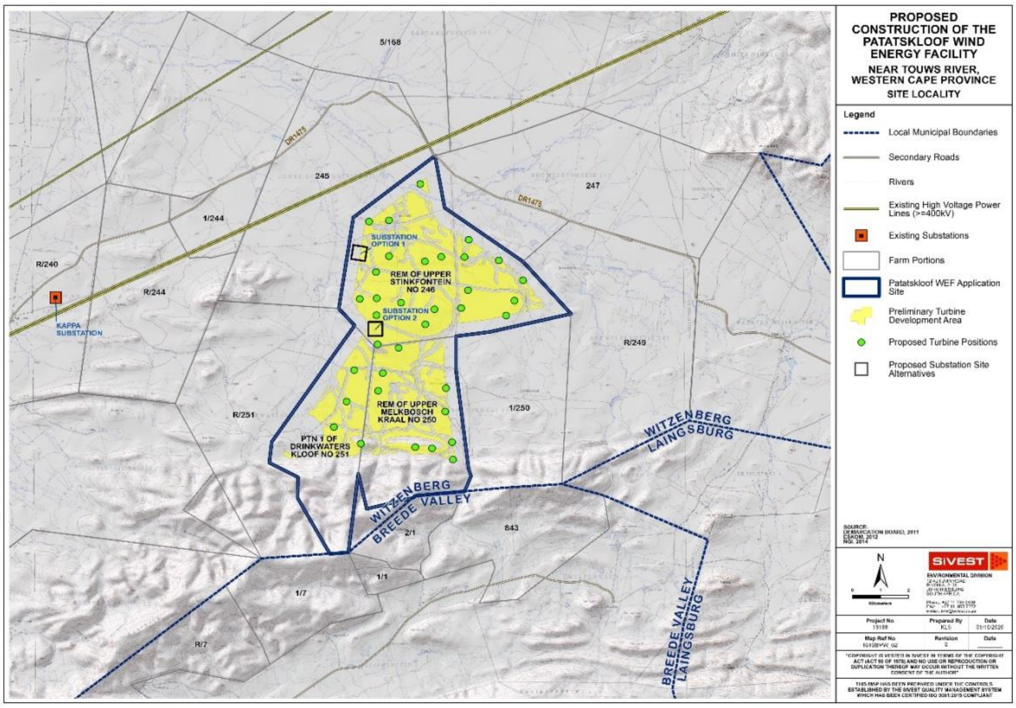

Figure 2: Patatskloof WEF Site Locality.

3.1.2 Grid Connection

At this stage, it is proposed that the 132kV power lines will connect the Patatskloof WEF on-site substation to the national grid, either *via* Kappa Substation or *via* the Adamskraal substation (**Figure 3**). The following properties are affected by the proposed grid connection:

- Remainder Of The Farm Upper Stinkfontein No 246;
- Remainder Of The Farm Melkbosch Kraal No 250;
- Portion 1 Of The Farm Drinkwaters Kloof No 251;
- Farm Platfontein No 240;
- Portion 1 Of The Farm Tooverberg No 244;
- Remainder Of The Farm Tooverberg No 244;
- Farm Lower Stinkfontein No 245;
- Remainder Of The Farm Drinkwaters Kloof No 251;and
- Remainder Of The Farm Zand Rivier No 252.

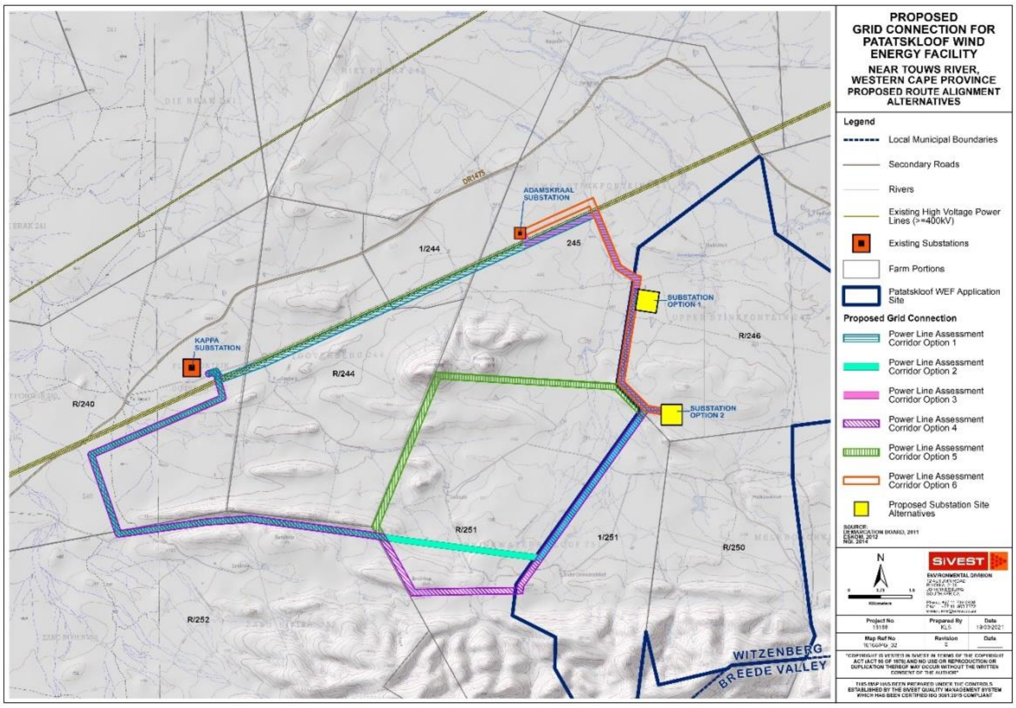

Figure 3: Proposed 132kV Power Line Route Alignment.

3.2 Project Description

It is anticipated that the proposed Patatskloof WEF will comprise up to thirty-five (35) wind turbines with a maximum total energy generation capacity of up to approximately 250MWac. The electricity generated by the proposed WEF development will be fed into the national grid *via* a 132kV overhead power line. The 132kV overhead power line will however require a separate EA and is subject to a separate BA process, which is currently being undertaken in parallel to the WEF BA process.

3.2.1 Wind Farm Components

- Up to 35 wind turbines, with a maximum export capacity of approximately 250MW. This will be subject to allowable limits in terms of the Renewable Energy Independent Power Producer Procurement Programme (REIPPPP);
- Each wind turbine will have a hub height of between 120m and 200m and rotor diameter of up to approximately 200m;
- Permanent compacted hardstanding areas / platforms (also known as crane pads) of approximately 100m x 100m (total footprint of approx. 100 00m2) per turbine during construction and for on-going maintenance purposes for the lifetime of the proposed development;
- Each wind turbine will consist of a foundation of up to approximately 30m in diameter. In addition, the foundations will be up to approximately 4m in depth;

- Electrical transformers (690V/11 to 33kV) adjacent to each wind turbine (typical footprint of up to approximately 3m x 2.5m) to step up the voltage to between 11kV and 33kV;
- One (1) new 11kV - 33/132kV on-site substation consisting of two (2) portions: IPP portion / yard (33kv portion of the shared 33kv/132kv portion) and an Eskom portion (132kv portion of the shared 33kv/132kv portion) including associated equipment and infrastructure, occupying a total area of approximately 25ha (i.e. 250 000m2) i.e. 15.5 ha for the IPP Portion and 15.5 ha for the Eskom Portion. The Eskom portion will be ceded over to Eskom once the IPP has constructed the onsite substation. The necessary Transfer of Rights will be lodged with DFFE when required;
- A Battery Energy Storage System (BESS) will be located next to the IPP portion / yard of the shared onsite 33/132kV substation and will be included as part of the 15.5ha. The storage capacity and type of technology would be determined at a later stage during the development phase, but most likely comprise an array of containers, outdoor cabinets and/or storage tanks;
- The wind turbines will be connected to the proposed substation *via* 11 to 33kV underground cabling and overhead power lines.
- Road servitude of 8m and a 20m underground cable or overhead line servitude.
- Internal roads with a width of up to approximately 5m will provide access to each wind turbine. Existing site roads will be used wherever possible, although new site roads will be constructed where necessary. Turns will have a radius of up to 50m for abnormal loads (especially turbine blades) to access the various wind turbine positions. It should be noted that the proposed application site will be accessed via the N1 National Route and DR1475, MR316 and MR319 WCG provincial Roads;
- One (1) construction laydown / staging area of up to approximately 3ha to be located on the site identified for the substation. It should be noted that no construction camps will be required in order to house workers overnight as all workers will be accommodated in the nearby town;
- Operation and Maintenance (O&M) buildings, including offices, a guard house, operational control centre, O&M area / warehouse / workshop and ablution facilities to be located on the site identified for the substation. This will be included in the 33kv portion/yard of the substation area i.e.15.5 ha of the IPP portion of the onsite substation
- A wind measuring lattice (approximately 120m in height) mast has already been strategically placed within the wind farm application site in order to collect data on wind conditions. A permanent met mast will also be installed;
- No new fencing is envisaged at this stage. Current fencing is standard farm fence approximately 1-1.5m in height. Fencing might be upgraded (if required) to be up to approximately 2m in height; and
- Water will either be sourced from existing boreholes located within the application site or will be trucked in, should the boreholes located within the application site be limited.
- Optic fibre overhead or underground line from the Adamskraal Substation to the proposed on-site substation.

3.2.2 Grid Components

The proposed grid connection infrastructure to serve the Patatskloof WEF will include the following components:

- One (1) new 11-33/132kV on-site substation, situated on a site of occupying an area of up to approximately 2ha. The proposed substation will be a step-up substation and will include an Eskom portion and an IPP portion, hence the substation has been included in both the BA for the WEF and in the BA for the grid infrastructure to allow for handover to Eskom. The applicant will remain in control of the low voltage components (*i.e.* 33kV components) of the substation, while the high voltage components (*i.e.* 132kV components) of this substation will likely be ceded to Eskom shortly after the completion of construction; and
- One (1) new 132kV overhead power line connecting the on-site substation to either Kappa Substation or Adamskraal Substation and thereby feeding the electricity into the national grid. Power line towers being considered for this development include self-supporting suspension monopole structures for relatively straight sections of the line and angle strain towers where the route alignment bends to a significant degree. Maximum tower height is expected to be approximately 25m.

3.3 Alternatives

3.3.1 Wind Energy Facility

No other activity or site alternatives are being considered. Renewable Energy development in South Africa is highly desirable from a social, environmental and development point of view and a wind energy facility is considered suitable for this site due to the high wind resource in this area.

The choice of technology selected for the Patatskloof WEF is based on environmental constraints and technical and economic considerations. No other technology alternatives are being considered as wind energy facilities are more suitable for the site than other forms of renewable energy due to the high wind resource.

The size of the wind turbines will depend on the development area and the total generation capacity that can be produced as a result. The choice of turbine to be used will ultimately be determined by technological and economic factors at a later stage.

Design and layout alternatives will be considered and assessed as part of the EIA. These include alternatives for the Substation locations and also for the construction / laydown area. The proposed preliminary layout is shown in **Figure *4*** below.

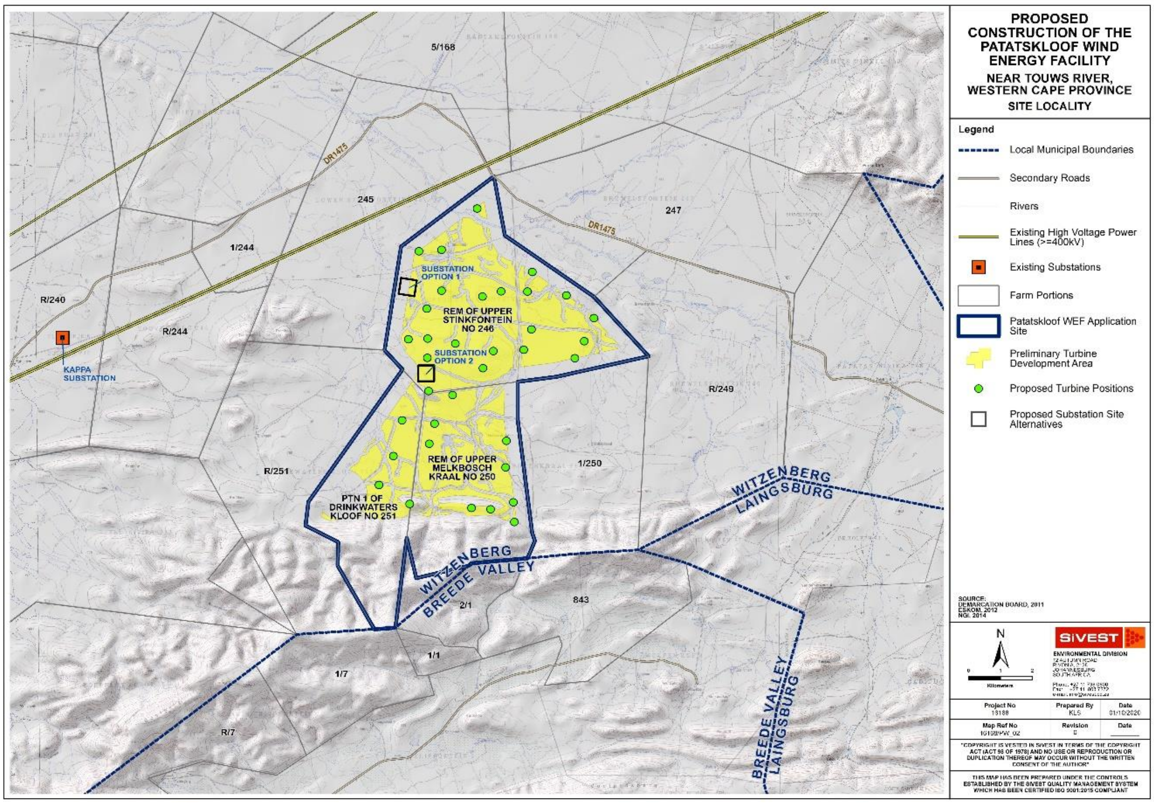

Figure 4: Preliminary Turbine layout and development area.

3.3.2 Grid Components

The grid connection infrastructure proposals include two (2) substation site alternatives, each of which are 25 hectares in extent, and six (6) power line route alignment alternatives (**Figure 5**). These alternatives will be considered and assessed as part of the BA process and will be amended or refined to avoid identified environmental sensitivities.

All power line route alignments will be assessed within a 150m wide assessment corridor (75m on either side of power line). These alternatives are described below:

- Power Line Corridor Option 1 is approximately 16km in length, linking either Substation Option 1 or Substation Option 2 to Kappa Substation.
- Power Line Corridor Option 2 is approximately 24km in length, linking either Substation Option 1 or Substation Option 2 to Kappa Substation.
- Power Line Corridor Option 3 is approximately 8km in length, linking either Substation Option 1 or Substation Option 2 to Adamskraal Substation.
- Power Line Corridor Option 4 is approximately 25km in length, linking either Substation Option 1 or Substation Option 2 to Kappa Substation.

- Power Line Corridor Option 5 is approximately 24km in length, linking either Substation Option 1 or Substation Option 2 to Kappa Substation. It should be noted that the assessment corridor applied to a short section of this route alignment serving Substation Option 2 has been widened to 300m.
- Power Line Corridor Option 6 is approximately 8km in length, linking either Substation Option 1 or Substation Option 2 to Adamskraal Substation.

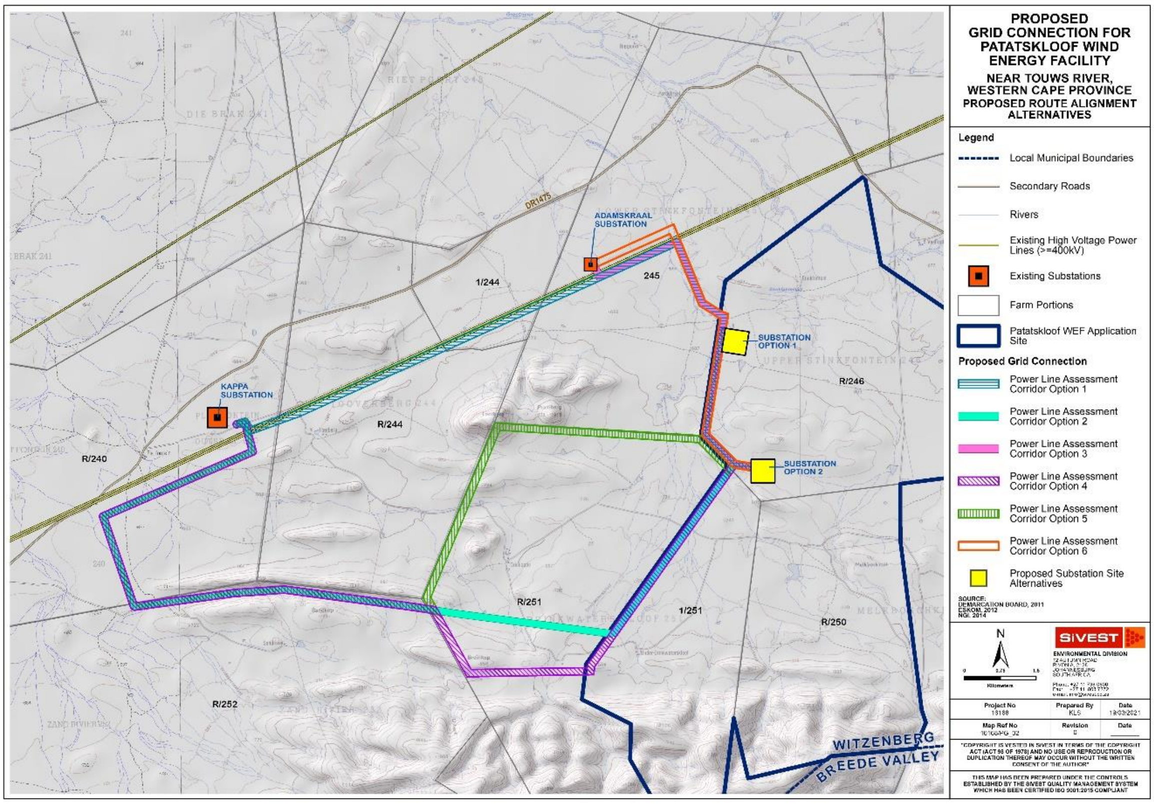

Figure 5: Proposed Substation and Power line options.

3.3.3 No-go Alternative

The 'no-go' alternative is the option of not undertaking the proposed grid connection infrastructure projects. Hence, if the 'no-go' option is implemented, there would be no development. This alternative would result in no environmental impacts from the proposed project on the site or surrounding local area. It provides the baseline against which other alternatives are compared and will be considered throughout the report.

The 'no-go' option is a feasible option; however, this would prevent the proposed development from contributing to the environmental, social and economic benefits associated with the development of the renewable energy sector.

4. LEGAL REQUIREMENT AND GUIDELINES

The present combined desktop and field-based palaeontological heritage report falls under Sections 35 and 38 (Heritage Resources Management) of the South African Heritage Resources Act (Act No. 25 of 1999), and it will also inform the EMPr for this project.

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

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

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

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

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

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

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

- (a) destroy, damage, excavate, alter, deface or otherwise disturb any archaeological or palaeontological site or any meteorite;
- (b) destroy, damage, excavate, remove from its original position, collect or own any archaeological or palaeontological material or object or any meteorite;
- (c) trade in, sell for private gain, export or attempt to export from the Republic any category of archaeological or palaeontological material or object, or any meteorite; or
- (d) bring onto or use at an archaeological or palaeontological site any excavation equipment or any equipment which assist in the detection or recovery of metals or archaeological and palaeontological material or objects, or use such equipment for the recovery of meteorites.

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

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

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

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

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

Where Preconstruction of Construction Phase mitigation, comprising palaeontological recording and collection of fossil material and associated geological data, is required as a condition of Environmental Authorization, this must be carried out by a suitably qualified professional palaeontologist under a Fossil Collection Permit issued by the relevant Heritage Resources Management Agency (in the present case, a Work Plan would be required by Heritage Western Cape, Cape Town). The fossil material collected must be curated in an approved repository (museum / university collection). Standards for palaeontological reporting and mitigation in the RSA have been established by Heritage Western Cape (2016, 2021) and SAHRA (2013). A tabulated Chance Fossil Finds Protocol which must be implemented throughout the Construction Phase of the WEF and grid connection infrastructure projects is provided in Appendix 4 to this report.

5. DESCRIPTION OF THE RECEIVING ENVIRONMENT

This section of the PIA presents a short, illustrated overview of the geology and palaeontological heritage encountered within the Patatskloof WEF project area, including the associated grid connection project area.

5.1 Geological context

The combined Patatskloof WEF, BESS and grid connection project area is situated along the semi-arid, hilly to flat-lying southern margins of the semi-arid to arid Ceres Karoo region of the Western Cape, some 25 km northeast of Touwsrivier (1: 50 000 topographic sheet 3320 Ladismith; 1: 50 000 sheets 3320AA Brewelsfontein, 3319BB Inverdoorn) (See satellite image in **Figure 61** and representative scenic shots in **Figure 6** to **Figure 11**). The southern edge of the WEF project area runs along the rugged, highly-dissected foothills of the narrow Bontberg – Mostertshoek Range which trends approximately west-east and lies within the northern margins of the Permo-Triassic Cape Fold Belt. The central and northern sectors of the WEF project area extend across rocky *rante* and gently-sloping, gravelly to sandy *vlaktes* as far as the broad valley and banks of the non-perennial Grootrivier in the north. The area is drained by various intermittently-flowing tributary streams of the Grootrivier system, including the Bella se Laagte and Adamskraalrivier, whose headwaters drain narrow gullies or *klowe* incised into the Bontberg Range. Much of the area is mantled by various Late Caenozoic superficial deposits, soils and karroid *bossieveld* vegetation with small trees confined to major water courses. Bedrock exposure is mainly limited to stream valleys and rocky ridges.

The geology of the project area is shown on adjoining 1: 250 000 geological sheets 3320 Ladismith and 3319 Worcester, published by the Council for Geoscience, Pretoria short sheet explanations by Theron *et al.* (1991) and Gresse and Theron (1992) respectively (**Figure *12***). The area spans the paraconformable to erosive contact between (1) Middle Devonian to Early Carboniferous shallow marine sediments of the Witteberg Group (Cape Supergroup) building the Bontberg Range and its foothills and (2) Middle Carboniferous to Middle Permian sediments of the Karoo Supergroup underlying the more subdued terrain to the north. The Karoo Supergroup succession here comprises a thick basal succession of dark, glacially-related sediments of the Dwyka Group (Middle Carboniferous to Early Permian) as well as several mudrock-dominated subunits of the lower Ecca Group (Early to Middle Permian). The constituent sedimentary formations of the Cape and Karoo Supergroups that are relevant to the present palaeontological heritage assessment are listed in Table 1 which includes only those rock units that are likely to be directly impacted by the proposed developments (Note, for example, that no WEF infrastructure is to be placed within the outcrop areas of Witteberg Group formations below the Lake Mentz Subgroupo / Kweekvlei Formation; see **Figure *12***). The only igneous rocks mapped within the project area comprises an elongate, NW-SE trending dyke which may be of Karoo Dolerite Suite age (*i.e.* Early Jurassic).

The sedimentary bedrocks underlying the WEF and grid connection project area young broadly from the SW to the NE. They are deformed into large-scale folds with E-W trending axes such as the tight, in part overfolded mega-anticline of the Bontberg range as well as a syncline – anticline pair affecting the Dwyka and Ecca Group successions to the north. Relief within the project area is strongly influenced by bedrock geology, with tougher sandstones of the Floriskraal Formation, Collingham Formation and tillites of the Dwyka Group building higher ridges while lower ground is underlain by less resistant-weathering mudrocks of the Kweekvlei, Waaipoort and several Lower Ecca formations. A north-dipping pediment surface (*c*. 870 to 700 m amsl) of probable Neogene age stretching northwards from the foothills of the Bontberg has been incised by several small tributaries of the Grootrivier (*e.g.* Bella se Laagte, Adamskraalrivier and unnamed streams) with local devellopmengt of springs (*e.g.* Stinkfontein located along a fault line). Relict patches of quartzitic "High Level Gravels" (Tg, yellow on the geological map **Figure *12***) still cap portions of the pediment surface which is also associated with deep saprolitic weathering of underlying bedrocks (especially the Dwyka)..

A range of Late Caenozoic superficial deposits blanket the Palaeozoic bedrocks over most of the WEF and grid connection project area. They include rubbly colluvial deposits (*e.g.* scree, debrites), pediment or "High Level" gravels, downwasted or eluvial surface gravels, sandy to gravelly river and stream alluvium as well as various soils, including local calcrete developments. These younger sediments are largely unconsolidated to semi-consolidated and are likely to be, for the most part, of Pleistocene to Recent age, although some might date from the Neogene (Late Tertiary) Period.

The sedimentary rock units mapped within the WEF, BESS and grid connection project area are listed in the legend to map **Figure 12** and shown in the stratigraphic column in **Figure *13***. Summary accounts of their geology, including sedimentology and age, in the Ceres Karoo region, together with extensive references, have already been provided in several previous palaeontological heritage assessments (PIAs) for renewable energy projects here, such as those for the Kolkies, Karee, Rietkloof (later renamed Idyebo), Perdekraal, Tooverberg, Pienaarspoort 1 and Pienaarspoort 2 WEFs (Almond 2015, 2016a, 2016b, 2018, 2020a, 2022, Butler 2018), the Kolkies and Sadawa solar energy facilities (Almond 202b, 2020c) as well as several other southern Karoo margin PIAs by the same authors (Almond 2019a, 2019b). They will therefore not be repeated at length here.

The following section of this report provides short comments with illustrations regarding representative exposures of the various rock units encountered during the recent field survey of the Patatskloof WEF project area. Associated palaeontological data is given in Section 5.2 of the report and Appendix 2.

Figure 6: View eastwards along the northern foothills of the Bontberg Range (RE/250) showing the extensive, shallow valley between the pale Witpoort Formation quartzites to the south and the narrow sandstone ridge of the Floriskraal Formation to the north.

Figure 7: View southwards across the eastern sector of RE/246 showing tombstone-weathered Dwyka tillites in the foreground, a low pediment surface in the middle ground (also on Dwyka) and the Bontberg Range on the skyline.

Figure 8: Flat-lying pediment surface cut across Dwyka Group bedrocks on RE/250 that has been deeply incised by an unnamed stream valley and subsequently exposed to karstic weathering, generating tombstones.

Figure 9: Low hill and pediment surface of tombstone-weathering Dwyka tillite on the western boundary of the Patatskloof WEF project area, along the border between RE/248 and RE/250, looking due south.

Figure 10: View northwards towards the Stinkfontein spring area on RE/246. The subdued relief here reflects weathered Dwyka tillites as well as mudrock-rich lower Ecca Group successions. The spring probably lies along a NW-SE fault line.

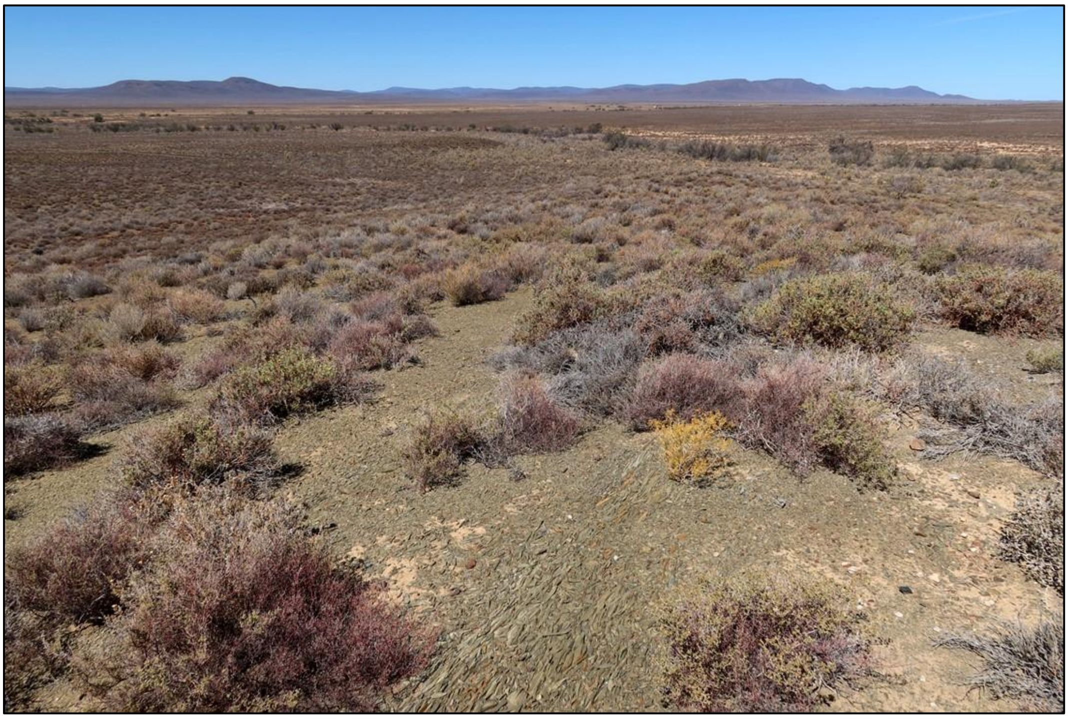

Figure 11: Undulating, low relief terrain just south of the Grootrivier on RE/246 that is underlain by shaly Ecca Group bedrocks (Tierberg Formation).

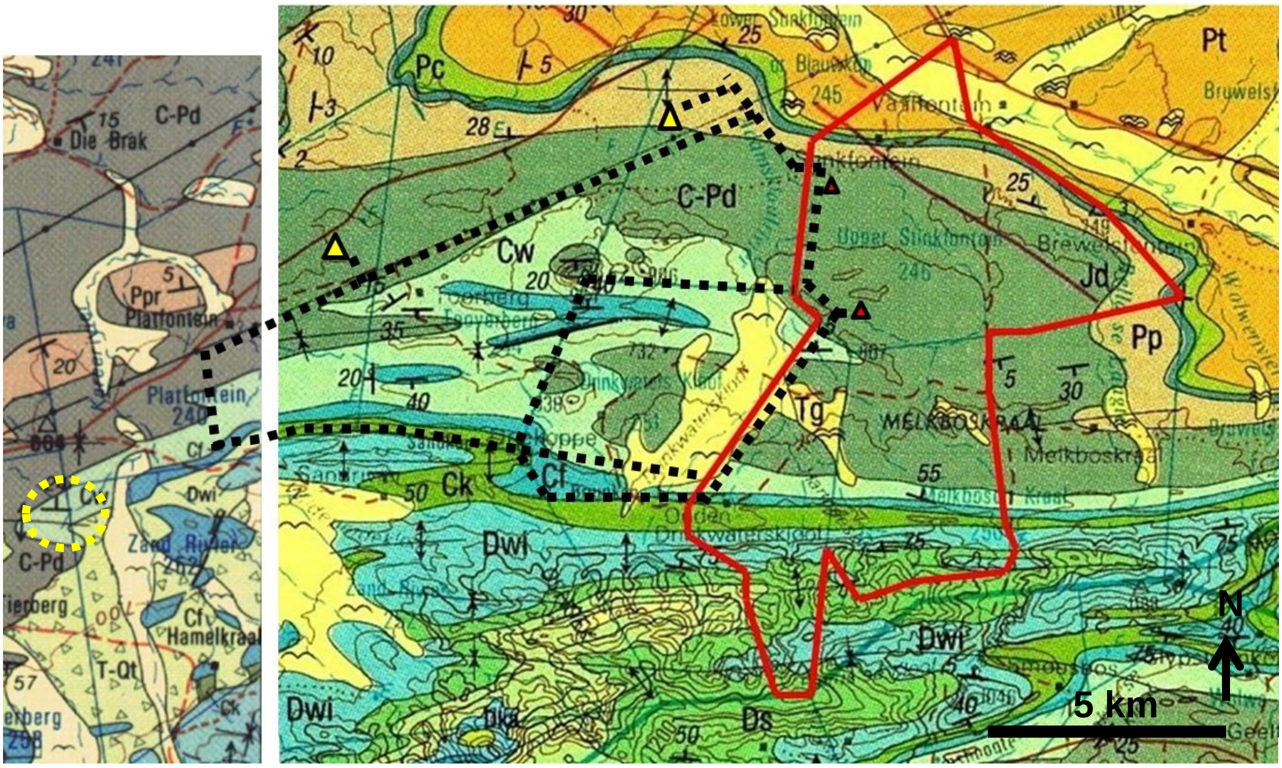

Figure 12: Extract from adjoining 1: 250 000 geology sheets 3319 Worcester and 3320 Ladismith (Council for Geoscience, Pretoria) showing the project area for the proposed Patatskloof WEF near Touwsrivier, Western Cape spanning the contact of the Cape and Karoo Supergroups in the Ceres Karoo region of the Western Cape (red polygon). The various 132 kV grid connection options under consideration between the on-site substation (2 options, red triangles) and either Kappa or Adamskraal Substations (yellow triangles) are schematically indicated by the black dotted lines (compare Figure 5 for key to grid options).

The main sedimentary rock units mapped here (not all of which will be impacted by the proposed WEF developments) include:

- **WITTEBERG GROUP: Dbl (blue-green) = Blinkberg Formation; Ds (middle green) = Swartruggens Formation; Dwi (pale blue) = Witpoort Formation; Ck (pea green) = Kweekvlei Formation; Cf (middle blue) = Floriskraal Formation; Cw (v. pale blue-green) = Waaipoort Formation. Fossiliferous concretions within the Waaipoort Formation on Tierberg 258, east of and outside the present project area, are outlined by the yellow dotted ellipse.**

- **DWYKA GROUP: C-Pd (grey / blue-grey) = Elandsvlei Formation**

- **ECCA GROUP: Pp (pale brown) = Prince Albert Formation; Pw (dark blue) = Whitehill Formation; Pc (pale green) = Collingham Formation; Pt (orange) = Tierberg Formation.**

- **SUPERFICIAL DEPOSITS: Tg (dark yellow with double flying bird symbol) = older pediment gravels (possibly Neogene / Pleistocene in age); pale yellow or white with single flying bird symbol = Quaternary to Recent alluvium; T-Qt (pale green) = Neogene gritty sands,colluvial and eluvial gravels**

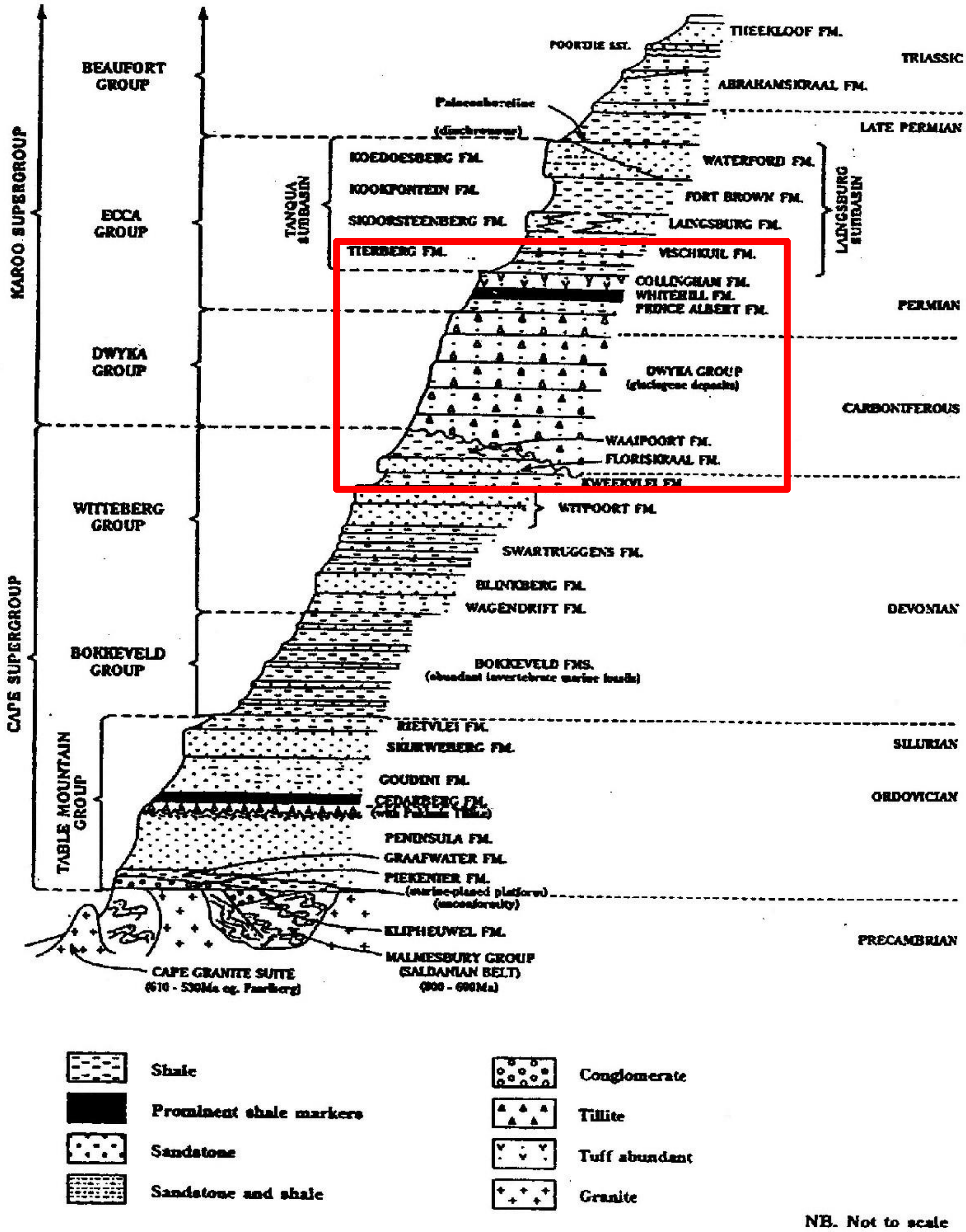

Figure 13: Schematic stratigraphic column for the Western Cape, the red box indicating the relative position of the various Late Palaeozoic sedimentary formations within the Cape Supergroup and Karoo Supergroup that crop out within the combined Patatskloof WEF, BESS and grid connection study area (Modified from original figure by H. de V. Wickens). Impacts on Witteberg Group rocks below the Kweekvlei Formation are unlikely.

Pale, tightly folded quartzites of the **Witpoort Formation** (Witteberg Group) build steep, rubble-strewn hillslopes along the northern face of the Bontberg. These beds will not be directly impacted by the proposed WEF development. Of geological interest are extensive, elongate lenses of the brownish to purple-brown hued sandstones of the "**Potdeksel Member**" overlying white, clean-washed **Perdepoort Member** quartzites on RE/251 and RE/250 (**Figure *14***). These massive to obscurely bedded, gravel-poor wackes (impure sandstones) are might be interpreted as slump facies related to rapid post-glacial melting of Gondwana ice sheets close to the Devonian – Carboniferous boundary. They are cut by steep S-sipping joints and show signs of extensive karstic weathering (*e.g.* case hardening, deep grooves).

Post-glacial mudrocks of the **Kweekvlei Formation** are generally poorly exposed due to colluvial and alluvial cover in the valley running between the Bontberg mountain front and Floriskraal ridge. However, occasional deep stream incision shows a thick succession of deeply weathered, khaki, ochreous, pinkish and grey green, flat-laminated mudrocks with horizons of elliptical ferruginous concretions of diagenetic origin. An unusually good section through most of the Kweekvlei succession is seen along a stream gulley on RE/250 (**Figure *16***). The upper part of the tabular-bedded succession shows upward-shoaling parasequences capped by flaser- and wavy-laminated siltstones and fine-grained wackes.

The sandstone-rich **Floriskraal Formation** builds a narrow, laterally persistent ridge just north of the Bontberg with three, laterally-persistent packages of pale, buff to orange-hued, tabular-bedded sandstones showing horizontal or tabular cross-lamination and occasional thin pebbly horizons (white vein quartz, occasional black chert). The steeply-dipping sandstones are well-jointed and often folded with quartz veining. Siltstone interbeds are poorly exposed due to rubbly colluvium.

The mudrock-dominated **Waaipoort Formation** is rarely exposed but occasional good stream bed and bank sections are seen on the northern side of the Florisokraal ridge on RE/250 and RE/251 (*e.g.* Hartbeeskloof). The bedrocks here largely comprise south-dipping beds of brownish to grey-green or khaki, wavy- or current-bedded micaceous wacke and siltstone. Some more massive wackes appear to be bioturbated. Horizons of dark blue-black, yellowish weathering, sphaeroidal to elliptical phosphatic concretions are seen within mudrock packages in the lower part of the Waaipoort succession.

Glacially-related sediments of the **Dwyka Group** underlie most of the central and northern sectors of the WEF project area as well as much of the grid connection project area as well. Several exposures here are of geoheritage interest. The Dwyka bedrocks are especially well exposed in the deeply-incised stream valley near Melkboskraal on RE250. Wavy colour banding seen on satellite images here reflects the series of four folded deglaciation cycles represented within the Dwyka succession. Much of the Dwyka has been truncated beneath an extensive Neogene pediment surface which is locally associated with pale grey-green, deep saprolitic weathering of the bedrocks – perhaps especially within the late stage deglaciation sequence (*i.e.* interglacial mudrocks) (*e.g.* borrow pit on RE/246, Melkboskraal incised valley where the weathered saprolite conmtains phosphatic veins and concretions as well as ferruginous carbonate concretions). Well-exposed, fresh interglacial mudrocks and dropstone laminites were not observed here.

Savagely jagged tombstone weathering is extensively seen in clast-poor Dwyka tillites where these are exposed along upland ridges; this feature might be related to karstic (solution) weathering of well-jointed massive bedrocks in the Karoo region. Boulder-sized dark rusty-brown ferruginous carbonate concretions of diagenetic origin occur at some localities. Thick packages of bouldery tillites within the lower portions of deglaciation cycles are very well developed in the eastern portion of RE/246 where they build low ridges in the otherwise flattish landscape. The polymict glacial erratics include a wide range of igneous, metamorphic and sedimentary rock types (granitoids, gneisses, BIF, amydaloidal lavas, sandstones, greyish and rusty-brown dolomites *etc*) and are often conspicuously rounded to subrounded. Isolated, irregular shaped to whale-backed bodies of clean-washed, well-sorted to gritty or pebbly quartzite that weather prominently out of the Dwyka outcrop area represent glacial, outwash fan or esker bodies constructed near the submerged margins of the ice sheet. The beds are often folded and quartz-veined and may show evidence of subglacial deformation (*e.g.* fluted and grooved partings). Hese bodies are typically associated with aprons of quartzitic rock rubble.

The **Prince Albert Formation** crops out in *vlaktes* and low hills along the northern margins of RE/246. Dropstone argillites are seen locally close to the lower contact with the Dwyka Group. The predominant dark, platy-weathering, shaly mudrocks are rarely well exposed but prominent-weathering beds and lenses of fine-grained wacke or dark, secondarily silicified and ferruginised mudrocks are seen locally (e.g. near Stinkfontein on RE/246) and may be highly folded. Blackish to metallic grey desert-varnished surface gravels often characterise the Prince Albert outcrop area.

The pale-weathering **Whitehill Formation** builds the lower, south-facing slopes of low hills on the southern side of the Grootrivier (RE/246) and is also exposed in a sizeable borrow pit along the Pienaarspoort – Ceres Karoo road. The fine-grained, laminated mudrocks with occasional greyish to olive-grey dolomitic concretions are typically deeply weathered and usually covered beneath several meters of shaly surface gravels as well as angular colluvial debris from the overlying Colingham Formation. Fresh, black carbonaceous mudrocks were not observed in the study area. Near Stinkfontein the Prince Albert – Whitehill transition zone if marked by a *c*. 4 meter-thick package of undulose to folded, thin-bedded, brownish-weathering, thin-bedded dolomite interbedded with pale grey shales.

The **Collingham Formation** crops out along the upper slopes of the low hills running around the northern margin of the WEF project area. The regularly interbedded shales, thin yellowish tuffs and medium-bedded grey to yellowish silicified mudrocks and / or wackes are typically highly tabular and well-jointed, generating abundant blocky colluvial debris. In this part of the outcrop area there are at least three laterally persistent, prominent-weathering, pale cherty beds (Matjiesfontein Member) up to 40 or 50 cm thick.

The thick, mudrock-dominated **Tierberg Formation** crops out in low hills and *vlaktes* south of the Grootrivier in the northernmost sector of RE/246, north of Stinkfontein. Tabular, dark-hued wackes within the lower Tierberg succession often show evidence of soft-sediment deformation (slump pillows and balls, recumbent bedding). Finley-laminated shales higher up also show very variable dips (sometimes vertical) and have probably also been deformed soon after deposition.

No unambiguous intrusions of the **Karoo Dolerite Suite** were encountered during the field study. A NW-SE trending dyke of possible Karoo (or perhaps Cretaceous) age is mapped within the project area. This may coincide with a prominent-weathering breccia zone composed of well-cemented fine quarzitic material recorded on RE/246 near Stinkfontein (with slight displacement of Ecca Group rock units in the region).

A wide range of consolidated to unconsolidated **superficial deposits** of Late Caenozoic age blanket most of the Patatskloof WEF and grid connection project areas.

In situ **silcrete** pedocretes were not encountered in the field. However, local high concentrations of subangular to well-rounded surface silcrete gravels of grey, pale brown and other hues indicate that silcrete bodies are present regionally in the Ceres Karoo - perhaps along elevated pediment surfaces in the Bontberg - or that they were previously present but have subsequently been denuded to form eluvial gravels. **Ferricretised gravels** with ferruginised clasts of quartzite and mudrock occur widely in the narrow valley bordering the Bontberg range. **Calcrete hardpans** are developed locally overlying Dwyka Group bedrocks where groundwaters are typically rich in lime; they are usually hidden in the subsurface beneath younger soils but are occasionally exposed along drainage lines. Elevated areas with high concentrations of coarse, bouldery **pale quartzite gravels** have been derived by downwasting of alluvial and eluvial gravels overlying previously extensive pediment surfaces ("High Level Gravels").

Thick (several m) aprons or prisms of coarse, poorly-sorted, angular to subrounded **alluvial and colluvial deposits** dominated by quartzitic rubble are associated with the Bontberg mountain front, where they blanket most of the Kweekvlei Formation outcrop area, as well as the narrow Floriskraal Formation ridge to a lesser extent. Alluvial gravels are commonly dominated by well-rounded quartzite clasts but polymict gravels derived from erratics within the Dwyka Group tillites also occur; likewise, erratics of many different lithologies typify eluvial surface and pediment gravels within the Dwyka outcrop area (BIF, amydaloidal lavas *etc*). Orange-hued **debrites** (massive, poorly-sorted debris flow deposits) composed of quartzite clasts within a gritty sand matrix are seen on the sloping margins of a deeply-incised stream valley on RE/250 near Melkbosch; they have been sourced from sandy and gravely material mantling the regional pediment surface here. Thick, unconsolidated, fine-grained sandy alluvium as well as coarse, cobbly to bouldery gravel bars are seen along the more active modern drainage lines such as Bella se Laagte, along the Stinkfontein valley and in the course of the Grootrivier. Surface gravels in the Ecca Group outcrop area are often metallic grey due to a patina of desert varnish and include secondary ferruginised clasts, vein quartz, and diagenetic nodular material (*e.g.*

rusty-brown ferruginous carbonate, grey stream dolomite), silicified mudrock, chert as well as pebbly to cobbly silcrete (see above).

Figure 14: Brownish-hued, sandy debrites of the "Potdeksel Member" overlying pale Perdepoort Member quartzites (both subunits of the Witpoort Formation) along the Bontberg mountain front, RE/251.

Figure 15: Polygonal jointing within case hardened, karstified "Potdeksel Member" wackes, RE/251 (hammer = 30 cm).

Figure 16: Erosion gulley exposure of gravel-capped, khaki, weathered shales of the Kweekvlei Formation near the northern entrance of Hartbeeskloof, RE/250.

Figure 17: Ochreous, ferruginous diagenetic concretion within the Kweekvlei Formation mudrocks, RE/251 (hammer = 30 cm).

Figure 18: Contact between upward-coarsening, shoaling packages within the upper part of the Kweekvlei Formation, Hartbeeskloof, RE/250 (hammer = 30 cm).

Figure 19: View eastwards along the narrow Floriskraal Formation ridge on RE/251 showing at least three laterally-persistent packages of pale-weathering sandstone.

Figure 20: Orange-weathering tabular, in part cross-bedded and pebbly sandstones of the Floriskraal Formation, RE/251.

Figure 21: Good streambed exposure of north-dipping, current- and wave-rippled wackes of the Waaipoort Formation, northern side of Hartbeeskloof on RE/250.

Figure 22: Hackly-weathering siltstones and brownish wackes of the Waaipoort Formation on the northern side of Hartbeeskloof on RE/250. Some of these beds show high levels of bioturbation.

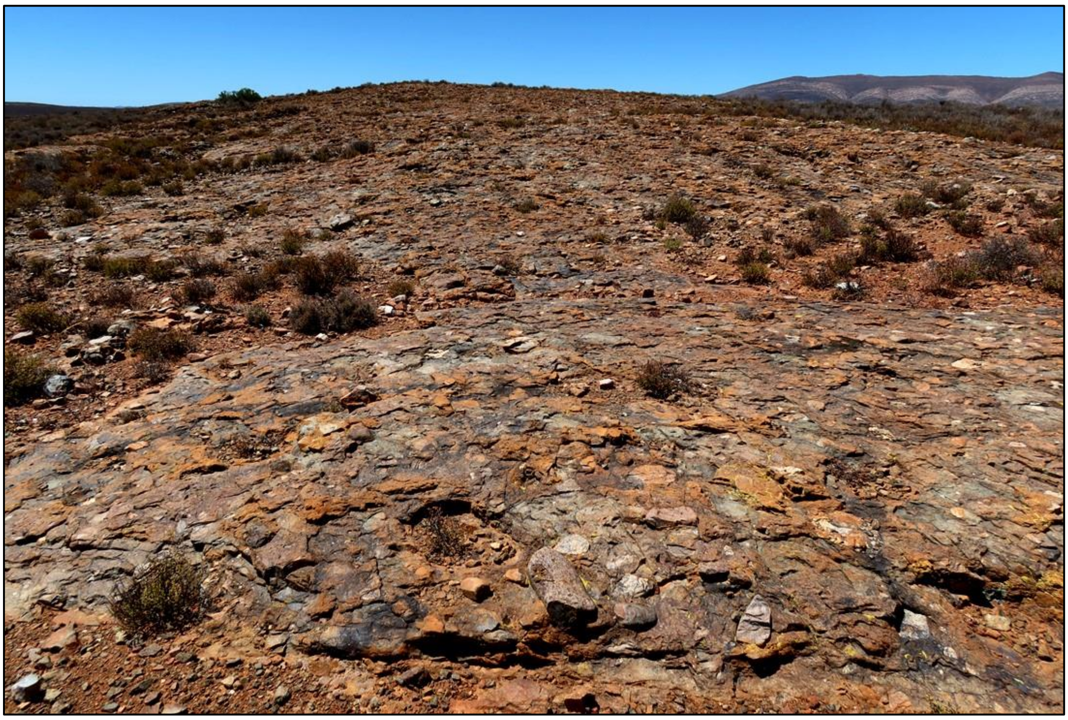

Figure 23: Low ridges composed of impressive clast-rich diamictite within the lower part of a Dwyka Group deglaciation cycle, eastern portion of RE/246. Such occurrences are of potential geoheritage interest.

Figure 24: Close-up of the polymict, clast- to matrix-supported, cobbly to bouldery diamictites of the Dwyka Group illustrated above, RE/246 (hammer = 30 cm). Many of the clasts seen here show moderately good rounding.

Figure 25: Hackly-weathering, dark blue-grey, clast-poor Dwyka tillites with occasional large, rusty-brown ferruginous carbonate concretions, here exposed in a stream valley near Stinkfontein, RE/246.

Figure 26: Unusually good section through massive to thick-bedded, olive-brown, tombstone-weathered Dwyka Group tillites exposed in the steep banks of a deeply incised stream valley near Melkboskraal, RE/250.

Figure 27: Water-worn, grey Dwyka Group glacial diamictites with dispersed, subrounded, cobbly to boulder erratics exposed in the bed of the stream valley illustrated above, RE/250 (hammer = 30 cm).

Figure 28: Hilly terrain underlain by khaki saprolite derived from weathered Dwyka Group sediments developed beneath an eroded pediment surface north of Melkboskraal (RE/250). Numerous prominent-weathering, pale quartzite bodies are enclosed within the Dwyka beds here – probably formed during a late phase of a deglaciation cycle.

Figure 29: Highly-jointed, irregular body of pale quartzite of possible esker or glacial outwash fan origin weathering out from the Dwyka tillites on the eastern portion of RE/246.

Figure 30: Well-developed, conical tombstone weathering typifies ridges and hillcrests of Dwyka tillite within the WEF project area, seen here on the western margins of RE/246.

Figure 31: Dark grey, platy shales of the post-glacial Prince Albert Formation exposed near Bella se Laagte on the eastern margins of RE/246 (hammer = 30 cm).

Figure 32: Well-jointed bed of silicified mudrock or fine-grained wacke within the Prince Albert Formation on RE/246 showing common metallic, dark grey patina of desert varnish.

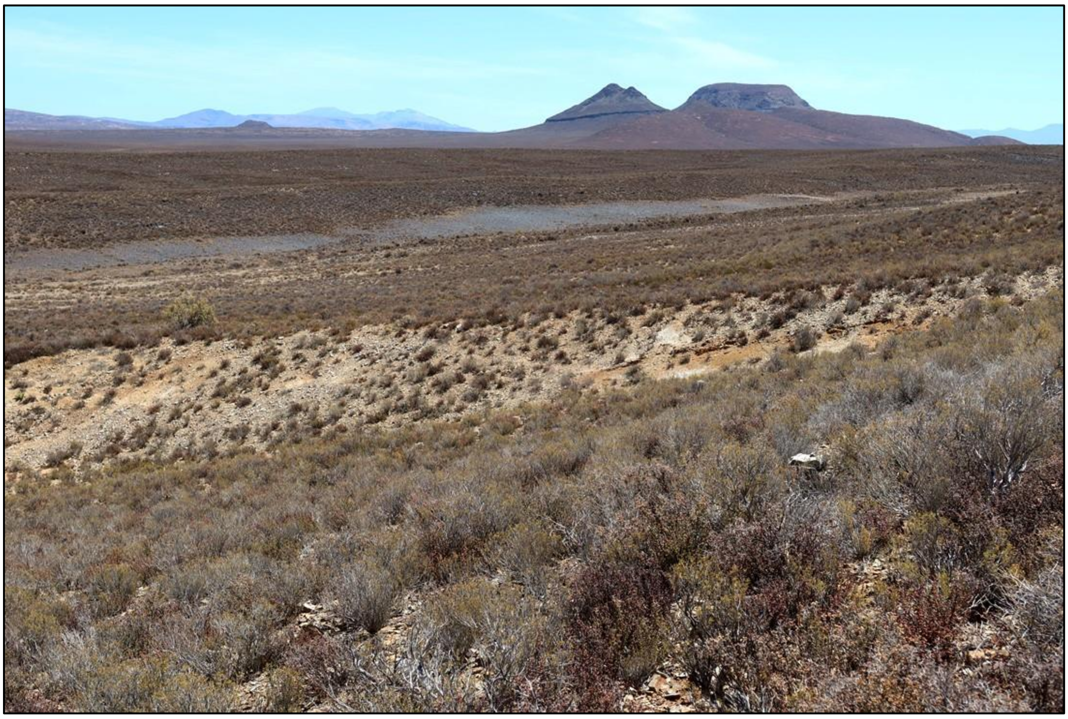

Figure 33: South-facing hillslopes of pale, deeply- weathered Whitehill Formation mudrocks in the northern sector of RE/246. The slopes are mantled with weathered colluvium derived from the overlying Collingham Formation. Note dark grey, desert-vanished surface gravels overlying the Prince Albert Formation in the middle distance and Toorberg on the skyline.

Figure 34: Package of thin, wavy beds of olive grey dolomite within the lowermost part of the Whitehill Formation, RE/246 (hammer = 30 cm).

Figure 35: Blocky-weathering, highly tabular siltstones, tuffs and wackes of the Collingham Formation, hillslope exposures on the northern portion of RE/246 (hammer = 30 cm).

Figure 36: Prominent-weathering, tabular cherty bed (c. 40-50 cm thick) of the Matjiesfontein Member, one of at least three similar beds within this sector of the Collingham Formation outcrop area, RE/246.

Figure 37: Hillslope exposures of grey-green siltstones and ferruginised, tabular wackes of the Tierberg Formation on RE/246 near Stinkfontein (hammer = 30 cm). The lowest bed seen here shows soft-sediment deformation in the form of small-scale recumbent folding.

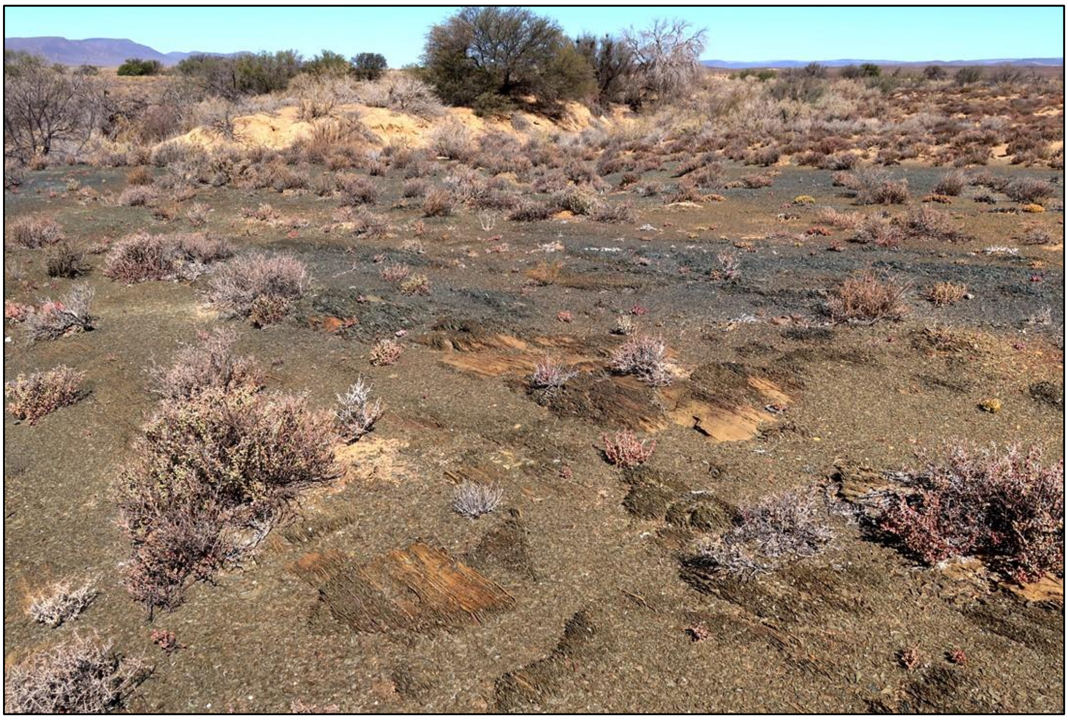

Figure 38: Thinly laminated Tierberg Formation mudrocks showing high, subvertical dips – possibly due to soft-sediment deformation - in the northern portion of RE/246.

Figure 39: Low ridge of quartz-cemented, blocky breccia which probably marks a fault running NW-SE through RE/246 near Stinkfontein (hammer = 30 cm). According to the geological map, this line is associated with dolerite dyke intrusion.

Figure 40: Thick, rubbly alluvial gravels with angular to subrounded clasts (mainly quartzite) erosively overlying steeply N-dipping shales of the Kweekvlei Formation, RE/250.

Figure 41: Ferruginous ferricrete gravels as well as downwasted quartzite blocks capping a thick prism of colluvial and alluvial debris along the Bontberg mountain front, RE/251.

Figure 42: Several meters of poorly-sorted, coarse alluvial gravels mantling Waaipoort Formation bedrocks north of Hartbeeskloof, RE/250.

Figure 43: Relict pale quartzite boulders downwasted from an earlier pediment surface overlying Dwyka bedrocks on RE/250, looking towards the SW with the Bontberg Range on the skyline and the darker, narrower Floriskraal ridge in front of it.

Figure 44: Typical surface gravels overlying the Dwyka Group outcrop area on RE/251 comprising fine ferricretised clasts, cobbles to boulders of pale quartzite as well as a range of exotic lithologies representing weathered-out glacial erratics.

Figure 45: Patch of downwasted, cobbly surface gravels dominated by multi-hued clasts of silcrete in the central portion of the WEF project area (northern sector of RE/250). The precise provenance of these locally abundant silcretes in the Ceres Karoo is not yet clear.

Figure 46: Close-up of subangular to subrounded cobbles of different coloured silcrete from the locality illustrated above (scale in cm and mm). Locally such silcretes constitute an important raw material for stone artefacts in the Ceres Karoo.

Figure 47: Orange-hued gravelly debrite horizon (arrowed) mantling a low-lying platform along an unnamed, deeply incised stream valley near Melkboskraal, RE/250. Note also the thick, pale greyish Dwyka saprolite (deeply weathered bedrock, RHS) underlying the flat pediment surface on the skyline.

Figure 48: Close-up of the well-cemented, rubbly debrite deposit indicated in the previous illustration showing angular to subrounded clasts within a gritty matrix, RE/250 (hammer = 30 cm).

Figure 49: Thick sandy to finely gravelly alluvium along the banks of Bella se Laagte on the eastern portion of RE/246. Occasional embedded MSA artefacts confirm a Pleistocene or younger age for these semi-consolidated deposits.

Figure 50: Partially exposed, rubbly calcrete hard pan beneath sandy alluvial soils along a shallow drainage line on RE/246 (hammer = 30 cm).

Figure 51: Gravel bars (clasts here mainly of Ecca wackes) and alluvial sands along the course of the braided Grootrivier, northern sector of RE/246.

5.2 Palaeontological heritage context and findings

The fossil record of the main sedimentary units represented within the Patatskloof WEF and grid connection project areas is outlined in **Table 1** (based largely on Almond & Pether 2008). It has been discussed in more detail, with extensive references to the academic literature, in several previous field-based PIA reports for the Ceres Karoo and the Matjiesfontein – Lainsgburg regions of the southern Great Karoo by Almond (2010a-c, 2015, 1016a-b, 2018, 2019a-b, 2020a-c). The inferred sensitivity of the project areas in terms of palaeontological heritage is mapped in **Figure *58*** which is based in turn on the web-based SAHRIS palaeosensitivity map / DFFE Screening Tool. It is noted, however, that the SAHRIS palaeosensitivity mapping requires extensive revision (*e.g.* under-estimated sensitivity of the Waaipoort Formation). The two most sensitive bedrock units within the WEF, BESS and grid connection project areas are (1) the Early Carboniferous Lake Mentz Subgroup at the top of the Witteberg Group (especially the Waaipoort Formation) and (2) the Early Permian Whitehill Formation.

Witteberg Formations below the Kweekvlei mudrocks that crop out within the Bontberg Range will not be directly impacted by the proposed development and so are not treated further here.

- **Lake Mentz Subgroup**

The basal **Kweekvlei Formation** mudrocks are poorly exposed along the Bontberg mountain front (**Figure *16***) and generally deeply-weathered beneath older pediment gravels here. No trace or body fossils were recorded from this rock unit during the site visit. Assemblages of U-shaped burrows (probably *Diplocraterion*) preserving only the burrow bases are seen within sandstone float blocks of the overlying **Floriskraal Formation** (**Figure *52***) but these trace fossils were not observed *in situ*. The **Waaipoort Formation** outcrop area is generally poorly exposed, with occasional stream sections seen north of the Floriskraal ridge (**Figure *21***). Phosphatic carbonate concretions observed here within the lower part of the Waaipoort sucession (**Figure 53**) might contain reworked vascular plant debris as well as a range of articulated fish remains (palaeoniscoids, sharks, acanthodians). Plant and fish fossils have been reported from several Waaiport Formation sites in the Ceres Karoo (*cf* Almond 2016b; see fossilferous beds outlined by yellow dotted ellipse on geological map **Figure 12**) while impressive fish death assemblages are known from rippled Waaipoort sandstone facies near Matjiesfontein. No fossils were recorded within Waaipoort early diagenetic concretions during the present study. The only biogenic structures observed within the Waaipoort Formation here were wave-rippled and -laminated siltstone and wacke horizons showing high levels of bioturbation, including low diversity trace fossil assemblages on some bedding planes (**Figure 54**, **Figure 55**).

- **Dwyka Group fossils**

With the exception of rare fossiliferous carbonate erratics, such as those from the Ceres Karoo containing small Precambrian stromatolites illustrated by Almond (2016b), the Dwyka tillites are for the most part unfossiliferous. Occasional grey to brownish carbonate erratic cobbles and boulders embedded within the unusually well-developed Dwyka boulder beds on the eastern portion of RE/246 contain small domical stromatolitic features. They are probably derived from the Late Archaean / Early Proterozoic Transvaal Supergroup carbonates cropping out in the northern part of the RSA but it is noted that fossiliferous carbonate erratics of Early Cambrian age with remains of archaeocyathid sponges and small trilobites are also recorded within the Dwyka beds along the southern Karoo Basin margin (Cooper & Oosthuizen 1974, Oosthuizen 1981). Poorly-vascular plant remains have been recorded from esker / outwash fan sandstones embedded within the Dwyka succession (Du Toit 1921), but no such occurrences were noted in the Patatskloof WEF project area. Where exposed, potentially fossiliferous thin-bedded interglacial to early post-glacial mudrocks are generally weathered to crumbly saprolite in the study area (*e.g.* incised valley near Melkboskraal on RE/250) and unlikely to be fossiliferous.

- **Ecca Group fossils**

The **Prince Albert Formation** exposures examined in the Patatskloof WEF project areas were generally too weathered and cleaved to contain well-preserved fossil remains. Occasional phosphatic lenses and beds within this formation have been reported to contain microfossils, such as the siliceous tests of radiolarians, elsewhere in the Laingsburg region (Strydom 1950).

The **Whitehill Formation**, well-known for its exquisitely preserved skeletal remains of crustaceans, fish and mesosaurid reptiles, is poorly-exposed and very deeply weathered in the study area (*cf* **Figure 33**, **Figure *34***). Fossil remains near-surface are not expected here; poorly-preserved, low-diversity trace fossil assemblages have been recorded within these beds elsewhere in the Ceres Karoo. No crustacean fossils were identified within occasional laminated concretions of diagenetic dolomite within the Whitehill Formation outcrop. The **Collingham Formation** is best known for its eurypterid (water scorpion) trackways and other trace fossils as well as occasional well-preserved petrified wood. Good bedding plane exposures are rare and the fossils recorded from this rock unit during the field survey comprise small-scale invertebrate burrows preserved within interbedded layers of tuff and silicified mudrock (**Figure 57**). A small range of simple invertebrate traces as well as locally abundant reworked plant debris, including well-preserved petrified wood, are preserved within flaggy sandstone or wacke facies of the **Tierberg Formation** elsewhere in the Ceres Karoo (*cf* Almond 2020d) but were not observed in the present study area. The lack of good bedding plane exposures of this formation, exacerbated by widespread cleavage development, limit palaeontological observations, however.

- **Late Caenozoic fossils**

Several occurrences of calcretised large, sphaeroidal termite nests of possible Pleistocene age have been observed embedded within saprolite or alluvial deposits the Ceres Karoo by the present author (Almond 2020d). Silicified wood reworked from Ecca bedrocks may be locally abundant within surface gravels in the Ceres Karoo (*cf* Almond 2020d). However, no fossil remains were recorded from the various Late Caenozoic superficial sediments (colluvium, alluvium *etc*) within the Patatskloof WEF project area.

See **Figure 61** for a plot of the handful of new fossil sites on a satellite map of the Patatskloof WEF, BESS and associated grid connection project areas.

Figure 52: Dense assemblage of poorly-preserved U-shaped burrows (cf Diplocraterion) showing only the base of the trace fossils, seen here in a sandstone float block from the Floriskraal Formation (scale in cm and mm), RE/250 (Loc. 403).

Figure 53: Zone of spheroidal, pearly blue-black phosphatic concretions within the lower Waaipoort Formation on the northern side of Hartbeeskloof on RE/250 (scale in cm) (Loc. 394). Such nodules might well contain fossil vascular plant and fish remains but none were recorded here.

Figure 54: Wave-rippled upper bedding surface of fine-grained wacke showing sparse invertebrate burrows (epichnial furrows) within a stream bed exposure of the Waaipoort Formation on the northern side of Hartbeeskloof, RE/250 (scale in cm) (Loc. 393).

Figure 55: Float block of wave-rippled Waaipoort Formation wacke showing simple endichnial to epichnial horizontal burrows (scale in cm and mm), same locality as previous figure.

Figure 56: One of a few erratic boulders and cobbles of greyish stromatolitic dolomite embedded within Dwyka Group boulder beds exposed on the eastern sector RE/246 (scale in cm and mm) (Loc. 351). The stromatolites may well be of Precambrian age but it is noted that fossiliferous carbonate erratics of Cambrian age are also known within the Dwyka Group along the southern Karoo margins.

Figure 57: Interbedded pale creamy, fine-grained tuff (volcanic ash) and grey silicified mudrock of the Collingham Formation on RE/250 showing biogenic reworking of the two sediment types within small invertebrate burrows (scale in cm and mm) (Loc. 368).

Table 1: Sedimentary rock units mapped within the Patatskloof WEF and grid connection project areas and their fossil records *(provisional palaeosensitivity rating: red – high; green – medium; blue – low).*

LATE CAENOZOIC FLUVIAL, LACUSTRINE & TERRESTRIAL DEPOSITS OF INTERIOR ***e.g.* Grahamstown Fm (Tg)** **(*N.B.* Most occurrences too small to be indicated on 1: 250 000 geological maps)** **Miocene to Holocene**		Fluvial, pan, lake and terrestrial sediments, including diatomite (diatom deposits), pedocretes (silcrete, ferricrete, calcrete), spring tufa / travertine, cave deposits, peats, colluvium	Bones and teeth of wide range of mammals (*e.g.* proboscideans, rhinos, bovids, horses, micromammals, hominins), reptiles (crocodiles, tortoises), ostrich egg shells, fish, freshwater and terrestrial molluscs (unionid bivalves, gastropods), crabs, trace fossils (*e.g.* termitaria, horizontal invertebrate burrows, stone artefacts), reworked blocks of petrified wood, leaves, rhizoliths, diatom floras, peats and palynomorphs.
ECCA GROUP Early – Middle Permian (290 – 266 Ma)	**Tierberg Fm (Pt)**	Offshore non-marine mudrocks with distal turbidite beds, prodeltaic sediments	Disarticulated microvertebrate remains (*e.g.* fish teeth, scales), sponge spicules, spare vascular plants (leaves, petrified wood), moderate diversity trace fossil assemblages (as below *plus* variety of additional taxa such as large ribbed pellet burrows, arthropod scratch burrows, *Siphonichnus etc*)
	Collingham Fm (Pc)	Offshore non-marine mudrocks with numerous volcanic ashes, subordinate turbidites	Low diversity but locally abundant ichnofaunas (horizontal “worm” burrows, arthropod trackways including giant eurypterids), vascular plant remains (petrified and compressed wood, twigs, leaves *etc*).
	Whitehill Fm (Pw)	Carbonaceous offshore non-marine mudrocks within minor volcanic ashes, dolomite nodules	Mesosaurid reptiles, rare cephalochordates, variety of palaeoniscoid fish, small eocarid crustaceans, insects, low diversity of trace fossils (*e.g.* king crab trackways, possible shark coprolites), palynomorphs, petrified wood and other sparse vascular plant remains (*Glossopteris* leaves, lycopods *etc*)
	Prince Albert Fm (Pp)	Marine to hyposaline basin plain mudrocks, minor volcanic ashes, phosphates and ironstones, post-glacial mudrocks at base	Low diversity marine invertebrates (bivalves, nautiloids, brachiopods), palaeoniscoid fish, sharks, fish coprolites, protozoans (foraminiferans, radiolarians), petrified wood, palynomorphs (spores, acritarchs), non-marine trace fossils (especially arthropods, fish, also various “worm” burrows), possible stromatolites, oolites
DWYKA GROUP (C-Pd) Late Carboniferous – Early Permian *c.* 320-290 Ma	**Elandsvlei Fm** Late Carboniferous – Early Permian	Predominantly massive tillites, with interglacial mudrocks at intervals	Interglacial mudrocks occasionally with low diversity marine fauna of invertebrates (molluscs, starfish, brachiopods, coprolites *etc*), palaeoniscoid fish, petrified wood, leaves (rare) and palynomorphs of *Glossopteris* Flora. Well-preserved non-marine ichnofauna (traces of fish, arthropods) in laminated mudrocks. Possible stromatolites, oolites at top of succession. Occasional Cambrian limestone erratics with archaeocyathid sponges, trilobites.
WITTEBERG GROUP	**Lake Mentz Subgroup**	lacustrine / lagoonal / coastal mudrocks, sandstones, minor conglomerates	Non-marine fish fauna (palaeoniscoids, sharks, acanthodians), vascular plants (*e.g.* lycopods), freshwater bivalves, traces, organic-walled microfossils

	Waaipoort Fm (Cw) **Floriskraal Fm (Cf)** **Kweekvlei Fm (Ck)**	Early Carboniferous	
	Witpoort Formation **(Dw)**	shallow marine sandstones, quartzites with minor lagoonal mudrocks, glacial sediments Late Devonian	Diverse lagoonal biota of fish (placoderms, acanthodians, sharks, several subgroups of bony fish, lampreys *etc*), arthropods (*e.g.* eurypterids), rich vascular plant flora (lycopods, progymnosperms *etc*), seaweeds, charophytes, low diversity trace assemblages, including *Spirophyton*

6. IDENTIFICATION AND ASSESSMENT OF IMPACTS

The potential impact of the proposed Patatskloof WEF development, BESS and the associated grid connection on legally-protected local fossil heritage resources is evaluated in this section of the report and summarized in **Table 3** to **Table 8** below. This assessment applies only to the *construction phase* of the developments since further significant impacts on fossil heritage during the planning, operational and decommissioning phases of the facility are not anticipated. The first assessment (**Table 3**) applies to all the key infrastructure described in Section 3 that will be situated within the WEF and grid connection project areas (*i.e.* wind turbine foundations, access roads, on-site substation, pylons, underground cables, as well as the construction camp, laydown areas and operational and maintenance buildings, BESS, overhead powerlines *etc*). Impacts of the grid connection options under consideration (See **Figure 3**) are separately assessed in **Table 4**. Potential impacts here refer mainly to any associated new access roads, which may entail substantial surface disturbance or clearance, since bedrock excavations for the pylon footings are generally small.

6.1. Palaeontological sensitivity of the project area

According to the provisional palaeosensitivity map based on the DFFE Screening Tool, the Patatskloof WEF and grid connection project areas includes outcrop areas of Low to Very High palaeosensitivity (**Figure 58**). It is noted that, in the author's opinion, the palaeosensitivity of many of the formations concerned has been incorrectly coded in the DFFE database.

- **Palaeosensitivity of the WEF project area**

Only a handful of fossil sites has been recorded within the WEF project area during the recent palaeontological heritage site visit (**Figure *61***). None of these sparse fossil remains are rare or of significant scientific or conservation value. They represent forms that occur widely within the outcrop areas of the sedimentary formations concerned. Most of the Cape Supergroup and Karoo Supergroup rock units represented within the study area are generally of low to (at most) medium palaeosensitivity (*cf* **Figure 58**). Important fossil biotas are known elsewhere in the Western Cape from fresh exposures of the Early Carboniferous Waaipoort and Early Permian Whitehill Formations (see above) but in the Patatskloof WEF, BESS and grid connection project area these units are both very poorly exposed and often deeply weathered so their palaeosensitivity here is now low. Similar conclusions have been reached by the author and others in several previous palaeontological heritage reports for the Ceres Karoo region (*e.g.* Almond 2010a-c, 2015, 2016a-b, 2018, 2020a-d, Almond 2022, Butler 2018).

The overall palaeontological sensitivity of the Patatskloof WEF project area is inferred to be generally **LOW** due to (1) poor sedimentary bedrock exposure, (2) high levels of tectonic cleavage development and (3) deep chemical weathering of mudrock facies. No high sensitivity fossil sites or palaeontological heritage No-Go areas were identified here during the present field survey.

The provisional palaeosensitivity mapping shown by the DFFE Screening Tool is therefore *contested* here.

- **Palaeosensitivity of grid connection corridors**

Similar conclusions apply equally to the palaeosensitivity of the various grid connection corridors under consideration to link the Patatskloof WEF to the national grid (see **Figure 5**) which are only treated here at desktop level. The corridors traverse portions of the Ceres Karoo that are underlain by the same stratigraphic units as those studied within the WEF project area and that have, for the most part, already been surveyed for previous electrical infrastructure and renewable energy projects (See PIA reports listed in the References for the Gamma-Omega 765 kV transmission line, Kappa Substation as well as the Perdekloof East, Kolkies, Karee and Pienaarspoort WEFs). Based on these previous PIA studies a general LOW palaeosensitivity for all the various corridors is inferred, with no high sensitivity fossil sites reported within them (Note that the only area where fossiliferous Waaipoort concretions have been recorded (Almond 2016b) lies east of and *outside* the Patatskloof WEF, BESS and grid connection corridor project area; see the extent of the Waaipoort formation in **Figure 12**). There is therefore no preference for any specific grid connection, with the proviso that shorter corridors are likely to have less impact than longer ones.

The palaeosensitivity mapping shown by the DFFE Screening Tool is *contested* here.

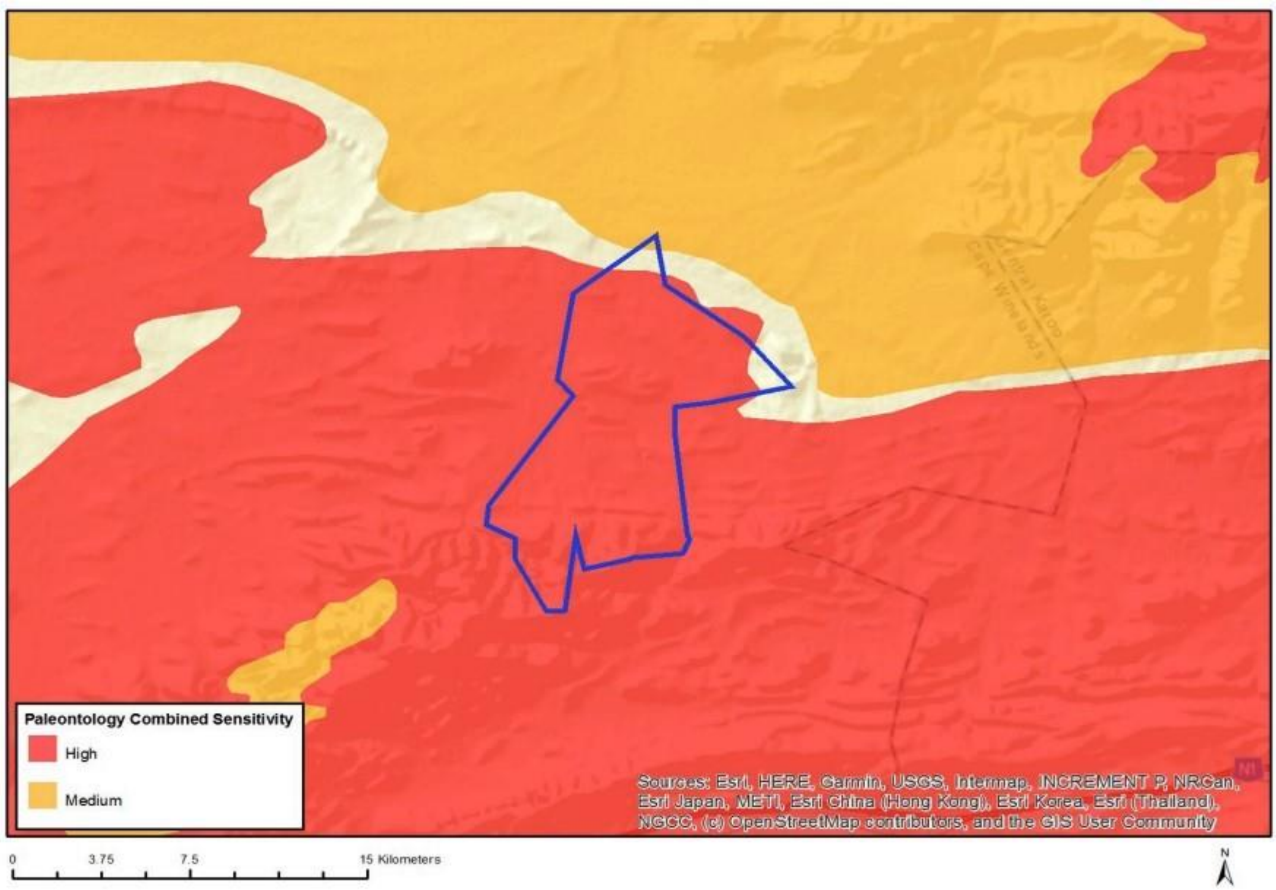

Figure 58: Paleontological sensitivity map for the Patatskloof WEF project area. The sensitivity ratings for many of the rock units involved are erroneous, in the author's view. Due to the scarcity of well-preserved, scientifically important fossils over the great majority of this region, based on several desktop studies and recent palaeontological fieldwork, it is inferred that the WEF and grid connection project areas are in practice of LOW palaeontologically sensitivity.

6.2. Identification of Potential Impacts

The construction phase of the proposed WEF, BESS and grid connection will entail extensive surface clearance as well as excavations into the superficial sediment cover and underlying bedrock (*e.g.* for widened or new access roads, wind turbine foundations, hardstanding areas, on-site substation, underground cables, construction laydown area, O&M building, overhead power lines, BESS *etc*). Construction of the facility may adversely affect potential fossil heritage within the development footprint by damaging, destroying, disturbing or permanently sealing-in fossils preserved at or beneath the surface of the ground that are then no longer available for scientific research or other public good. The planning, operational and de-commissioning phases of the facility are unlikely to involve further adverse impacts on local palaeontological heritage and are therefore not separately assessed in this report. The potential palaeontological heritage resource impacts identified during the PIA assessment can be briefly summarized as follows:

- ***Planning / Pre-construction Phase***

No significant impacts on palaeontological heritage anticipated.

- ***Construction Phase***

Potential Impact 1: Disturbance, damage or destruction of fossil heritage resources preserved at or below the ground due to surface clearance and excavations (especially into sedimentary bedrock).

- ***Operational Phase***

No significant impacts on palaeontological heritage anticipated.

- ***Decommissioning Phase***

No significant impacts on palaeontological heritage anticipated

- ***Cumulative impacts***

No significant cumulative impacts on palaeontological heritage anticipated as a consequence of multiple renewable energy developments(wind, solar and grid connections) in the region.

6.3. Assessment of WEF and grid connection project impacts

Current impacts on palaeontological heritage within the Patatskloof WEF, BESS and grid connection project areas include ongoing destruction of fossils by natural weathering and erosion processes plus very minor impacts due to agricultural activities. Loss of fossils due to illegal collection is probably negligible.

Potential impacts of the construction phase of the proposed Patatskloof WEF, BESS and associated grid connection on local fossil heritage resources, with and without mitigation, are assessed below in **Table 3** and **Table 4** respectively, according to the Environmental Impact Assessment (EIA) Methodology developed by SiVEST. Further significant impacts on fossil heritage during the planning, operational and decommissioning phases of the facility are not anticipated.

Given the closely comparable geology of the WEF and grid connection project areas, the inferred impact ratings are the same in both cases.

6.3.1. Construction Phase: Disturbance, damage or destruction of fossils

The destruction, damage or disturbance out of context of legally-protected, scientifically-important fossils preserved at the ground surface or below ground that may occur during construction of the WEF, BESS / grid connection entail *direct negative* impacts to palaeontological heritage resources that are confined to the development footprint (*site*). These impacts can often be mitigated but cannot be fully rectified (*i.e.* they are *irreversible*). All the sedimentary formations represented within the study area contain fossils of *some* sort, so impacts at some level on fossil heritage are definite. However, the majority of the fossils recorded are of widespread occurrence and low scientific or conservation value while sedimentary bedrock exposure levels are low to very low. Impacts on rare, well-preserved fossils of high scientific / conservation significance are therefore *unlikely*. Since most (but *not* all) of the fossils concerned are probably of widespread occurrence elsewhere within the outcrop areas of the formations concerned, the potential loss of irreplaceable fossil resources without mitigation is therefore rated as *marginal*. Such impacts are of *permanent* duration. Their intensity / magnitude during the construction phase is rated as *low* without mitigation. Without mitigation, a NEGATIVE LOW impact significance is accordingly inferred for both the WEF, BESS and grid connection projects. The assessment applies equally to all grid connection options under consideration.

Potential negative impacts can be reduced through implementation of the Chance Fossil Finds Procedure during the construction phase. With mitigation, the impact significance of the proposed WEF / grid connection project remains NEGATIVE LOW but potential improvements to the palaeontological database through professional mitigation can be regarded as a positive impact..

Confidence levels of this assessment are HIGH because it is supported by several previous palaeontological field assessments undertaken in the broader Ceres Karoo / Tanqua Karoo region by the author and colleagues (See References and discussion on cumulative impacts below).

6.3.2. No-Go Option impacts

In the case of the No-Go Alternative (*i.e.* no WEF, BESS / grid development), the possible loss of local heritage resources through construction activities (negative impact) would be avoided while potential improvements in palaeontological understanding through professional mitigation - *i.e.* recording and collection of palaeontological material and data (positive impacts) - would be lost. The slow destruction of fossils exposed at the surface through natural weathering and erosion would continue (with very minor negative impacts attributable to agricultural activities or illegal fossil collection), but at the same time new fossils are revealed for scientific study. On balance, it is concluded that No-Go alternative would have a *neutral* impact on palaeontological heritage.

6.4. Cumulative impacts

Cumulative impacts addressed here principally concern the *potential* loss of a significant fraction of scientifically valuable and legally-protected fossil heritage preserved within the Lake Mentz Group (Witteberg Group), Dwyka Group, lower Ecca Group and older alluvial deposits in the Ceres Karoo region of the Western Cape through multiple alternative energy developments (**Figure 59** and **Table 2**). Project areas which are underlain by quite different stratigraphic units with very different fossil assemblages - such as the Bokkeveld Group or Beaufort Group - are not considered to be strictly relevant for the present cumulative impact analysis (*e.g.* Kudusberg WEF, Oya Energy Facility, Brandvallei WEF, Montague Road Solar and Touwsrivier Solar Facilities). Since potentially fossiliferous, consolidated Late Caenozoic alluvial deposits will normally not be impacted in WEF developments because they usually lie along well-buffered drainage lines they are not considered for the purpose of this analysis.

Several existing, proposed or authorised renewable energy projects within a 35 km radius of the Patatskloof WEF and grid connection project areas are mapped in **Figure 59** below (No comprehensive data is available for any other large-scale industrial developments in the region). PIA reports for the majority of these projects have been submitted by the present author (see References) who has also undertaken studies for additional renewable energy projects in the region which are not shown on the map (*viz*. Perdekraal West WEF, Pienaarspoort 1 and 2 WEFs, Veroniva Solar, Sadawa Solar, Kolkies Solar projects,). PIA reports are also available for the Tooverberg WEF by Butler (2018) and for the Witberge WEF by Hart and Miller (2011).

The cumulative impacts analysis shown in **Table 2** is based on the Environmental Impact Assessment (EIA) Methodology developed by SiVEST.This cumulative impact assessment applies only to the construction phases of the renewable energy developments, since significant additional impacts on palaeontological heritage during the planning, operational and de-commissioning phases are not anticipated.

In all the strictly *relevant* field-based palaeontological studies in the Ceres Karoo listed above the palaeontological sensitivity of the project area and the palaeontological heritage impact significance for the developments concerned has been rated as *low*. In all cases it was concluded by the author that, despite the potential occurrence of scientifically-important fossil remains (notably fossil vertebrates, petrified wood), the overall impact significance of the proposed developments was low because the probability of significant impacts on *scientifically important, unique or rare fossils* was slight. While fossils do indeed occur within most of the formations present, they tend to be sparse – especially as far as fossil vertebrates are concerned - while the great majority represent common forms that occur widely within the outcrop areas of the rock units concerned. Important exceptions include well-articulated skeletal remains of palaeoniscoid fish and mesosaurid reptiles in the Waaipoort and Whitehill Formations.

Anticipated cumulative impacts of the known renewable energy projects proposed or authorised for the margins of the Ceres Karoo region– *including* the associated grid connection - are assessed as *NEGATIVE LOW* without mitigation. The overall impact significance remains NEGATIVE LOW with full mitigation but impacts will then occur at a lower intensity and will be partially offset by valuable new scientific data. The analysis only applies *provided that* all the proposed monitoring and mitigation recommendations made for all these various renewable energy projects are followed through (*N.B.* This is inherently unpredictable, and, sadly, unlikely). Unavoidable residual negative impacts may be partially offset by the improved understanding of Ceres Karoo palaeontology resulting from appropriate professional mitigation. This is regarded as a *positive* impact for Karoo palaeontological heritage.

In conclusion, the cumulative impacts on local fossil heritage anticipated for the various renewable energy projects in the Ceres Karoo region of the Western Cape – including the proposed Patatskloof Wind Energy Facility and its associated grid connection – fall within acceptable limits, *provided that* all recommended mitigation recommendations for these projects are followed through.

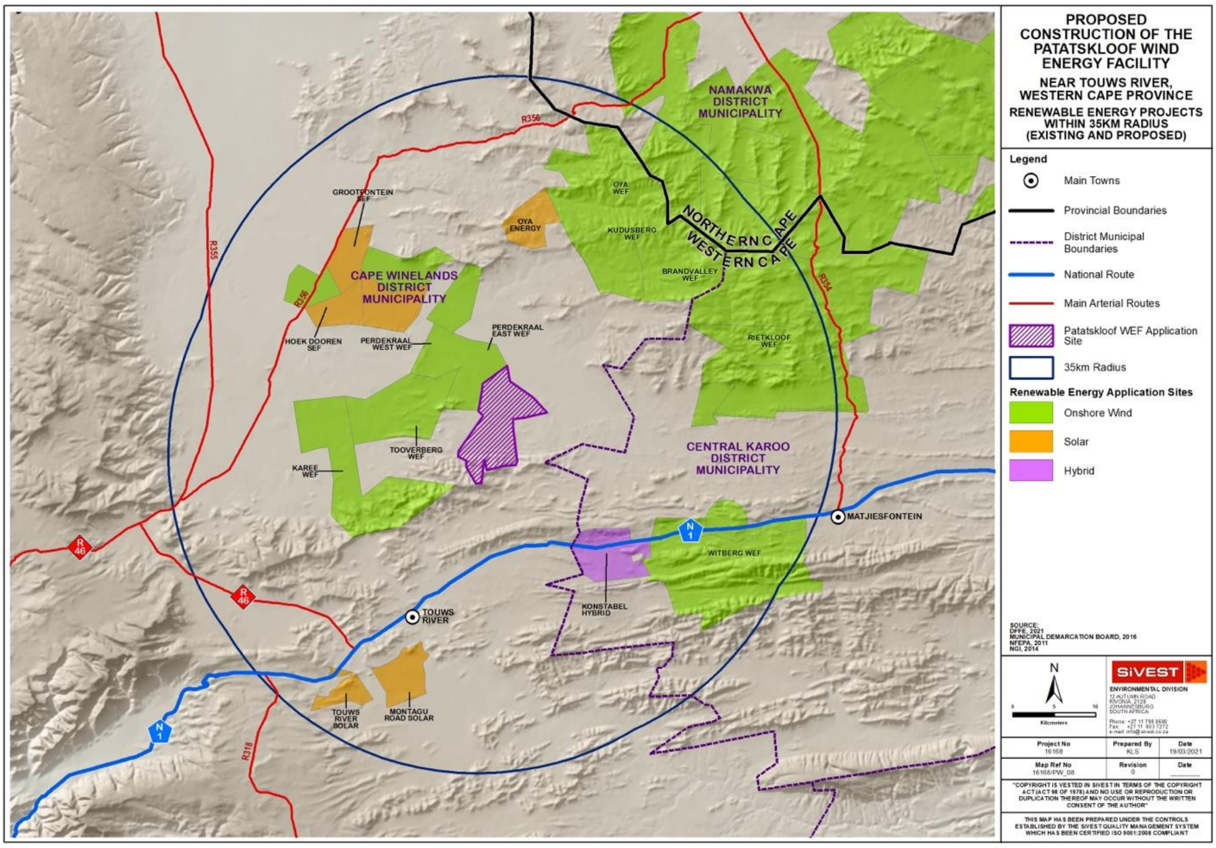

Figure 59: Map showing project areas for authorized and proposed renewable energy projects within a 35 km radius of the Patatskloof WEF, BESS and grid connection project areas (Image provided by SiVEST). Additional unmapped renewable energy projects and PIA reports based in the broader Ceres Karoo region have also been taken into consideration here (e.g. Pienaarspoort 1 and 2 WEFs, Veroniva Solar, Sadawa Solar, Kolkies Solar) and are listed in the References.

Table 2: Renewable energy developments proposed within a 35km radius of the Patatskloof WEF application site

Applicant	Project	Technology	Capacity	Status of Application / Development
Oya Energy (Pty) Ltd	Oya Energy Facility	Hybrid (Solar / Fuel-Based)	305MW	EIA Process underway
Brandvalley Wind Farm (Pty) Ltd	Brandvalley WEF	Wind	140MW	Approved
Kudusberg Wind Farm (Pty) Ltd	Kudusberg WEF	Wind	325W	Approved
South Africa Mainstream Renewable Power Perdekraal West (Pty) Ltd	Perdekraal West WEF & Associated Grid Connection Infrastructure	Wind	150M	Approved
South Africa Mainstream Renewable Power Perdekraal East (Pty) Ltd	Perdekraal East WEF & Associated Grid Connection Infrastructure	Wind	110MW	Operational
South Africa Mainstream Renewable Power Developments (Pty) Ltd	Karee WEF	Wind	140MW	EIA Process underway
Rietkloof Wind Farm (Pty) Ltd	Rietkloof WEF	Wind	186MW	Approved
ENERTRAG SA (Pty) Ltd	Tooverberg WEF & Associated Grid Connection Infrastructure	Wind	140MW	Approved
Witberg Wind Power (Pty) Ltd	Witberg WEF	Wind	120MW	Approved
Montagu Road Solar (Pty) Ltd	Montagu Road Solar	Solar PV	75MW	Approved
Touwsrivier Solar	Touwsrivier Solar	Solar PV	36MW	Approved

N.B. several of these projects are not strictly relevant for the present analysis while a number of additional renewable energy projects have recently been proposed in the area. A PIA report for the Montagu Road Solar project was not available at the time of writing.

Table 3: Assessment of paleontological heritage impacts for the proposed Patatskloof Wind Energy Facility (Construction Phase)

ENVIRONMENTAL PARAMETER	ISSUE / IMPACT / ENVIRONMENTAL EFFECT/ NATURE	ENVIRONMENTAL SIGNIFICANCE BEFORE MITIGATION									RECOMMENDED MITIGATION MEASURES	ENVIRONMENTAL SIGNIFICANCE AFTER MITIGATION								
		E	P	R	L	D	I / M	TOTAL	STATUS (+ OR -)	S		E	P	R	L	D	I / M	TOTAL	STATUS (+ OR -)	S
Construction Phase																				
Fossil heritage resources	Disturbance, damage or destruction of fossils at or beneath the ground surface due to surface clearance and bedrock excavations	1	1	4	2	4	1	12	_	L	Application of Chance Fossil Finds Procedure during construction phase	1	1	4	2	4	1	12	_	L

Table 4: Assessment of paleontological heritage impacts for the proposed Patatskloof Wind Energy Facility grid connection (Construction Phase) (This assessment applies equally to all corridor options under consideration)

ENVIRONMENTAL PARAMETER	ISSUE / IMPACT / ENVIRONMENTAL EFFECT/ NATURE	ENVIRONMENTAL SIGNIFICANCE BEFORE MITIGATION									RECOMMENDED MITIGATION MEASURES	ENVIRONMENTAL SIGNIFICANCE AFTER MITIGATION								
		E	P	R	L	D	I / M	TOTAL	STATUS (+ OR -)	S		E	P	R	L	D	I / M	TOTAL	STATUS (+ OR -)	S
Construction Phase																				
Fossil heritage resources	Disturbance, damage or destruction of fossils at or beneath the ground surface due to surface clearance and bedrock excavations	1	1	4	2	4	1	12	_	L	Application of Chance Fossil Finds Procedure during construction phase	1	1	4	2	4	1	12	_	L

Table 5: Assessment of cumulative impacts for the Patatskloof WEF, BESS plus grid connection and other renewable energy developments in the region.

Fossil heritage resources	Disturbance, damage or destruction of fossils at or beneath the ground surface due to surface clearance and bedrock excavations	3	2	4	2	4	1	15	_	L	Application of Chance Fossil Finds Procedure during construction phase	3	2	4	2	4	1	15	_	L

6.5. Overall Impact Rating

Overall impact ratings for the Patatskloof WEF, BESS and associated grid connection projects – including all phases of the developments - are provided in **Table *6*** and **Table 7** below (These are essentially the same as the impact tables for the Construction Phase since further significant impacts during the Operational and De-commissioning Phases are not anticipated). The significance of relevant cumulative impacts is assessed in **Table 8**. Recommended monitoring and mitigation measures for these developments – viz. the application of a Chance Fossil Finds Procedure during the Construction Phase **-** are outlined in more detail in **Section 8** of this report.

Table 6: Overall impact rating for the Patatskloof WEF project

ENVIRONMENTAL PARAMETER	ISSUE / IMPACT / ENVIRONMENTAL EFFECT/ NATURE	ENVIRONMENTAL SIGNIFICANCE BEFORE MITIGATION									RECOMMENDED MITIGATION MEASURES	ENVIRONMENTAL SIGNIFICANCE AFTER MITIGATION								
		E	P	R	L	D	I / M	TOTAL	STATUS (+ OR -)	S		E	P	R	L	D	I / M	TOTAL	STATUS (+ OR -)	S
Construction Phase																				
Fossil heritage resources	Disturbance, damage or destruction of fossils at or beneath the ground surface due to surface clearance and bedrock excavations	1	1	4	2	4	1	12	_	L	Application of Chance Fossil Finds Procedure during construction phase	1	1	4	2	4	1	12	_	L

Table 7: Overall impact rating for the Patatskloof WEF grid connection project (applies equally to all options under consideration)

ENVIRONMENTAL PARAMETER	ISSUE / IMPACT / ENVIRONMENTAL EFFECT/ NATURE	ENVIRONMENTAL SIGNIFICANCE BEFORE MITIGATION									RECOMMENDED MITIGATION MEASURES	ENVIRONMENTAL SIGNIFICANCE AFTER MITIGATION								
		E	P	R	L	D	I / M	TOTAL	STATUS (+ OR -)	S		E	P	R	L	D	I / M	TOTAL	STATUS (+ OR -)	S
Construction Phase																				
Fossil heritage resources	Disturbance, damage or destruction of fossils at or beneath the ground surface due to surface clearance and bedrock excavations	1	1	4	2	4	1	12	_	L	Application of Chance Fossil Finds Procedure during construction phase	1	1	4	2	4	1	12	_	L

Table 8: Overall cumulative impact rating for the Patatskloof WEF and grid connection project in the context of other authorized renewable energy developments in the Ceres Karoo region

Fossil heritage resources	Disturbance, damage or destruction of fossils at or beneath the ground surface due to surface clearance and bedrock excavations	3	2	4	2	4	1	15	_	L	Application of Chance Fossil Finds Procedure during construction phase	3	2	4	2	4	1	15	_	L

7. COMPARATIVE ASSESSMENT OF ALTERNATIVES

7.1 Patatskloof WEF

A comparable NEGATIVE LOW impact significance (without mitigation), as assessed in **Table 3**, applies equally to all project infrastructure alternatives and layout options under consideration that are outlined in Section 3.3 of this report. This includes the various site options for the on-site substation and construction laydown area. Given their very similar geological - and hence palaeontological – contexts and anticipated low impact significance, there are no preferences on palaeontological heritage grounds for any particular layout among the various site options under consideration.

Key

PREFERRED	The alternative will result in a low impact / reduce the impact / result in a positive impact
FAVOURABLE	The impact will be relatively insignificant
LEAST PREFERRED	The alternative will result in a high impact / increase the impact
NO PREFERENCE	The alternative will result in equal impacts

Table 9: Comparative assessment of Patatskloof WEF layout options

Alternative	Preference	Reasons (incl. potential issues)
SUBSTATION SITE ALTERNATIVES		
Substation Option 1	None	Similar geological / palaeontological context (low sensitivity)
Substation Option 2	None	
CONSTRUCTION LAYDOWN AREA SITE ALTERNATIVES		
Construction Laydown Area Option 1	None	Similar geological / palaeontological context (low sensitivity)
Construction Laydown Area Option 2	None	

7.2 Patatskloof WEF grid connection

As shown in map **Figure *58***, Grid Options 1 to 6 all traverse terrain of comparable geology and inferred low palaeosensitivity. Grid connections connecting the on-site substation with the Adamskraal Substation (Alt 3, Alt 6) are marginally preferred on palaeontological heritage grounds to those connecting to the Kappa Substation since impacts on potential fossil heritage are minimized through the shortness of the line and of the accompanying access road. *However, there is no marked preference on palaeontological heritage grounds between any one of the six grid connection options, given their very similar geological and palaeontological context and anticipated low impact significance.*

Table 10: Comparative assessment of Patatskloof WEF grid connection options

Alternative	Preference	Reasons (incl. potential issues)
GRID CONNECTION ALTERNATIVES		
Grid Option 3 (Sub1 or 2)	Preferred	Shorter grid line. Either option has similar impact significance due to similar geological context.
Grid Option 6 (Sub 1 or 2)		
Grid Option 1 (Sub1 or 2)	Least preferred	Longer grid line. All options have similar impact significance due to similar geological context.
Grid Option 2 (Sub 1 or 2)		
Grid Option 4 (Sub1 or 2)		
Grid Option 5 (Sub1 or 2)		

8. PROPOSED MONITORING AND MITIGATION: INPUT TO EMPR

A very small number of fossil sites have been recorded within the Patatskloof WEF project area (Section **5**, Appendix 2) as well as in the vicinity of but *outside* some of the grid connection options under consideration (**Figure *61***). All the known fossil sites lie well away from the proposed WEF infrastructure footprints (see satellite image **Figure *61***) while all are rated as being of low scientific or conservation significance (Proposed Field Rating IIIC Local Resource; see tabulated palaeontological data in Appendix 2) ***The distribution of fossil sites need therefore have no influence on the proposed layout of the WEF or associated grid connections.***

During the construction phase the Chance Fossil Finds Protocol summarized in Appendix 4 should be fully implemented (See also summary of monitoring and mitigation recommendations in Table 11 below). The Environmental Control Officer (ECO) / Environmental Site Officer (ESO) responsible for the development should be made aware of the possibility of important fossil remains (vertebrate bones, teeth, 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 Environmental Site Officer on an on-going basis during the construction phase is therefore recommended. Significant fossil finds should be safeguarded and reported at the earliest opportunity to Heritage Western Cape for recording and sampling by a professional palaeontologist (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).

The palaeontologist responsible for any mitigation work will be required to submit a Work Plan to Heritage Western Cape (HWC) and a Mitigation Report must be submitted to HWC for consideration. All fieldwork and reporting should meet the standards of international best practice as well as those developed for PIA reports by SAHRA (2013) and Heritage Western Cape (2021). Fossil material collected must be safeguarded and curated within an approved palaeontological repository (*e.g.* museum or university collection) with full collection data. **These recommendations must be included within the EMPr for the Patatskloof WEF and associated grid connection developments.**

Table 11: Tabulated summary of monitoring and mitigation recommendations regarding Palaeontological Heritage for the Construction Phase of the Patatskloof WEF and grid connection

PALAEONTOLOGICAL HERITAGE: CONSTRUCTION PHASE					
Impact/Aspect	**Mitigation/Management Actions**	***Responsibility***	***Methodology***	**Mitigation/Management Objectives and Outcomes**	***Frequency***
Disturbance, damage or destruction of fossil remains preserved at or below the ground surface through site clearance of bedrock excavations.	Monitoring of substantial, deeper excavations (> 1m)	ECO / ESO	Visual inspection of excavations Application of Chance Fossil Finds Protocol Safeguarding newly exposed fossils - *in situ*, if feasible – pending mitigation.	Reporting and safeguarding of significant new fossil finds (*e.g.* vertebrate bones, teeth, petrified wood, shells) to Heritage Western Cape for potential mitigation.	Ongoing throughout Construction Phase
	Submission of Work Plan to / application for Fossil Collection permit from responsible Heritage Resources Agency (PHRA) Recording and sampling / collection of significant new fossil finds that have been reported by ECO / ESO	Specialist palaeontologist appointed by developer	Recording of fossil material as well as associated geological data. Professional sampling / collection of fossils. Curation of fossils and site data within an approved repository (museum / university palaeontological collection)	Conservation and recording of new fossil material of scientific / conservation value within project area	Triggered by chance fossil finds alert from ECO / ESO / PHRA
	Palaeontological mitigation reporting to responsible Heritage Resources Agency (PRHA)	Specialist palaeontologist appointed by developer	Submission of Fossil Collection Report to responsible Heritage Resources Agency (PRHA)	Conservation and recording of new fossil material of scientific / conservation value within project area	Following specialist palaeontological mitigation

N.B

- A more detailed Chance Fossil Finds Protocol is appended to the PIA report
- Palaeontological mitigation is normally only needed in the Construction Phase

8. SUMMARY & CONCLUSIONS

8.1 Summary of Findings.

The Patatskloof WEF, BESS and grid connection project areas are underlain by several basinal to shallow marine sedimentary formations of the Witteberg Group (Cape Supergroup), Dwyka Group and Ecca Group (Karoo Supergroup) of Palaeozoic age. All these units are potentially fossiliferous but only two – the Early Carboniferous Waaipoort Formation and the Early Permian Whitehill Formation – are generally regarded as of high palaeosensitivty due to their record of well-preserved fish, mesosaurid reptiles, crustaceans and plant fossils in the Tanqua - Ceres Karoo region and elsewhere. A recent 2-day palaeontological field survey shows that the Waaipoort Formation is very poorly exposed within the WEF project area, although potentially fossiliferous phosphatic carbonate concretions do occur here, while the uppermost several meters of the Whitehill Formation are intensely weathered. The only fossil remains recorded during the site visit comprise (a) occasional stromatolitic carbonate erratics within the Dwyka Group and (2) low-diversity, poorly-preserved trace fossil assemblages in the Floriskraal and Collingham Formations. These fossils occur widely within the outcrop areas of the formations concerned and are not of high scientific interest or conservation value. Desktop reviews of several previous palaeontological assessment reports relevant to the grid connection project area show that the bedrocks here are likewise of low palaeosensitivity with no significant fossil sites recorded within the various grid corridors under consideration.

As a consequence of (1) the paucity of irreplaceable, unique or rare fossil remains within the WEF and grid connection project areas, as well as (2) the extensive superficial sediment cover overlying most potentially-fossiliferous bedrocks here, the overall impact significance of the construction phase of the proposed Patatskloof WEF and grid connection regarding legally-protected palaeontological heritage resources is assessed as LOW (negative status), with and without mitigation. This assessment applies equally to all layout alternatives and grid connection options under consideration. There is therefore no preference on palaeontological heritage grounds for any specific layout (*e.g.* location of on-site substation, construction laydown area, grid connection corridor) among those under consideration. No significant further impacts on fossil heritage are anticipated during the operational and decommissioning phases of the renewable energy developments. The No-Go alternative (*i.e.* no WEF / grid development) would probably have a neutral impact on palaeontological heritage.

No palaeontological High Sensitivity or No-Go areas have been identified within the WEF and grid connection project areas. None of the recorded fossil sites lies within the development footprint as currently defined. Pending the potential discovery of significant new fossil material here during the construction phase, no specialist palaeontological monitoring or mitigation is recommended for these developments. The Environmental Site Officer (ESO) should be made aware of the possibility of important fossil remains (bones, teeth, fish, 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 Environmental Site Officer on an on-going basis during the construction phase is therefore recommended. Significant fossil finds should be safeguarded and reported at the earliest opportunity to Heritage Western Cape for recording and sampling by a professional palaeontologist. A protocol for Chance Fossil Finds is appended to this report (Appendix 4). These recommendations must be included within the EMPrs for the Patatskloof WEF and grid connection developments.

Provided that these monitoring and mitigation measures are followed through, residual impacts for the Patatskloof WEF and grid projects are rated as LOW. Inevitable loss of some fossil heritage during the construction phase may be - at least partially - offset by an improved understanding of local palaeontological heritage through professional recording and mitigation of any significant new fossil finds (This may be considered as a positive impact).

Due to the generally low palaeosensitivity of the Ceres Karoo as a whole, anticipated cumulative impacts of the known renewable energy projects proposed or authorised in the region are assessed as LOW (negative) with and without mitigation. It is concluded that, as far as fossil heritage resources are concerned, the proposed Patatskloof WEF and grid connection projects, whether considered individually or together, will not result in any unacceptable loss or impact considering all the renewable energy projects proposed in the area. This analysis only applies provided that all the proposed monitoring and mitigation recommendations made for the other renewable energy projects proposed or authorised in the Ceres Karoo are fully and consistently implemented.

There are no fatal flaws in the Patatskloof WEF and grid development proposals as far as fossil heritage is concerned. Provided that the proposed recommendations for palaeontological monitoring and mitigation are fully implemented, there are no objections on palaeontological heritage grounds to authorization of these renewable energy developments.

8.2 Conclusions and Impact Statement

In terms of palaeontological heritage resources, the proposed Patatskloof WEF, BESS and associated grid connection are assigned a similar overall impact significance rating (Construction Phase) of NEGATIVE LOW without mitigation and NEGATIVE LOW following mitigation. No significant further impacts on fossil heritage resources are anticipated in the planning, operational and decommissioning phases. The No-Go Option is likely to have a neutral impact significance. All layout options under consideration have a similar impact significance and there is therefore no preference on palaeontological heritage grounds for a specific design option (e.g. on-site substation location, grid connection corridor). Anticipated cumulative impacts in the context of several planned or authorized renewable energy projects in the Ceres Karoo region are assessed as NEGATIVE LOW with and without mitigation and therefore fall within acceptable limits.

The proposed Patatskloof WEF, BESS and grid connection developments are not fatally flawed and, on condition that the recommended mitigation measures are included within the EMPr and implemented in full, there are no objections on palaeontological heritage grounds to their authorization.

This palaeontological impact assessment - including the tables provided in Sections 6 and 7 of the report – together with recommendations for the Environmental Management Programme apply to the final proposed layouts of the Patatskloof WEF (with refined buildable areas as shown in **Figure *60*** at the end of this report) and the associated Grid Connection.

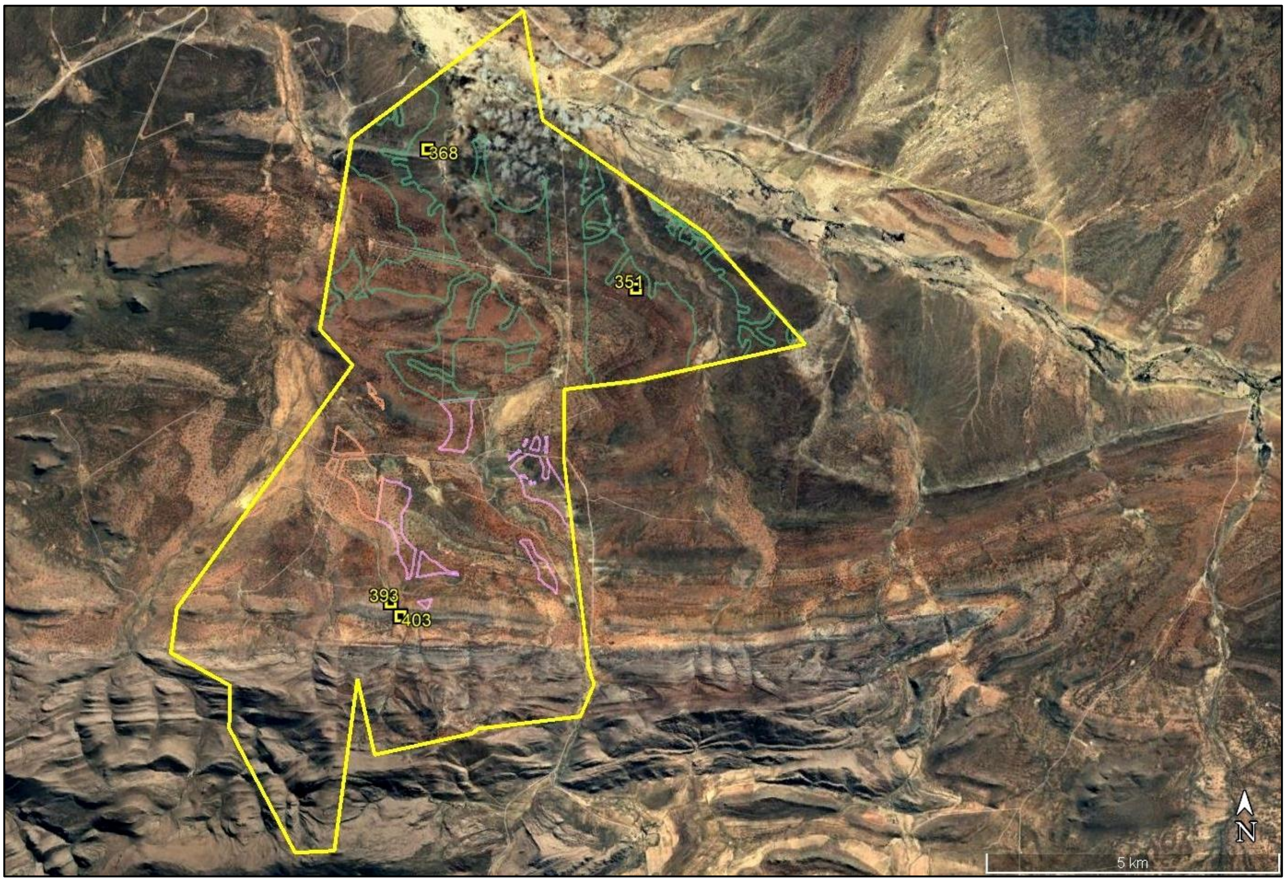

Figure 60: Google Earth© satellite showing recorded fossils sites in the context of the Patatskloof WEF project area (yellow polygon) and refined buildable areas (green and pink polygons). Note than none of the fossil sites falls within the buildable areas.

9. REFERENCES

N.B. Extensive references to the technical geological and palaeontological literature for the Ceres Karoo are provided in the various PIA reports by Almond listed below.

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APPENDIX 1: JOHN ALMOND SHORT CV

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).

APPENDIX 2: PATATSKLOOF WEFS FOSSIL SITE DATA – DECEMBER 2020

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 recoded during the 2-day field survey. The absence of recorded fossil sites in any area therefore does *not* mean that no fossils are present there.

See **Figure *61*** below for plot of new fossil sites on a satellite map of the Patatskloof WEF, BESS and associated grid connection project areas.

Loc.	GPS data	Comments
351	S33° 06' 23.6" E20° 10' 31.5"	RE/246. Dwyka Group boulder beds. One of a few erratic boulders and cobbles of greyish stromatolitic dolomite embedded within Dwyka Group boulder beds exposed on the eastern sector RE/246. The stromatolites may well be of Precambrian age but it is noted that fossiliferous carbonate erratics of Cambrian age are also known within the Dwyka Group along the southern Karoo margins. Proposed Fields Rating IIIC Local Resource. No mitigation recommended.
368	S33° 05' 06.4" E20° 08' 14.0"	RE/250. Collingham Formation. Interbedded pale creamy, fine-grained tuff (volcanic ash) and grey silicified mudrock of the Collingham Formation on hillslopes in the northern sector of RE/250 showing biogenic reworking of the two sediment types within small invertebrate burrows. Proposed Fields Rating IIIC Local Resource . No mitigation recommended.
393	S33° 09' 16.8" E20° 07' 49.7"	RE/250. Waaipoort Formation. Wave-rippled upper bedding surface of fine-grained wacke showing sparse invertebrate burrows (epichnial furrows) within a stream bed exposure of the Waaipoort Formation on the northern side of Hartbeeskloof, RE/250. Proposed Fields Rating IIIC Local Resource. No mitigation recommended.
394	S33° 09' 18.0" E20° 07' 49.6"	RE/250. Waaipoort Formation. Zone of sphaeroidal, pearly blue-black phosphatic concretions within the lower Waaipoort Formation on the northern side of Hartbeeskloof on RE/250. Such nodules might well contain fossil vascular plant and fish remains but none were recorded here. No mitigation recommended.
403	S33° 09' 24.4" E20° 07' 56.1"	RE/250 Floriskraal Formation. Dense assemblage of poorly-preserved U-shaped burrows (*cf Diplocraterion*) showing only the base of the trace fossils, seen here in a sandstone float block from the Floriskraal Formation. Proposed Fields Rating IIIC Local Resource. No mitigation recommended.

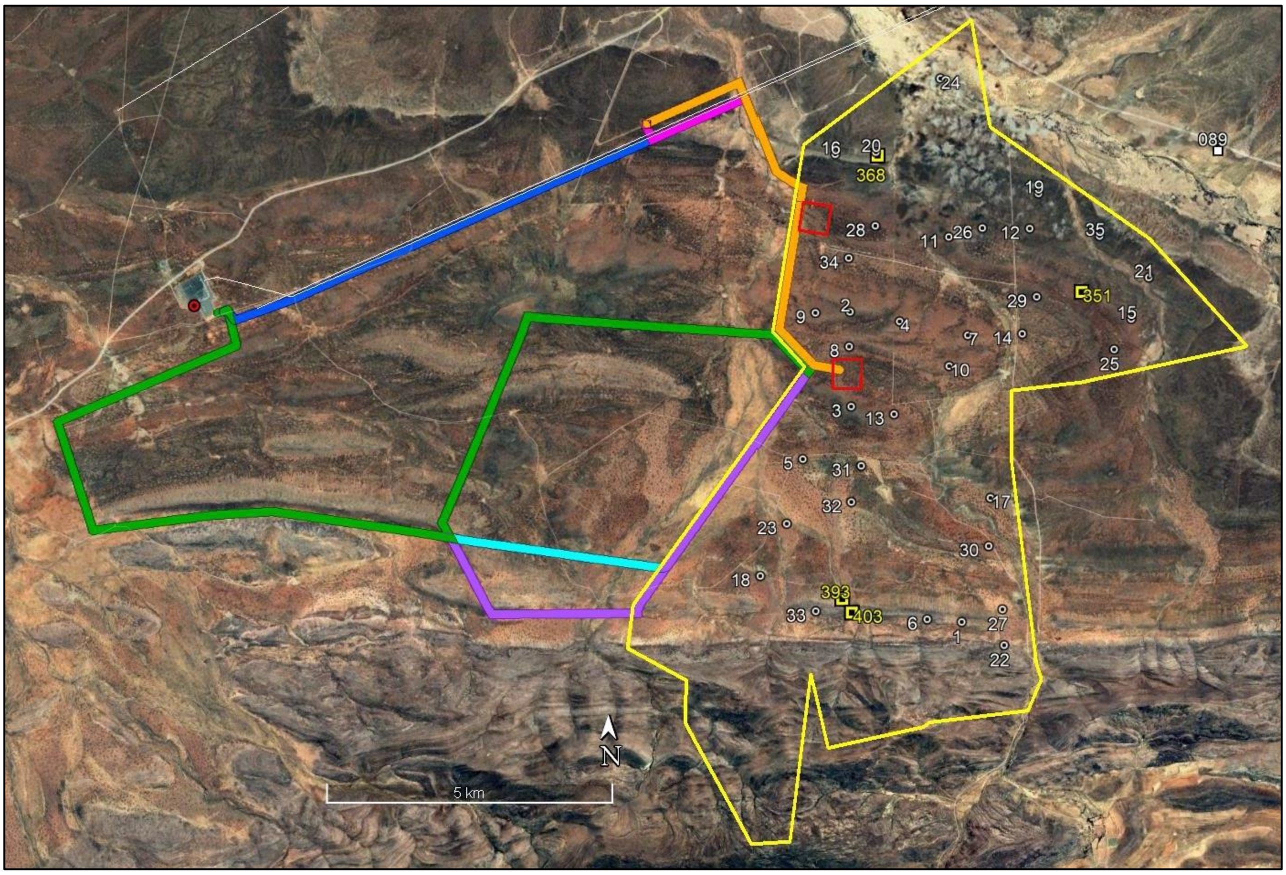

Figure 61: Google Earth© satellite image of the Patatskloof WEF project area in the Ceres Karoo, Western Cape (yellow polygon) showing new fossil sites recorded during the recent field study (yellow numbered squares; see table above for details). White numbered circles = provisional wind turbine locations. Red squares = two options for on-site substation. Also shown are the various grid connection options to Kappa or Adamskraal Substations.

None of the recorded fossil sites of high scientific or conservation significance (Proposed Field Rating IIIC Local Resource) and they do not lie within the footprint of the WEF (*N.B*. this is currently incomplete – *e.g.* access road network to be determined) or within the grid connection corridors. Based on a desktop review of several relevant PIA reports, no significant fossil sites have been previously recorded within the grid corridors.

APPENDIX 3: SITE SENSITIVITY VERIFICATION (IN TERMS OF PART A OF THE ASSESSMENT PROTOCOLS PUBLISHED IN GN 320 ON 20 MARCH 2020

3.1. Introduction

It is proposed to develop the Patatskloof WEF, BESS and associated grid infrastructure on a site in the Ceres Karoo located approximately 20 northeast of Touwsrivier in the in the Cape Winelands District Municipality, Western Cape Province. The WEF will comprise up to thirty-five wind turbines with a maximum total energy generation capacity of up to approximately 250MWac. The electricity generated will be fed into the national grid *via* a 132kV overhead power line toeither Kappa Substation or Adamskraal substation in the Ceres Karoo.

In accordance with Appendix 6 of the National Environmental Management Act (Act 107 of 1998, as amended) (NEMA) Environmental Impact Assessment (EIA) Regulations of 2014 (as amended), a site sensitivity verification has been undertaken in order to confirm the current land use and environmental sensitivity of the proposed project area as identified by the National Web-Based Environmental Screening Tool (Screening Tool).

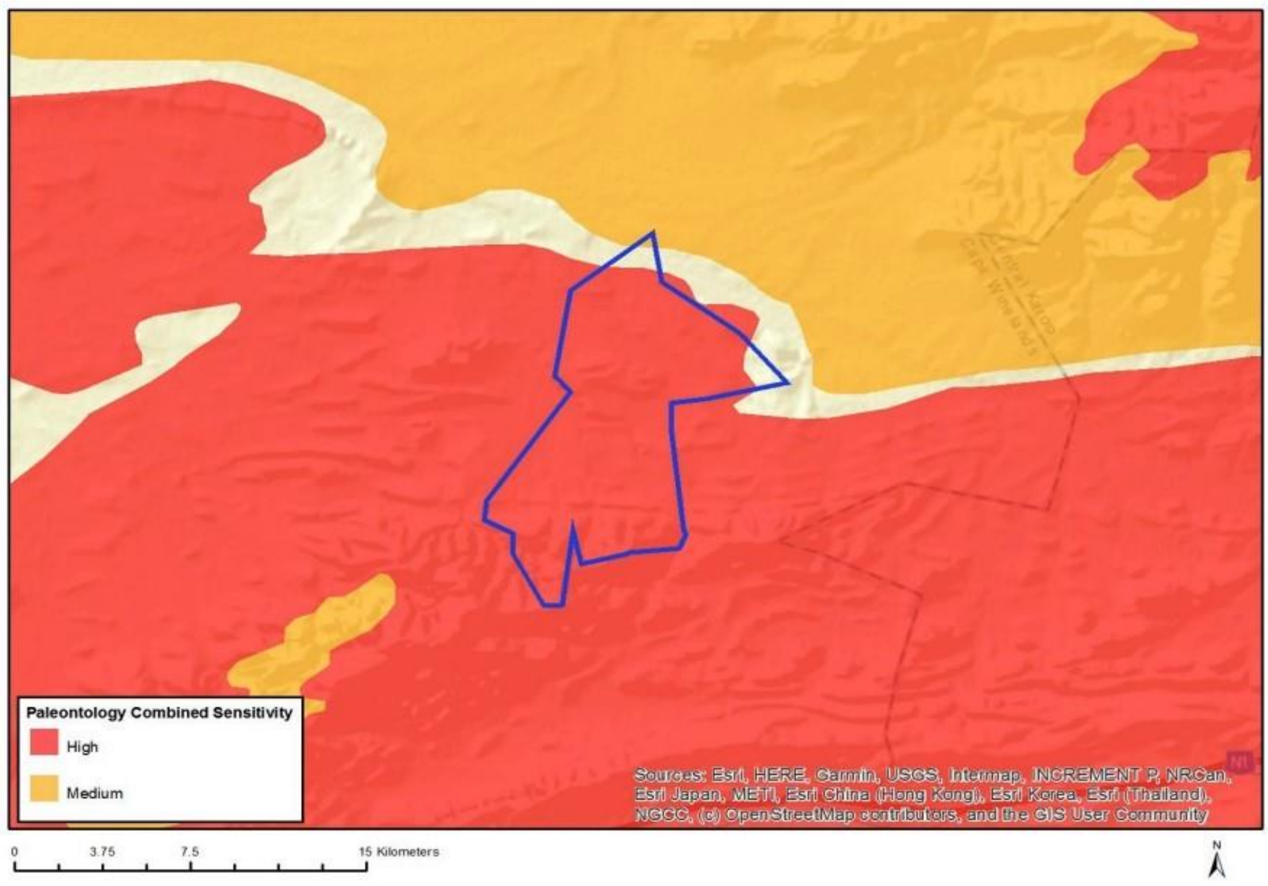

Figure 62: DFFE Screening Tool paleontological sensitivity map for the Patatskloof WEF project area. The sensitivity ratings for many of the rock units involved are erroneous, in the author's view. Due to the scarcity of well-preserved, scientifically important fossils over the great majority of this region, based on several desktop studies and recent palaeontological fieldwork, it is inferred that the WEF and associated grid connection project areas are in practice of LOW palaeontologically sensitivity.

3.2. National environmental screening tool

According to the provisional palaeosensitivity map based on the DFFE Screening Tool, the Patatskloof WEF and grid connection project areas includes outcrop areas of Low to High palaeosensitivity (**Figure *62***). It is noted that, in the author's opinion, the palaeosensitivity of many of the formations concerned has been incorrectly coded in the DFFE database.

3.3. Site sensitivity verification

The desktop and field-based Palaeontological Heritage Site Sensitivity Verification of the Patatskloof WEF, BESS and grid connection project areas was based on the following information resources:

1. A detailed project outline, kmz files, screening report and maps provided by SiVEST Environmental Division and PGS Heritage;
2. A desktop review of: (a) the relevant 1:50 000 scale topographic maps, (b) Google Earth© satellite imagery, (c) published geological and palaeontological literature, including 1:250 000 geological maps (3220 Ladismith, 3319 Worcester) and relevant sheet explanations as well as (d) several previous and fossil heritage (PIA) assessments for renewable energy and transmission line projects in the Ceres Karoo region near Touwsrivier by the author and colleagues.
3. The author's field experience with the formations concerned and their palaeontological; and
4. A two-day field assessment of the Patatskloof WEF project area, including portions of all land parcels involved, by the author and an experienced field assistant during the period 5 and 6 December 2020. Sectors of the Grid Connection project area lying outside the WEF project area itself were *not* re-surveyed but are treated here on a desktop level. This is because the areas concerned have already been well-covered by previous field-based palaeontological heritage studies for earlier renewable energy and transmission line projects and are therefore considered to be well-understood as well as generally of low palaeosensitivity.

3.4. Outcome of site sensitivity verification

- **Paleosensitivity of the WEF project area**

Only a handful of fossil sites has been recorded within the Patatskloof WEF project area during the recent palaeontological heritage site visit. None of these sparse fossil remains are rare or of significant scientific or conservation value. They represent forms that occur widely within the outcrop areas of the sedimentary formations concerned. Most of the Cape Supergroup and Karoo Supergroup rock units represented within the study area are generally of low to (at most) medium palaeosensitivity. Important fossil biotas are known elsewhere in the Western Cape from fresh exposures of the Early Carboniferous Waaipoort and Early Permian Whitehill Formations (see above) but in the Patatskloof WEF and grid connection project area these units are both very poorly exposed and often deeply weathered so their palaeosensitivity here is now low. Similar conclusions have been reached by the author and others in several previous palaeontological heritage reports for the Ceres Karoo region.

The overall palaeontological sensitivity of the Patatskloof WEF project area is inferred to be generally LOW due to (1) poor sedimentary bedrock exposure, (2) high levels of tectonic cleavage development and (3) deep chemical weathering of mudrock facies. No high sensitivity fossil sites or palaeontological heritage No-Go areas were identified here during the present field survey.

The palaeosensitivity mapping shown by the DFFE Screening Tool is therefore *contested* here,

- **Palaeosensitivity of grid connection corridors**

Similar conclusions apply equally to the palaeosensitivity of the various grid connection corridors under consideration to link the Patatskloof WEF to the national grid. The corridors traverse portions of the Ceres Karoo that are underlain by the same stratigraphic units as those studied within the WEF project area and that have, for the most part, already been surveyed for previous electrical infrastructure and renewable energy projects. Based on these previous PIA studies a general LOW palaeosensitivity for all the various corridors is inferred, with no high sensitivity fossil sites reported within them

The palaeosensitivity mapping shown by the DFFE Screening Tool is *contested* here.

3.5. Conclusion

On the basis of both desktop and field data, the Patatskloof WEF, BESS and grid connection project areas in the Ceres Karoo, Western Cape are inferred to be generally of Low Palaeosensitivity in practice. **The provisional Low to High Palaeosensitivities proposed by the DFFE Screening Tool for these areas are therefore contested.**

<table>
<tr><th colspan="3">APPENDIX 4: CHANCE FOSSIL FINDS PROCEDURE: Patatskloof WEF and grid connection, Ceres Karoo near Touwsrivier</th></tr>
<tr><td>Province & region:</td><td colspan="2">Western Cape: Cape Winelands District Municipality / Witzenberg Local 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">Witteberg Group (Kweekvlei, Floriskraal & Waaipoort Fms), Dwyka Group, Ecca Group (Prince Albert, Whitehill, Collingham & Tierberg Formations), Late Caenozoic colluvium and alluvium.</td></tr>
<tr><td>Potential fossils</td><td colspan="2">In bedrocks: fossil fish, mesosaurid reptiles, shelly invertebrates, vascular plants (incl. petrified wood), trace fossil assemblages. In colluvium and alluvium: teeth, bones and horncores of mammals, non-marine molluscs, calcretised trace fossils (e.g. termitaria), reworked fossil wood.</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>

To be appended

APPENDIX 5: Specialist Declaration