Hoedemaker Member beds exposed on the slopes of Rondekop

PROPOSED GAMMA 400 kV GRIDLINE PROJECT

Palaeontological Heritage

DFFE Reference:	**TBA**
Report Prepared by:	**Dr John E. Almond**
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EXECUTIVE SUMMARY

Red Cap Energy (Pty) Ltd ('Red Cap') is proposing to develop a 400 kV grid connection (Gamma Gridline Corridor) from the Nuweveld Collector Substation within the authorized Nuweveld Wind Farm Development near Loxton to the existing Eskom Gamma Substation on the Farm Uit Vlugt Fontein 1/265, located some 30 km southeast of Hutchinson. The proposed new gridline would be approximately 110 km long, starting and ending in the Western Cape Province (Central Karoo District Municipality and Beaufort West Local Municipality) while intervening portions of the line would traverse land in the Northern Cape Province (Pixley ka Seme District Municipality and Ubuntu Local Municipality). Associated infrastructure developments include a 300 m x 300 m expansion to the Gamma Substation (including transformers and other standard substation infrastructure) and access tracks for construction and maintenance of the line.

The project area for the Gamma Gridline and associated grid connection infrastructure (the Gamma Gridline Corridor) is underlain by (1) fossiliferous continental sediments of the Teekloof Formation (Lower Beaufort Group, Karoo Supergroup) of Middle to Late Permian age as well as by (2) a range of Late Caenozoic superficial sediments, most of which – with the possible exception of consolidated older alluvial deposits – are, at most, sparsely fossiliferous. However, provisional palaeosensitivity mapping of the project area using the DFFE Screening Tool and SAHRIS suggests that this is largely of Very High sensitivity.

Several previous and ongoing field-based PIA studies for renewable energy projects within and on the margins of the grid connection corridor (*e.g.* Nuweveld East Wind Farm, Mura Solar projects, Modderfontein WEF, iLanga Solar projects, Victoria West Grid Connection project) indicate that occasional vertebrate and other fossil sites of scientific and conservation value do indeed occur here, but they are often sparsely distributed and unpredictable. The slopes of Vaalkop on Farm Leeukloof 43, situated at the western end of the gridline corridor (but *outside* the likely grid footprint), have been identified as a Very High Palaeosensitivity area. The Biesiespoort Station area within the adjoining Noblesfontein WEF and Modderfontein WEF project[1] areas (Farms Nobelsfontein 248, Matjiesfontein 220 and Modderfontein 228) is considered to be a High Sensitivity area on the basis of the long history of key vertebrate fossil collection here. However, this area lies just *outside* and to the north of the Gamma Gridline Corridor. Based on a recent two and a half day reconnaissance-level drive through the Gamma Gridline Corridor as well as recent palaeontological surveys for the renewable energy projects listed above, the great majority of the gridline corridor is likely to be of Low Palaeosensitivity in practice. This is due to (1) extensive cover by unfossiliferous superficial sediments, (2) intense regional dolerite intrusion and (3) near-surface weathering. Good exposures of potentially fossiliferous, consolidated older alluvial deposits were not encountered during the drive-through, even along larger water courses such as the Soutrivier. The provisional DFFE Screening Tool mapping is therefore *contested* here. The potential for unrecorded fossil sites of high scientific / conservation significance within the Lower Beaufort Group bedrocks and older alluvial deposits cannot be excluded, however. These sites can only be recorded through a palaeontological walk-down of the final grid connection route.

The proposed grid connection development will entail excavations into the superficial sediment cover as well as into the underlying, *potentially* fossiliferous bedrocks during the construction phase. As

[1] The EA for the Modderfontein WEF has lapsed and is therefore not expected to be developed.

such, there is a possibility that the development may adversely affect legally protected and scientifically important fossil heritage within the project footprint by destroying, damaging, disturbing or permanently sealing-in fossils at or beneath the ground surface that are then no longer available for scientific research or other public good. Excavations for access track cuttings as well as surface clearance for new sectors of access track (*c*. 46 ha footprint) are likely to be, by far, the most important source of impacts on palaeontological heritage (more than pylon footings, for example).

The significance of impacts on palaeontological heritage resources during the Construction Phase of the proposed Gamma Gridline and associated grid connection infrastructure is assessed as LOW (NEGATIVE), both before and following the recommended mitigation. No impacts are anticipated during the Operational Phase of the project. The impact significance of the No-Go Option is rated as VERY LOW (NEGATIVE). The cumulative impact significance in the context of comparable renewable energy and grid connection developments in the region (within a radius of *c*. 30 km of the Gamma Gridline Corridor) is provisionally assessed as MEDIUM (NEGATIVE) without mitigation. This would fall to LOW (NEGATIVE) *provided that* the proposed monitoring and mitigation recommendations made for all these various renewable energy projects are consistently and fully implemented (this is unfortunately open to question). The anticipated cumulative impacts following full mitigation lie within acceptable limits.

Most - but not all - previously recorded fossil sites of scientific importance within the corridor will have already been collected so mitigation with regard to these sites is not necessary. The potential for further, *unrecorded* sites of high palaeosensitivity within the understudied project area is substantial, however. Proposed palaeontological heritage mitigation for the Gamma Gridline and associated infrastructure development includes:

- Avoidance of Very High Palaeosensitivity areas identified during the Screening Phase, which includes the slopes of Vaalkop on Farm Leeukloof 43 (red polygon, incorporating a buffer zone, in satellite map Figure 6-2), previously identified as a Very High Palaeosensitivity research area for the Hoedemaker Member within the Nuweveld East Wind Farm project area (Almond 2020a) (In contrast, any new High Sensitivity areas identified during the proposed pre-construction walkdown can be effectively mitigated during the Pre-Construction or Construction Phases through professional recording and collection and so need not be avoided).

- A pre-construction walkdown of potentially sensitive sectors of the project footprint - as identified from satellite imagery and the existing fossil database - by a palaeontological specialist. Palaeontological sites of scientific / conservation value should be recorded and, if feasible, collected together with pertinent field data, with recommendations for further mitigation measures – if any are necessary. Micrositing of grid infrastructure is very unlikely to be required.

- Application of a Chance Fossil Finds Protocol during the Construction Phase (See Appendix 2).

The qualified palaeontological specialist involved in the Pre-construction Walkdown and any mitigation triggered by Chance Fossil Finds will need to submit an application for a Fossil Collection Permit (SAHRA) for land portions affected in the Northern Cape and / or a Work Plan to the Heritage Western Cape (HWC) for portions affected in the Western Cape. Fossil material collected must be curated in an approved palaeontological depository (*e.g.* museum / university fossil collection) together with all essential collection data. The palaeontological studies should conform to international best practice for palaeontological fieldwork and adhere as far as possible to the minimum standards for palaeontological heritage studies developed by SAHRA (2013) and HWC (2021). The palaeontological assessment reports must be submitted for consideration to the responsible Provincial Heritage Resources Agency (either SAHRA or HWC).

These mitigation measures must be included within the EMPr for the Gamma Gridline and associated infrastructure development.

No fatal flaws have been identified regarding the proposed development. Provided that the mitigation measures outlined above are included within the EMPr for the project and are fully implemented, there are no objections on palaeontological heritage grounds to environmental authorisation of the Gamma Gridline Corridor.

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;	**1.1** **Appendix 1**
b) a declaration that the specialist is independent in a form as may be specified by the competent authority;	**pp v - vi**
c) an indication of the scope of, and the purpose for which, the report was prepared;	**1.3**
(cA) an indication of the quality and age of base data used for the specialist report;	**1.4**
(cB) a description of existing impacts on the site, cumulative impacts of the proposed development and levels of acceptable change;	**7**
d) the date and season of the site investigation and the relevance of the season to the outcome of the assessment;	**1.4**
e) a description of the methodology adopted in preparing the report or carrying out the specialised process inclusive of equipment and modelling used;	**1.4**
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;	**5 & 6** **Appendix 3**
g) an identification of any areas to be avoided, including buffers;	**6**
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 6-2**
i) a description of any assumptions made and any uncertainties or gaps in knowledge;	**1.5**
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 to 7**
k) any mitigation measures for inclusion in the EMPr;	**8** **Appendix 2**
l) any conditions for inclusion in the environmental authorisation;	**8 & 9**
m) any monitoring requirements for inclusion in the EMPr or environmental authorisation;	**8 & 9**

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;	**11**
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.	
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.	

environmental affairs

Department:
Environmental Affairs
REPUBLIC OF SOUTH AFRICA

DETAILS OF THE SPECIALIST, DECLARATION OF INTEREST AND UNDERTAKING UNDER OATH

	(For official use only)
File Reference Number:	
NEAS Reference Number:	DEA/EIA/
Date Received:	

Application for authorisation in terms of the National Environmental Management Act, Act No. 107 of 1998, as amended and the Environmental Impact Assessment (EIA) Regulations, 2014, as amended (the Regulations)

PROJECT TITLE

PROPOSED GAMMA GRIDLINE

Kindly note the following:

1. This form must always be used for applications that must be subjected to Basic Assessment or Scoping & Environmental Impact Reporting where this Department is the Competent Authority.
2. This form is current as of 01 September 2018. It is the responsibility of the Applicant / Environmental Assessment Practitioner (EAP) to ascertain whether subsequent versions of the form have been published or produced by the Competent Authority. The latest available Departmental templates are available at https://www.environment.gov.za/documents/forms.
3. A copy of this form containing original signatures must be appended to all Draft and Final Reports submitted to the department for consideration.
4. All documentation delivered to the physical address contained in this form must be delivered during the official Departmental Officer Hours which is visible on the Departmental gate.
5. All EIA related documents (includes application forms, reports or any EIA related submissions) that are faxed; emailed; delivered to Security or placed in the Departmental Tender Box will not be accepted, only hardcopy submissions are accepted.

Departmental Details

Postal address:
Department of Environmental Affairs
Attention: Chief Director: Integrated Environmental Authorisations
Private Bag X447
Pretoria
0001

Physical address:
Department of Environmental Affairs
Attention: Chief Director: Integrated Environmental Authorisations
Environment House
473 Steve Biko Road
Arcadia

Queries must be directed to the Directorate: Coordination, Strategic Planning and Support at:
Email: EIAAdmin@environment.gov.za

SPECIALIST INFORMATION

Specialist Company Name:	NATURA VIVA CC			
B-BBEE	Contribution level (indicate 1 to 8 or non-compliant)	4	Percentage Procurement recognition	100
Specialist name:	Dr John Edward Almond			
Specialist Qualifications:	PhD (palaeontology)			
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E-mail:	naturaviva@universe.co.za			

DECLARATION BY THE SPECIALIST

I, **Dr John Edward Almond**, declare that –

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

Signature of the Specialist

NATURA VIVA CC

Name of Company

15 October2022

Date

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amsl	above mean sea level
DFFE	Department of Forestry, Fisheries and the Environment (previously DEA)
ECO	Environmental Control Officer
EMPr	Environmental Management Programme
ESO	Environmental Site Officer
HWC	Heritage Western Cape
Ma	millions of years ago
M amsl	meters above mean sea level
OHL	Overhead Line
PIA	palaeontological heritage impact assessment
SAHRA	South African Heritage Resources Agency
SAHRIS	South African Heritage Resources Information System
WEF	Wind Energy Facility

1 INTRODUCTION

Red Cap Energy (Pty) Ltd (‘Red Cap’) has received Environmental Authorisation for three wind farms and for a 400 kV grid corridor collectively known as Nuweveld Wind Farm Development, located between Loxton and Beaufort West in the Western Cape Province. The approved grid corridor links the Nuweveld Wind Farm projects to the Droërivier Substation located near Beaufort West and approximately 65 km to the south of the wind farms (refer to Figure 1-1).

Red Cap is also proposing to develop four additional wind farms and associated grid connections, known as the Hoogland Projects. The Hoogland Wind Farms are located north and south of the Nuweveld complex. The Hoogland grid connections will terminate at the Nuweveld Collector Substation (refer to Figure 1-1) and are the subject of separate applications.

To expand the capacity of the Eskom grid and improve the functionality of the grid in the area, an additional 400 kV grid connection - referred to hereafter as the Gamma Gridline - is required from the Nuweveld Collector Substation to the existing Eskom Gamma Substation. The latter is situated on the Northern / Western Cape boundary on the Farm Uit Vlugt Fontein 1/265 some 90 km to the east, 4.3 km to the northeast of the N1 trunk road and some 30 km southeast of Hutchinson. The proposed new gridline would be approximately 110 km long, starting and ending in the Western Cape Province (Central Karoo District Municipality and Beaufort West Local Municipality) while intervening portions of the line would traverse land in the Northern Cape Province (Pixley ka Seme District Municipality and Ubuntu Local Municipality).

This additional line will improve functionality by creating a 400 kV ring-line between the Droërivier Substation, Gamma Substation and the Collector Substation, and create opportunities for other renewable energy farm developments (such as the proposed Hoogland projects) to tie-into the grid either at the Nuweveld Collector Substation or along the new 400 kV line. As such, the proposed new line will allow Eskom to release further renewable energy potential in an area that is becoming a renewable energy development node in South Africa, thereby helping to alleviate South Africa’s power crisis.

A 300 m x 300 m expansion to the Gamma Substation (including transformers and other standard substation infrastructure) and access tracks for construction and maintenance of the line will also be required and form components of the present project.

Dr John Edward Almond of *Natura Viva* cc, Cape Town, as been appointed by Red Cap to undertake a combined desktop and field-based palaeontological heritage study of the proposed electrical infrastructure project. The study is triggered by the provisional Very High Palaeosensitivity of the Gamma Gridline Corridor (or project area) as mapped by the DFFE Screening Tool and the SAHRIS Palaeosensitivity Map. Most of the Gamma Grid Corridor falls within the Northern Cape Province but short sectors towards the western and eastern ends fall within the Western Cape Province. The responsible Provincial Heritage Resources Agencies are SAHRA and HWC respectively. The Independent EAP responsible for the project is Ms Belinda Clark of the CEN IEM Unit, Port Elizabeth.

The project triggers activities listed in terms of the Environmental Impact Assessment Regulations, 2014, as amended. These activities require authorisation from the Department of Forestry, Fisheries and the Environment (DFFE), prior to commencement. An application for Environmental Authorisation

(EA) will be submitted and informed by a Basic Assessment (BA) process as the project lies wholly within a strategic transmission corridor[2] specifically identified for the placement of this infrastructure.

Specialist studies have been commissioned to verify the sensitivity and assess the impacts of the project under the Gazetted specialist protocols (GN R 320 and GN R 1150 of 2020).

[2] As per the requirements of Government Notice 113 of 16 February 2018 for transmission lines falling within a strategic transmission corridor.

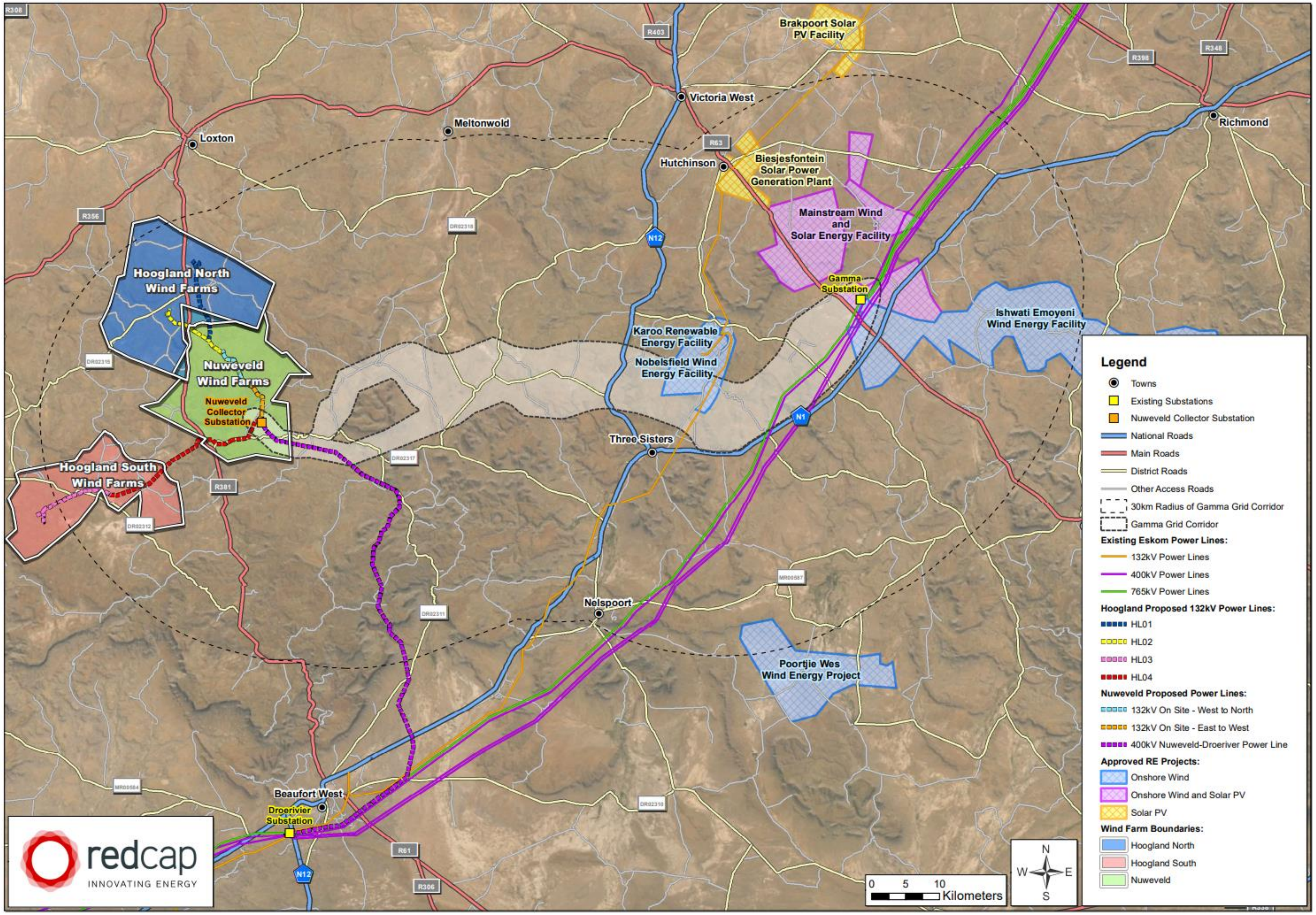


Figure 1-1: Regional context map showing the location of the Gamma Grid Corridor (pale brown polygon) between the Nuweveld Wind Farm Development (green polygon) which is situated between Beaufort West and Loxton and the exiting Eskom Gamma MTS near Hutchinson, located some 90 km to the east. Also shown are several other renewable energy developments of relevance to the cumulative impact assessment for the present project.

2 ASSESSMENT METHODOLOGY

2.1 Specialist Credentials

Dr John Almond of *Natura Viva* cc, Cape Town has a doctoral degree in Palaeontology as well as some thirty years of palaeontological fieldwork experience in the RSA. He has been involved in numerous palaeontological impact assessment projects (PIAs) in the wider Karoo region and elsewhere over the past twenty years or more – including the Red Cap Nuweveld and Hoogland wind farm projects as well as several additional WEF and solar projects in the vicinity of, or overlapping with, the Gamma Grid Corridor project area (please see References and the short Specialist CV provided in Appendix 1).

2.2 Terms of Reference

Please see the Terms of Reference specified by Red Cap in Appendix 4.

2.3 Scope and Purpose of Report

The present desktop PIA report assesses potential impacts on local palaeontological heritage resources that may result from the proposed Gamma Gridline Connection development. It is based on field data from several previous as well as on-going PIA studies for renewable energy projects conducted by the author in the region as well as geological maps and other relevant scientific literature (see Section 1.4). Additional supporting field data from a two and a half-day reconnaissance-level drive through of the Gamma Gridline Corridor undertaken in September 2022

The specialist PIA study will contribute to the over-arching Heritage Impact Assessment - co-ordinated by Dr Jayson Orton of ASHA Consulting, Muizenberg – that forms part of the Basic Assessment process that is being conducted for this grid connection development by CEN, as well as to the relevant EMPr.

2.4 Approach and Methodology

2.4.1 Information sources

The desktop and field-based palaeontological heritage study of the proposed Gamma Gridline Connection is based on the following information resources:

1. A detailed project outline, kmz files, screening report and maps provided by Red Cap;

2. A desktop review of:
(a) the relevant 1:50 000 scale topographic maps (3122CD, DA, DB, DC, DD, 3123CA, CB, CC, CD) and the 1:250 000 scale topographic map 3122 Victoria West),
(b) Google Earth© satellite imagery,
(c) published geological and palaeontological literature, including 1:250 000 geological maps (3122 Victoria West) and the relevant sheet explanation (Le Roux & Keyser 1988), as well as
(d) several previous and on-going fossil heritage (PIA) assessments for renewable energy and transmission line projects in the Karoo region between Beaufort West, Loxton and Victoria West by the author, as listed in the References under Almond;

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 and a half--day, reconnaissance-level palaeontological heritage drive-through of the Gamma Grid Corridor project area by the author on 21 to 23 September 2022. The season in which the site visit took place does not have a critical bearing on this palaeontological study. However, paleontological field studies - including the photographic recording of geological landscapes, rock exposures and fossil sites - in winter weather may be hampered by short days, low light, and rainfall while rainy or muddy conditions may constrain site access and productivity.

2.4.2 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 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 and Northern 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 which is also the basis for the DFFE Screening Tool mapping. 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 within the project footprint. When rock units of moderate to high palaeontological sensitivity are present within the development footprint - as here - 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 the responsible Provincial Heritage Management Agencies (in this case a Fossil Collection Permit from SAHRA and an approved Work Plan from Heritage Western Cape) 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 very large study area, and (2) the extensive superficial sediment cover in some sectors of this region of the Great Karoo, the palaeontological heritage reconnaissance-level field study largely entailed a review of relevant stratigraphy and bedrock exposure levels. Examination of potentially fossiliferous sites with good bedrock exposure – which tend to be concentrated along drainage lines as well as steeper hillslopes and erosion gullies – was not feasible since landowner access permission was not available. Good exposures and sections through Late Caenozoic alluvial deposits were also noted. It is emphasized 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 Great Karoo has a large element of unpredictability. Several fossil sites are discovered simply by chance. 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.

2.5 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 Gamma Gridline Corridor study, several combined desktop and field-based PIA and academic studies have been carried out within the project area as well as on its margins (See References and map Figures 6.2 and 7.1). Bedrock exposure levels here are highly variable – generally poor but locally very good. However, the majority of the area remains unstudied on the ground with few recorded fossil sites while considerable uncertainties remain concerning the mapping of lithostratigraphic units (*e.g.* members) as well as Karoo fossil assemblage zones in this sector of the Main Karoo Basin (Section 5). Confidence levels for the present palaeontological assessment are therefore rated as Medium, at best. As such, a pre-construction walk-down of potentially sensitive / fossiliferous areas prior to construction, as well as a construction phase fossil chance-finds procedure are key recommendations. Noting this, these assumptions and limitations are not anticipated to materially affect the findings of this study.

3 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 Authorisation, this must be carried out by a suitably qualified palaeontological specialist under a Fossil Collection Permit issued by the relevant Heritage Resources Management Agency (In the case of mitigation within the Western Cape, a Work Plan must be submitted for approval by Heritage Western Cape, Cape Town). The fossil material collected must be curated in an approved repository (*e.g.* museum / university collection). Standards for palaeontological reporting and mitigation in the RSA have been established by Heritage Western Cape (2016, 2021) and SAHRA (2013).

4 PROJECT DESCRIPTION

The proposed 400 kV Gamma Gridline would have a ≤ 55m wide servitude, which may be kept clear of taller vegetation (trees) and, where required and feasible, accommodate access tracks needed for construction and maintenance.

Lattice type pylons will be used for the project. Different lattice type pylon will be required along the gridline depending on the topography and span characteristics. Most of the pylons will be cross-rope suspension towers, with self-supporting towers being used at turn points, at steep slopes or where a very large distance needs to be spanned.

All pylon types would attach to concrete plinths and foundations of varying sizes depending on pylon type. Guy wires with concrete anchor blocks will also be required for providing additional support and to stabilise some of the pylons/ towers.

The footprints of the 400 kV towers are conservatively assumed to be 100 m^2 each. The average span of the 400 kV line will be 400 m.

Temporary laydown areas will be identified along the powerline route, with the main equipment and construction yards being based in one of the surrounding towns. It is anticipated that the total area required for the temporary laydown areas is up to 5 ha.

Existing access roads and tracks (upgraded to ± 2-4m wide where needed) will be used as far as possible and new access tracks would be established, where needed, outside of specialist identified No-Go areas. These would be 2-4 m wide (wider than 2m when side drains are needed or due to the topography). For this assessment, Red Cap conservatively assumes that 4 m wide access tracks will be required for the length of the line with an additional 5 km allowance for deviations from the gridline route[3].

4.1 Project Location

The approved Nuweveld Collector Substation is located within the approved Nuweveld East Wind Farm project area on Farm Leeukloof 43, situated some 56 km north of Beaufort West in the Western Cape Province (refer to Figure 1-1). The existing Gamma Substation is located approximately 90 km to the east of the Nuweveld Collector Substation on the Farm Uit Vlugt Fontein 1/265, 4.3 km to the northeast of the N1 trunk road and some 30 km southeast of Hutchinson. Although the gridline starts and ends in the Western Cape (Central Karoo District Municipality and Beaufort West Local Municipality), portions of the line would traverse land in the Northern Cape (Pixley ka Seme District Municipality and Ubuntu Local Municipality).

The current land use along the corridor is characterised by large agricultural holdings with mostly low-density livestock and game grazing being the main land use. Dry climatic conditions are such that cropping is very limited and is restricted to valley bottoms, often near or around farmsteads. The landscape character of the corridor is typical of Great Karoo and comprises sections of plains and open valleys with dispersed drainage systems and rougher terrain including mesas (table type mountains/hills), *koppies*, rocky ridges and outcrops and plateaux.

4.2 Routing of Corridor

Electricity will be stepped-up to 400 kV at the approved Nuweveld Collector Substation for evacuation *via* the *c.* 110 km Gamma Gridline to the existing Gamma Substation (as well as *via* the approved Nuweveld Gridline). The new gridline will form part of the national grid.

The route of the line must be pre-negotiated with the respective landowners, which includes obtaining in-principle agreements from the landowners that the line may traverse their land. While every effort will be made to adhere to the provisional route (following post-authorisation specialist micro-siting), deviations of infrastructure within the route are possible to avoid potential additional No-Go areas (following post-authorisation specialist micro-siting)..

Following a specialist assessment and landowner negotiations, a refined grid connection corridor for assessment purposes has been established. The pre-negotiated route will be aligned within the assessment Corridor, based on specialist studies and recommendations amongst other technical details– see ***Figure 1-1***.

[3] For example, if the line is 110 km long (+ 5km allowance for any deviation), the disturbance footprint (in ha) assumed for access tracks will be ((0.004 km x 115 km) x 100 = 46 ha

4.3 Grid Connection Components

4.3.1 Pylon Types

Lattice type pylons are required for the overhead line. Different pylon types will be required at different areas depending on the topography and span characteristics.The majority of pylons are likely to be the Cross-Rope Suspension Tower, with self-supporting towers only being used at turn points in the alignment.

4.3.2 Access

The site can be accessed *via* the well-established existing road network in the area. Access to the west would be *via* Beaufort West or Loxton using the R381, and access to the central and eastern portions of the corridor would be from the N1 and N12 *via* Three Sisters. Figure 1-1 shows the existing road network in the area.

Existing access roads and tracks (upgraded to ±2-4 m wide where needed) will be used for construction and maintenance as far as possible and new access tracks would also be ±2-4m wide. These tracks would avoid steep areas and drainage lines and rather use existing roads/tracks to cross these features as far as possible.

Access tracks would be upgraded or established during the construction phase to enable access for the construction of the pylons and stringing of the lines. In certain areas, such as where the line spans over a sensitive watercourse, ascends very steep slopes or spans an ecologically sensitive area, the service track will not run parallel to the line but will be routed to access the specific pylons (where possible). These tracks would not be rehabilitated as they would continue to provide access for maintenance and management purposes and will be maintained throughout the life of the project.

It is conservatively assumed that the total area required for the access tracks is up to 46 ha (*i.e.* assuming the new tracks are required for the entire route of the powerline).

4.3.3 Temporary areas

During construction, temporary laydown areas will be identified along the powerline route, with the main construction yards being located along the alignment or in one of the surrounding towns. It is anticipated that the total area required for the temporary laydown areas is up to 5 ha.

4.3.4 Gamma Substation Expansion

A 300 m x 300 m expansion to the Gamma Substation (including transformers and other standard substation infrastructure) forms a component of the project.

4.3.5 Summary of components and disturbance footprints

Table 4-1 below sets out the total disturbance footprint for the project.

Table 4-1: Summary of the components and approximate areas of impact within the Gamma Grid Connection Corridor

Component	Description	Ha
Substation Infrastructure	300 m x 300 m expansion to the Gamma Substation (including transformers and other standard substation infrastructure)	9 ha (permanent)
Overhead lines and pylons	There will be a 400 kV overhead line supported by mostly lattice structure pylons. The spans (distance between pylons) on the pylons are on average 400 m. Each pylon is conservatively assumed to have a footprint of 100 m^2	110 km 2.75 ha (permanent)
Access roads and tracks	Existing access roads and tracks (upgraded to ± 2-4 m wide where needed) will be used as far as possible and new access tracks would be created where needed (±2-4 m wide).	46 ha (permanent)
Temporary areas	Temporary laydown areas will be identified along the alignment, with the main equipment and construction yards being located along the alignment or based in one of the surrounding towns. It is anticipated that the total area required for the temporary laydown areas is up to 5 ha.	5 ha (temporary)
Total disturbance footprint:	**Temporary**	**5 ha**
Total disturbance footprint:	**Permanent**	**57.75 ha**

4.4 Timeframes

Construction is likely to commence no earlier than about 1 year after the issuing of an EA (if approved).

The construction period for the project would be between 18 – 24 months. On completion the gridline would be ceded to Eskom and become part of the National Grid infrastructure. Therefore it is unlikely that it would be decommissioned.

4.5 Alternatives

A comprehensive iterative design process has been undertaken to inform the location of the refined grid connection corridor, including No-Go areas within the corridor.

Integration of the screening and assessment of environmental and social constraints alongside the technical components of the project early in a project lifecycle have allowed for the reduction of risks to the project and supports the application of the mitigation hierarchy by demonstrating the avoidance and minimisation of impacts.

However, the project will be assessed against the '**No-Go' alternative**. The 'No-Go' alternative is the option of not constructing the project where the status quo would prevail.

5 BASELINE DESCRIPTION OF THE RECEIVING ENVIRONMENT

5.1 Topography

The Gamma Gridline Corridor spans a wide spectrum of scenic, semi-arid, karroid terrain within the Upper Karoo physiographic region of the Northern and Western Cape (Partridge *et al.* 2010) within an altitudinal range of approximately 1200 to 1800 m amsl. (see satellite map of corridor Figure 5-3). Higher-lying, mountainous areas in the west (*e.g.* Perdeberg 1798 m amsl), in the centre (*e.g.* Grootkop 1391 m amsl.) and towards the east (SE of The Horseshoe) feature steep-sided mountains, rocky ridges (*e.g.* Grasberg – Skeurberg range) and upland plateaux capped by rugged doleritic terrain and resistant-weathering, baked metasediments. The intervening lower elevation rocky plateaux and alluvial *vlaktes* are largely mantled by gravelly and sandy alluvial deposits, usually with limited bedrock exposure away from drainage lines. They are drained by several, variously deeply-incised to shallow, non-perennial water courses such as the Kromrivier in the west, the Soutriver, Maarhaarspruit and Kookfonteinspruit in the centre, and the Taaibosspruit, Gabrielspruit and Brakrivier in the east. Vegetation cover is dominated by karroid bossies and summer rainfall grasses with woody plants mainly confined along larger watercourses and in sporadic bush clumps.

5.2 Geological context

The geology of the Gamma Gridline Corridor project area is outlined on 1: 250 000 geological sheet 3122 Victoria West (Council for Geoscience, Pretoria) (Figure 5-4) with a short accompanying explanation by Le Roux & Keyser (1988). Illustrated accounts of portions of the project area as well as comparable Upper Karoo areas in the region are given in previous or forthcoming PIA reports by Almond (*e.g.* for the Gamma – Omega Transmission Line, Nuweveld and Hoogland Cluster WEFs, Nuweveld Grid Connection, Modderfontein WEF, Mura Solar Projects) (See Figure 6-2).

The project area is situated in the west-central sector of the Main Karoo Basin of the RSA and is largely underlain at depth by continental (fluvial / lacustrine) sediments of the **Lower Beaufort Group** / **Adelaide Subgroup** (Karoo Supergroup) of late Middle to early Late Permian age (*c*. 260 to 256 Ma = million years ago). According to the current 1: 250 000 geological map, which probably requires revision, the Beaufort Group sedimentary succession represented within the Gamma Gridline Corridor is assigned to the lower part of the Teekloof Formation - *viz*. the sandstone-dominated **Poortjie Member** and the overlying mudrock-dominated **Hoedemaker Member**. The latter, more recessive-weathering unit crops out mainly at the western and eastern extremities of the gridline corridor. Small, isolated intervening outcrop areas of the Hoedemaker Member are often extensively baked by dolerite intrusions in the vicinity. The palaeoenvironmentally and palaeobiologically critical boundary between the Middle and Late Permian Periods at *c*. 260 Ma lies within the lower part of the Poortjie Member (Figure 5-37). The **Oukloof Member** sandstone package overlying the Hoedemaker Member is not mapped within the gridline corridor itself, but occurs just outside this on higher hillslopes on the

Perdeberg, Bobbejaanskop and The Horseshoe. It is very likely that additional, unmapped occurrences of this Teekloof Formation subunit occur within the corridor itself, for example on Modderfontein 228 (*cf* Figure 5-31).

It is noted that the member-scale lithostratigraphy and associated biostratigraphical zonation of the Lower Beaufort Group succession in this sector of the Main Karoo Basin - including the long-distance correlation of the main channel sandstone packages such as the Poortjie Member - remains unresolved (*cf* Day & Rubidge 2020a). The diachronous contact between the Poortjie and Hoedemaker Members in the western sector of the study area is transitional over an interval some 25-30 m. It is marked here by the Reiersvlei meanderbelt package identified by Smith (1987, 2021) and is of considerable palaeontological as well as palaeoenvironmental interest. The precise level of the contact is arbitrary to an extent and has been variously interpreted in maps and scientific literature (*cf* Figures 5-1 & 5-2). On the 1: 250 000 geological map (Figure 5-4) the entire Reiersvlei Meander Belt seems to have been incorporated within the upper Poortjie Member. Smith and Keyser (1995) place the contact at the top of the last thick, multistorey channel sandstone of the Poortjie Member (excluding the Reiersvlei package). The stratigraphic column in Maharaj *et al.* (2019) appears to place the contact at the incoming of thick reddish mudrock packages above Reiersvlei Meanderbelt 2, while the column in Smith *et al.* (2021) places it lower down within a red bed succession at the level of Meanderbelt 1 of the Reiersvlei package.

The Poortjie – Hoedemaker transition zone characterised by a succession of thin, single-storey channel sandstones and intervening, predominantly reddish-brown mudrocks (Smith & Keyser 1995, Paiva 2015, Maharaj et al. 2019, Smith *et al.* 2021) (Figure 5-1, Figure 5-2, Figure 5-14). This stratigraphic interval records the transition from thick, multi-storey channel sandstones dominated by downstream accretion process typical of the Poortjie Member to laterally accreting, meandering river systems of the Hoedemaker Member. The transition is accompanied by more frequent development of crevasse splay deposits and calcareous palaesols on the floodplain driven by increased aridification in the Karoo Basin and aggradation of the Reiersvlei Meanderbelt sedimentary prism (Maharaj *et al.* 2019, Smith *et al.* 2021). In contrast, a subsidence-driven transition is favoured by Paiva (2015).

In this subregion of the Upper Karoo the Lower Beaufort Group sediments are intruded by an extensive network of dyke and sill complexes of the Early Jurassic **Karoo Dolerite Suite** (*e.g.* Perdeberg, Brandersberg, the area NW of Three Sisters, The Horseshoe and rugged uplands to its southeast) (Duncan & Marsh 2006). These intrusions have thermally metamorphosed and altered the adjoining country rocks, locally compromising fossil preservation. Kimberlite pipes or other intrusions are not mapped within the project area (*cf* Late Jurassic ~150 Ma kimberlites of the **Victoria West Province** mapped SW of this town by Skinner & Truswell 2006).

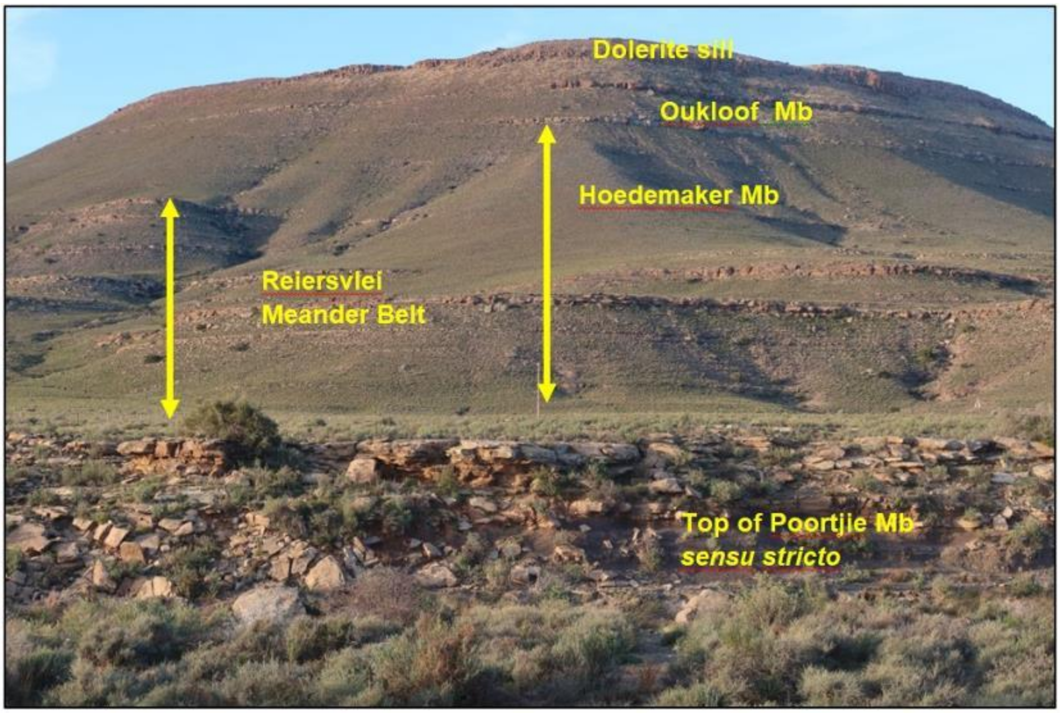


Figure 5-1: South-western slopes of Perdeberg near Booiskraal homestead showing the main lithostratigraphic subunits of the lower Teekloof Formation represented here. The Reiersvlei Meanderbelt package is provisionally included within the base of the Hoedemaker Member here. Previous mapping included it within the upper Poortjie Member while it has been variously partitioned between the members by other workers (see text for discussion).

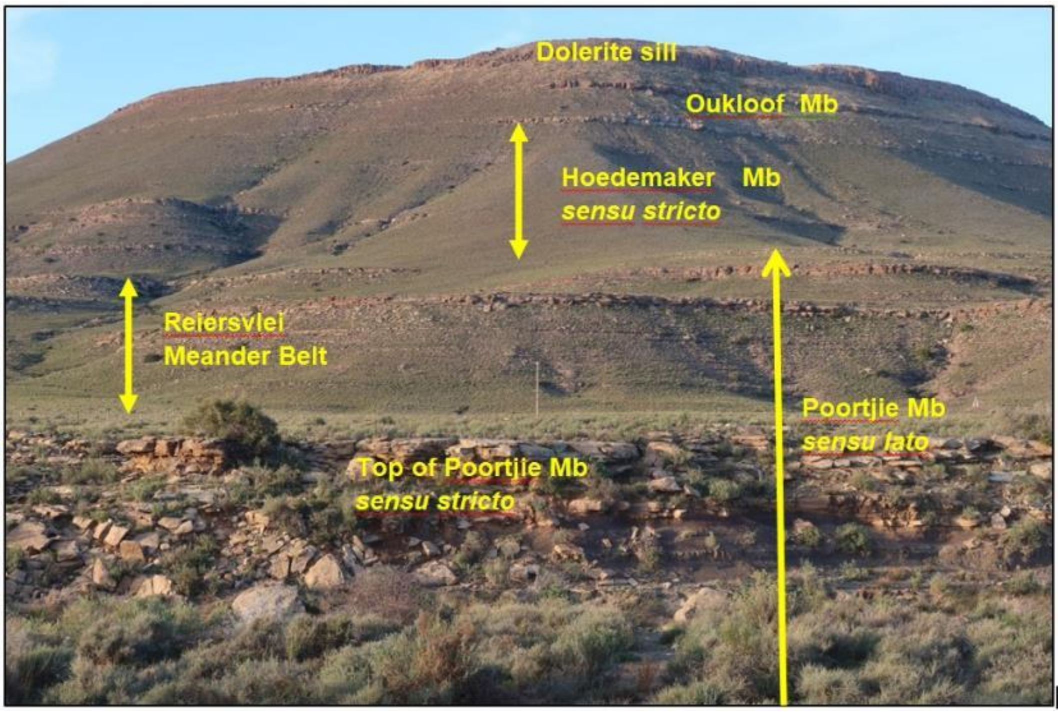


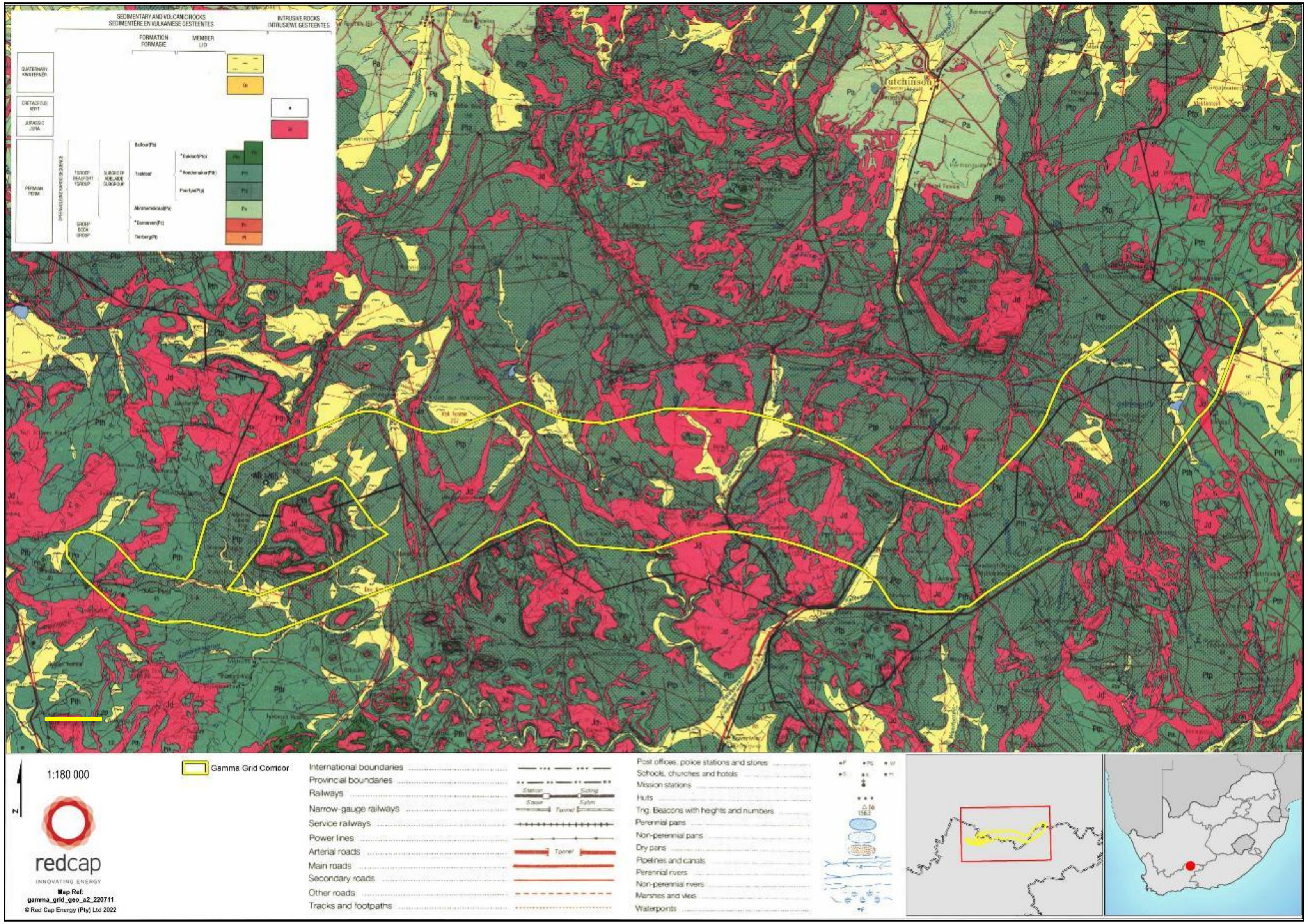
Figure 5-2: Alternative stratigraphic subdivision of the Lower Beaufort Group succession on Perdeberg. Here the Reiersvlei sandstones are included within the upper part of the Poortjie Member (as mapped by the Council for Geoscience on the 1: 250 000 geology sheet 3122). See also Figure 5-14 for the same succession exposed on the southern face of Perdeberge.

The Permian sediments and Jurassic intrusions within the project area are extensively mantled by a range of **Late Caenozoic superficial deposits**, limiting exposure levels of fresh (unweathered), potentially fossiliferous Permian sediments, especially in low-relief lowlands and on upland plateaux. In addition to thick, consolidated (calcretised) to unconsolidated, gravelly to silty alluvial sediments along major active or defunct drainage lines (*e.g.* Soutrivier, Brakrivier and their tributaries), these younger cover sediments include pan deposits (*e.g.* shallow *brak-kolle*), colluvial (slope) and eluvial (downwasted) surface gravels, pedocretes (*e.g.* calcrete), spring deposits and a spectrum of mainly sandy to gravelly soils. Coarse older alluvial deposits ("High Level Gravels") are not separately mapped within the project area at 1: 250 000 scale but elevated terrace gravels of Pleistocene and younger age are likely to be present along major drainage lines.

Photographs of selected exposures of Teekloof Formation bedrocks within or close to the Gamma Gridline Corridor culled from previous PIA reports by the author as well as from the recent reconnaissance-level drive-through are provided in Figures 5-1, 5-2, 5-6 to 5-33 below (see also photo on title page).

Figure 5-3: Google Earth© satellite map of the proposed Gamma Gridline Corridor (yellow polygon) between the Nuweveld Collector Substation (green triangle), located within the Nuweveld Wind Farm (green polygon) project area near Loxton, and the existing Eskom Gamma Substation near Hutchinson (blue triangle) some 90 km to the east. The corridor encompasses a range of semi-arid, hilly to mountainous terrain as well as low-lying alluvial* vlaktes *within the Upper Karoo region netween Loxton and Beaufort West. Areas featuring major dolerite intrusions appear rusty-brown here.

Figure 5-4 (following page): Extract from 1: 250 000 geology sheet 3122 Victoria West showing the project area for the Gamma Gridline Corridor (yellow polygon) between the Nuweveld Wind Farm Development project area in the west and the existing Eskom Gamma MTS in the east, Western and Northern Cape Provinces (Base map published by the Council for Geoscience, Pretoria. Image provided by Red Cap). The main rock units represented here include:
Ptp (middle green with stipple) = Middle to Late Permian Poortjie Member, Teekloof Formation (Adelaide Subgroup).
Pth (middle green without stipple) = Late Permian Hoedemaker Member, Teekloof Formation (Adelaide Subgroup).
Pto (middle green without stipple) = Late Permian Oukloof Member, Teekloof Formation (Adelaide Subgroup).
Jd (red) = sills and dykes of the Early Jurassic Karoo Dolerite Suite.
Pale yellow with flying bird symbol = Late Caenozoic (Neogene / Pleistocene to Recent) alluvium.
N.B. The mapping of the various stratigraphic subunits of the Lower Beaufort Group shown here is currently contested and may require considerable revision in future, based on detailed field mapping and collection of additional biostratigraphic data. In particular, the contact between the Poortjie and Hoedemaker Members is equivocal while unmapped sandstone packages of the overlying Oukloof Member might be present at higher elevations in the eastern sector of the project area.
Scale bar (bottom LHS) = 4 km.



SEDIMENTARY AND VOLCANIC ROCKS
SEDIMENTÊRE EN VULKANIESE GESTEENTES
INTRUSIVE ROCKS
INTRUSIEWE GESTEENTES
Hutchinson
1:180 000
N
Gamma Grid Corridor
International boundaries
Provincial boundaries
Railways
Station
Siding
Narrow-gauge railways
Tunnel
Service railways
Power lines
Arterial roads
Main roads
Secondary roads
Other roads
Tracks and footpaths
Post offices, police stations and stores
Schools, churches and hotels
Mission stations
Huts
Trig. Beacons with heights and numbers
Perennial pans
Non-perennial pans
Dry pans
Pipelines and canals
Perennial rivers
Non-perennial rivers
Marshes and vleis
Waterpoints
redcap
INNOVATING ENERGY
Map Ref:
gamma_grid_geo_a2_220711
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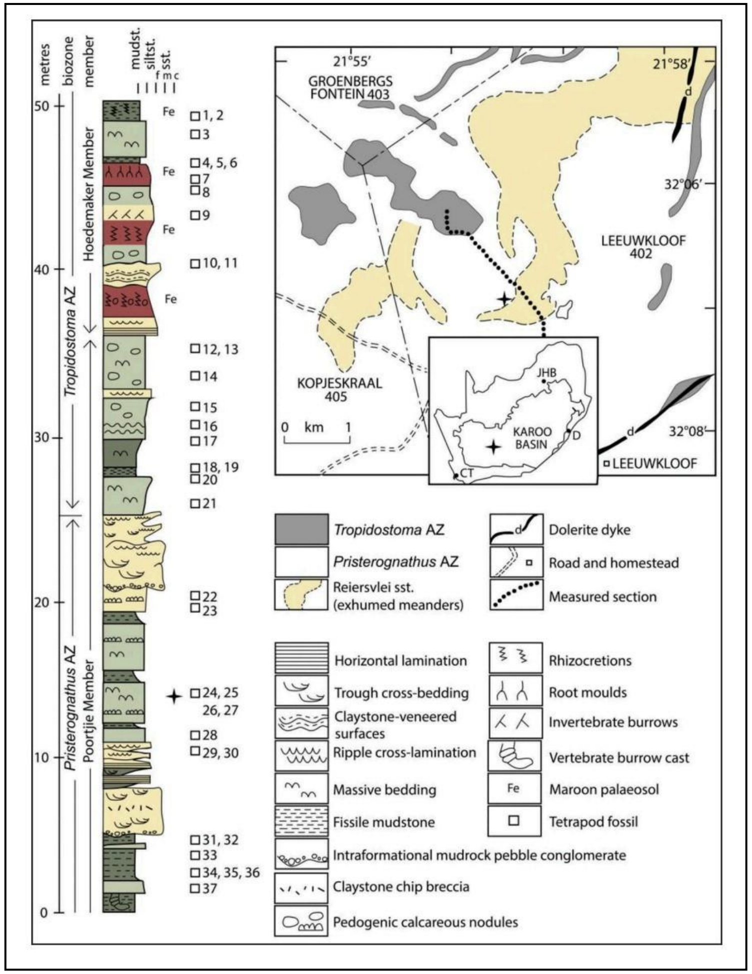

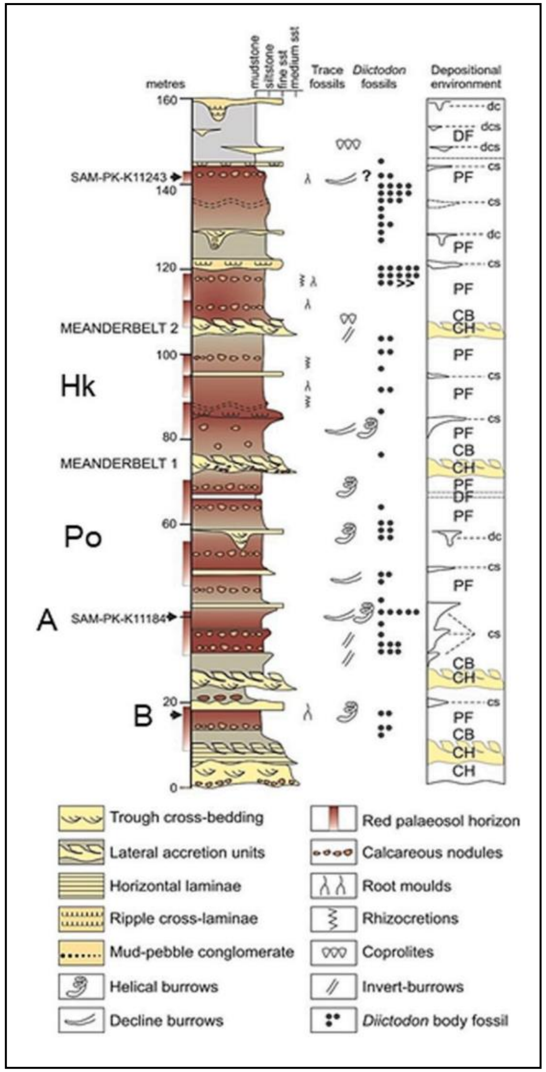

Figure 5-5: Stratigraphic logs for the transition between the Poortjie Member and Hoedemaker Member of the Teekloof Formation close to the Gamma Gridline Corridor project area SE of Loxton: (a) from Maharaj* et al. *(2019); (b) from Smith* et al. *(2021). The placement of the boundary between the two members is somewhat arbitrary and differs in the two sections shown (see text for discussion).

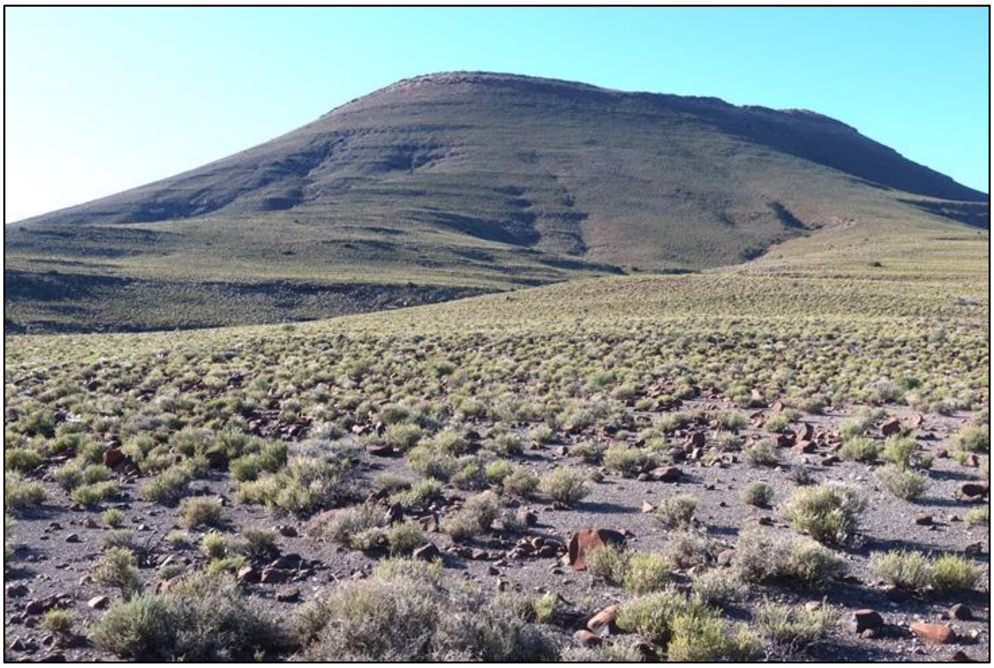

Figure 5-6: Eastern slopes of Vaalkop on Leeukloof 43, close to the western end of the Gamma Gridline Corridor, with mudrocks and thin channel / crevasse splay sandstones of the Hoedemaker Member in the foreground and lower hillslopes overlain by Oukloof Member sandstone package capped by Karoo dolerite.

Figure 5-7: Thick, amalgamated (multi-storey) channel sandstone package within the lower Poortjie Member exposed in the Duikerkrans riverbank cliffs along the Kromrivier Valley, c. 5.5 km west of Booiskraal, Eldorado 45 (Image from Almond 2020b).

Figure 5-8: View of the Perdeberg from the SW looking across the Kromrivier Valley which in this area is deeply incised into upper Poortjie Member sandstones, Duiker Kranse 3/45 (Image from Almond 2020b).

Figure 5-9: Excellent gullied exposures through thick packages of dusky purple-brown overbank mudrocks of the upper Poortjie Member occur on Abrams Kraal 206 to the north-east of the Perdeberg. Disappointingly, these beds have only yielded sparse vertebrate fossils so far, usually in association with basal channel breccias.

Figure 5-10: View eastwards along the well-vegetated, incised stream valley to the northwest of Perdeberg, Abrams Kraal 206, flanked by dolerite intrusions and baked metasediments.

Figure 5-11: Blocky-weathering dolerite sill just west of Abrahamskraal homestead with thick sandy alluvium in the foreground.

Figure 5-12: Sandy **vlaktes** *with sparse* **bossies** *on the north-eastern periphery of the Perdeberg massif, Abrams Kraal 206. Low sandstone-capped plateaux in the foothills belong to the Poortjie Member.*

Figure 5-13: Low ridges of brownish Poortjie Member sandstones with very little associated mudrock exposure occur in the sandy vlaktes southwest of Leeufontein.

Figure 5-14: Lower Teekloof Formation succession along the southern slopes of Perdeberg on Farm 396. Prominent-weathering sandstone packages of the Poortjie Member below and Oukloof Member above are well seen here (compare annotated Figures 5-2 and 5-3). The intervening, mudrock-dominated Hoedemaker Member does contain thin sandstone units, especially towards the base.

Figure 5-15: Heterolithic, thin-bedded package of Teekloof Formation sandstones and mudrocks (mapped within the Poortjie Member) exposed along the banks of the Kromrivier near Hillcrest homestead, with Hoedemaker and Oukloof Members capped by dolerite exposed on the steep slopes of Bobbejaanskop in the background (close to the southern margins of the gridline corridor) (Image from Almond 2020b).

Figure 5-16: Hilly terrain to south of Wagenarskraal is dominated by low dolerite* koppies *and highly baked country rocks, seen here with the dolerite-capped Brandersberg in the background.

Figure 5-17: View north-eastwards across the gravelly to sandy* vlaktes *in the central sector of the grid corridor, seen from between Wagenaarskraal and Orlogsfontein. Bedrock exposures in this region are very limited and often baked by dolerite intrusion.

Figure 5-18: Small roadside exposure of purple-brown Poortjie Member mudrocks mantled by rusty-brown dolerite gravels seen c. 2km west of the Soutrivier.

Figure 5-19: View south-westwards across the wide, shallow valley of the Soutrivier near Brakpoort. Consolidated, potentially fossiliferous, older alluvial deposits are not exposed here but well-developed terrace gravels with common Early Stone Age artefacts do occur further upstream to the northwest. The pale white efflorescence is probably a mixture of sulfate, carbonate and chloride salts which give the river its name.

Figure 5-20: Gentle hillslopes bordering the Soutrivier Valley near Brakpoort show intermittent good bedrock exposures along stream gullies.

Figure 5-21: Thermally metamorphosed Poortjie Member mudrocks (now dark grey hornfels) and sandstones (now pale quartzites) capped by a dolerite sill, road cutting along the N12 near Brakfontein. Baking during dolerite intrusion will have seriously compromised fossil preservation in the vicinity of major igneous intrusions.

Figure 5-22: Good, fresh road cutting sections through the Lower Beaufort Group succession within the Gamma Grid corridor are quite rare. The package of interbedded Poortjie Member mudrocks and wackes seen here is exposed along the N12 on Brakfontein 225.

Figure 5-23: Good, albeit small, exposures of Teeklof Formation mudrock facies are seen in occasional borrow pits, as here on the western footslopes of Grasberg, but the bedrocks are often disturbed near-surface by quarrying and dumping.

Figure 5-24: Exposure of Beaufort Group sediments on the slopes of dolerite-capped* koppies *within the grid corridor is usually severely constrained by a pervasive mantle of doleritic and quartzitic colluvium, with the exception of occasional erosion gullies, as seen here on the western slopes of Grasberg.

Figure 5-25: View westwards across the central sector of the Gamma Grid corridor from the N12 with Brandersberg and Perdeberg in the distance. The intervening flat terrain is drained by the Soutrivier and its tributaries and features very low levels of bedrock exposure due to soil cover as well as grassy and shrubby* bossieveld *vegetation.

Figure 5-26: Lower Teekloof Formation succession seen from the N1 just west of Taaibosfontein (Zwartkopjes 240) showing a lower package of thin, closely spaced "Poortjie Member" sandstone units overlain by the sandstone-poor Hoedemaker Member.

Figure 5-27: Stepped, NE-facing escarpment on the western margins of Modderfontein 228 showing three thin, closely-spaced channel sandstone packages (orange-brown, grey-brown and yellowish in ascending order) that are currently mapped within the Poortjie Member at the base of the Teekloof Formation but may in fact belong to a younger package (Image from Almond 2021a).

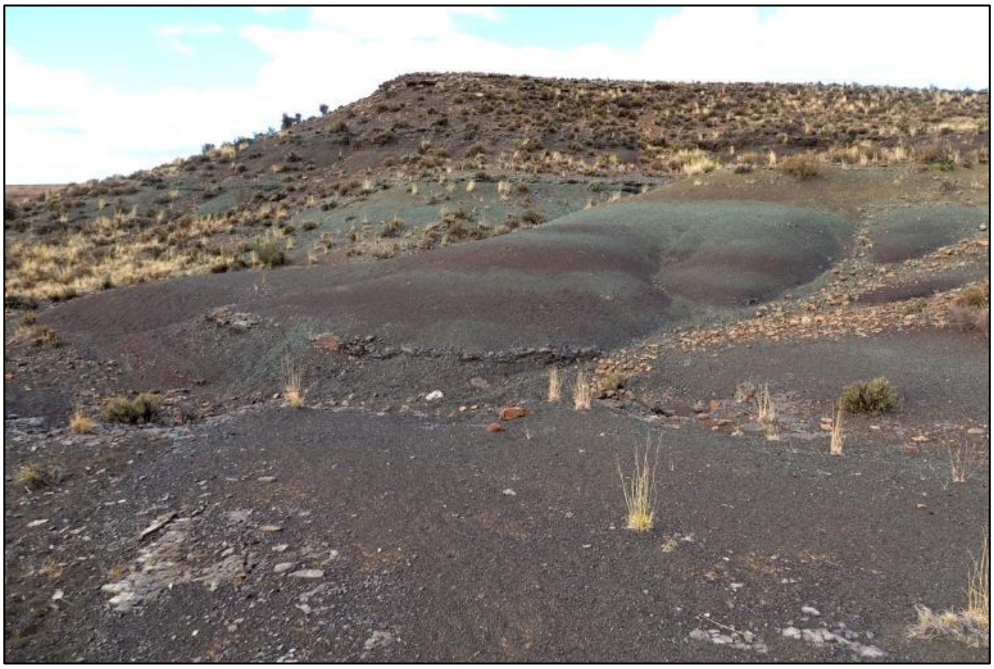

Figure 5-28: Well-exposed, colour-banded overbank mudrocks of the Teekloof Formation exposed in the central portion of Phaisant Kraal 1 that are mapped within the Poortjie Member but probably belong to the overlying Hoedemaker Member. These beds have yielded several vertebrate fossils (Image from Almond 2021a).

Figure 5-29: Relictual blocks of ferruginised basal channel breccio-conglomerate (in foreground) exposed south of Rondekop on Phaisant Kraal 1. These beds may lie along the Poortjie / Hoedemaker contact or perhaps within the Hoedemaker Member. They do not contain obvious skeletal remains but these, like the associated calcrete nodules, may have been leached out during metamorphosis (Image from Almond 2021a).

Figure 5-30: Stream bed and bank exposure of baked Teekloof Formation sediments in a region of the Modderfontein WEF project area with intense dolerite intrusion showing typical spotting by pale-rimmed cavities (vugs), some of which may represent metamorphosed pedogenic calcrete concretions. Note thick alluvial deposits in the background on the right (Image from Almond 2021a).

Figure 5-31: Closely-spaced, comparatively thick channel sandstone packages overlying a thick mudrock package and capped by dolerite, SW portion of Modderfontein 228. The sandstones here might belong to the Oukloof Member overlying Hoedemaker Member mudrocks but they are not currently mapped as such (Image from Almond 2021a).

Figure 5-32: Lower Beaufort Group bedrocks in the vicinity of the Gamma MTS are extensively intruded and baked by Karoo dolerite, here building the rubbly koppies in the middle ground as well as capping Bulberg in the background (Image from Almond 2021b).

5.3. Palaeontological heritage context

The terrestrial (fluvial / lacustrine) sediments of the Poortjie Member and Hoedemaker Member of the Teekloof Formation that are mapped within the Gamma Gridline Corridor are associated with important fossil assemblages of late Middle Permian to early Late Permian age. According the latest biostratigraphic zonation of the Main Karoo Basin by Smith *et al*. (2020) these assemblages are assigned to (1) the *Diictodon – Styracocephalus* Subzone of the ***Tapinocephalus*** **Assemblage Zone** (AZ) within the lowest portion of the Poortjie Member, preceding the end-Capitanian Extinction Event of *c*. 260 Ma. (Day & Rubidge 2020), and (2) to the ***Endothiodon*** **Assemblage Zone** within the remainder of the Poortjie Member as well as most, if not all, of the Hoedemaker Member (Day & Smith 2020) (See biostratigraphic chart in Figure 5-33). Probable, but unmapped, erosional outliers of the Oukloof Member sandstone package within the gridline corridor will be associated with the ***Cistecephalus*** **Assemblage Zone** which may well also occur locally within the uppermost Hoedemaker Member beds (Smith 2020) but this needs to be tested by additional fieldwork. These fossil assemblages include a wide range of vertebrates (bony fish, temnospondyl amphibians, true reptiles, therapsids), non-marine molluscs, invertebrate and vertebrate trace fossils (including tetrapod trackways and burrows) as well as petrified wood, palynomorphs and other plant remains of the *Glossopteris* Flora. The fossils are variously associated with channel sandstones (including basal breccio-conglomerates) as well as crevasse splay sandstones (*e.g.* palaeosurfaces) and - especially - overbank mudrock facies with calcretised palaeosol horizons. They have been reviewed in the publications listed above as well as by Smith *et al.* (2012), supplemented by recent PIA reports by the present author for the Red Cap Nuweveld and Hoogland WEFs and grid connections as well as the Modderfontein WEF (See References). Additional fossil sites have recently been recorded within the iLanga solar project areas between Modderfontein and the Gamma Substation (Almond, in prep. 2022).

Whether or not upper *Tapinocephalus* AZ beds are actually represented within lower Poortjie Member beds in the gridline corridor has not yet been established. Lower *Endothiodon* AZ (*Lycosuchus* – *Eunotosaurus* Subzone) assemblages are associated with the overlying upper Poortjie Member beds while the *Tropidostoma* – *Gorgonops* Subzone is represented within the Hoedemaker Member. The Reiersvlei Meanderbelt transition zone has yielded good material of *Endothiodon* low down (Maharaj *et al.* 2019) and probably belongs, at least in part, within the lower part of the *Endothiodon* AZ where this genus of sizeable dicynodont tends to be most abundant. The *Cistecephalus* AZ that is mainly associated with the Oukloof Member sandstone package – not mapped within the present project area but seen just outside this, for example on the upper slopes of Perdeberg and The Horseshoe - may extend up to 20 below the Oukloof package into the underlying Hoedemaker Member mudrocks (Smith 2020). As discussed by Day and Rubidge (2020a), the purported Poortjie Member package mapped towards the eastern end of the gridline corridor (Nobelsfontein WEF – Modderfontein WEF project areas) yields fossils of the *Tropidostoma* AZ (now incorporated into the upper *Endothiodon* AZ). It might therefore represent an unnamed channel sandstone package that is separate from, and younger, than the Poortjie Member *sensu stricto*. Alternatively, this younger package may be equivalent to the Reiersvlei Meanderbelt succession recognised in the Perdeberg region towards the western end of the grid corridor (see also Almond 2021a). Interestingly, fossils of the *Cistecephalus* and even *Daptocephalus* AZ have been reported from the Hoedemaker Member succession in the same area (Day & Rubidge 2020a) (Fig. 5-18). New palaeontological data from the Gamma Gridline Corridor project area may help resolve these ambiguities.

Only a few fossil sites are mapped within the present gridline corridor project area by Kitching (1977) whose biozonation scheme is now very outdated. More recent mapping of Karoo vertebrate fossil sites by Nicolas (2007) also shows a marked gap in palaeontological knowledge over most of the region (Figure 5-34). Concentrations of fossil sites shown here towards the south may represent, in part, fieldwork by the Council for Geoscience in the Booiskraal – Perdeberg area in the west (Dr Colin MacRae, late 1900s). The dense cluster of sites towards the eastern end of the corridor reflects a long and ongoing history of scientific fossil collection in the Biesiespoort Station area (Noblesfontein and Modderfontein WEF project areas) by many of the great names in Karoo palaeontology, as recently reviewed by Day and Rubidge (2020a; see also Almond 2021a and map Figure 5-35). Historical fossil sites are not indicated within the gridline corridor on the 1: 250 000 Victoria West geology sheet, apart from a single *Pristerognathus* AZ site (now *Endothiodon* AZ) from the Poortjie Member to the SW of Perdeberg (small black triangle on map Figure 5-4).

A key skull specimen of the large therocephalian *Pristerognathus* studied by J. van den Heever (1987) was collected from the Poortjie Member on the lower slopes of Perdeberg (R. Smith, pers, comm., 2022). Rich assemblages of small dicynodonts (especially *Diictodon*) within the Hoedemaker Member on the Farm Leeukloof 43, within the Nuweveld East Wind Farm project area just west of the present project area, are the subject of on-going benchmark taphonomic studies on Beaufort Group tetrapods by Dr Smith of Wits University (*e.g.* Smith 1993). A few additional sites with skulls and postcrania of small- to large-bodied dicynodonts, including probable *Endothiodon*, tetrapod burrow casts, plant stem casts and invertebrate trace fossil assemblages have been recorded from the Hoedmaker Member beds close to or within the western end of the Gamma Gridline Corridor during recent PIAs for the Red Cap Nuweveld East Wind Farm (Almond 2020a) and the Mura Solar Projects (Almond in prep., 2022). Several fragmentary bones, including a concentration of robust cranial fragments of a sizeable tetrapod exhibiting a high degree of pachyostosis, recently collected on Abrams Kraal 206 have probably weathered out of a channel sandstone body (*e.g.* basal breccia lens) within the upper Poortjie Member / Reiersvlei Meanderbelt interval. They are tantalizing since they might belong to a tapinocephalid dinocephalian – a Middle Permian group of large herbivores that has only been recorded hitherto as far up the Lower Beaufort succession as the lower Poortjie Member (Day *et al.* 2015a, 2015b).

Despite the long history of palaeontological research near Biesiespoort, situated c. 30 km south of Victoria West, a field-based PIA has not been undertaken for the authorized Nobelsfontein WEF which has already been constructed here (*cf* desktop study by Almond 2015a which covers part of the WEF project area). No PIA report could be located for the adjoining Biesiespoort Solar PV Facility project area. As emphasized by Day and Rubidge (2020a) in their review of the important Biesiespoort fossil biota and reiterated by Almond (2021a):

- A considerable proportion of Beaufort Group vertebrate fossils in institutional collections, especially as far as the Upper Karoo is concerned, has been collected in the Victoria West area. They include a wide spectrum of reptilian and therapsid subgroups.
- There is an unusually long history of fossil collection by prominent Karoo palaeontologists from sites near Biesiespoort Station (Farms Noblesfontein 248, Matjiesfontein 220, Modderfontein 228), from the famous Robert Broom in the 1920s until the present day (See locality map Figure 5-35). Consequently fossil specimens from the area are now curated at several museums both in South Africa and abroad.
- A number of Holotype Karoo tetrapod specimens come from the Biesiespoort area, including taxa of herbivorous dicynodonts and carnivorous forms such as gorgonopsians (Figure 5-38).
- The region south of Victoria West is of key biostratigraphic interest because of the apparent mismatch between the Teekloof Formation lithostratigraphy and the recorded vertebrate fossil assemblages, compared with the better known sections along the Nuweveld Escarpment (Figure 5-36). This anomaly is currently unresolved and might be real or, at least in part, stem from mis-mapping of the various members on the published geological maps.

Vertebrate and other fossils are also common in bedrocks provisionally assigned to the Poortjie and Hoedemaker Members within the neighbouring Modderfontein WEF project area, although a high proportion of the Beaufort Group country rocks here has been thermally metamorphosed by regional dolerite intrusion, compromising fossil preservation (Almond 2015b, 2021a). Several new sites here have yielded fairly numerous small-bodied *plus* a few medium-bodied therapsids (mainly small herbivorous dicynodonts, rare carnivorous theridonts), straight and helical tetrapod burrow casts as well as low diversity invertebrate trace fossils and rare plant remains (leaf impressions, possible wood moulds).

Hoedemaker Member beds to the east of the Eskom Gamma MTS near Hutchinson also show a high level of thermal alteration, with only a handful of fragmentary, baked therapsid remains recorded here in the recent PIA for the Great Karoo Renewable Energy Cluster gridline corridor to Gamma MTS by Almond (2021b). No palaeontological field data is yet available for the Mainstream Victoria West Wind and Solar Energy Facility and grid connection near Hutchinson (*cf* desktop study by Almond 2010b). Full field-based PIA reports for the Ishwati Emoyeni WEF and grid connection project areas to the east of Gamma MTS are still outstanding (*cf* Butler 2022; also desktop PIAs by Rossouw 2014, 2021); fossils assemblages in these cases probably fall largely within the *Endothiodon* and *Cistecephalus* Assemblage Zone. Full field-based PIAs for the Umsinde and Khangela Emoyeni WEFs just to the east and its grid connection to Gamma MTS are also not available (*cf* reconnaissance-level field PIA by Almond 2015c and subsequent PIA comments by Almond 2020c, 2020d). No PIA data is available for the Aurora Power Solutions (APS) Betelgeuse PV Solar Project Four situated east of the Gamma Substation whose application has now lapsed.

A series of small solar project areas forming part of the Brakpoort Solar PV Facility, located some 30 km NE of Victoria West, overlie poorly exposed older bedrocks of the Abrahamskraal Formation and are therefore not strictly relevant to the Gamma Gridline Corridor assessment (*cf* short desktop and field-based PIAs by Almond 2011, 2012a-c). No PIA report could be located for the proposed solar PV project area on Farm Biesjesfontein 270 just south of Hutchinson. Six small, low relief solar project areas within the Poortjie Renewable Energy Facility east of Nelspoort are currently mapped within the Teekloof Formation and *Endothiodon* AZ (Almond 2022b; this report does *not* cover the associated Poortjie Wes Cluster Grid project area). However, recent records of dinocephalians in the *vlaktes* and Escarpment Zone west of Aberdeen (Prof. B.S. Rubidge and Mike Day, pers. comm., 2022) as well as possible but unconfirmed dinocephalian (but perhaps pareiasaur) fragments in the Nelspoort project area suggest that the Abrahamskraal Formation outcrop area might extend this far north.

The Gamma-Omega 765 kV transmission line between Beaufort West and Gamma MTS traverses the eastern sector of the Gamma Gridline Corridor to the northeast of the N1 near Taaibosfontein. The field-based PIA for this project by Almond (2010a) recorded locally abundant small dicynodonts and a few therocephalians near Taaibosfontein as well as a sparse scatter of other fossils elsewhere

– including *Scoyenia* Ichnofacies invertebrate traces and possible *Cistecephalus* skull near Rondekop – but in many sectors the palaeontological sensitivity of the bedrocks was found to have been compromised by dolerite intrusion. A desktop study for a further Gamma – Omega line was submitted by Durand (2017). PIA studies for the Droerivier / Hydra 1 to 3 powerlines which transect the Gamma Gridline Corridor are not available.

On-going field-based palaeontological studies for the adjoining iLanga solar projects which partially overlap the Gamma Grid Corridor between Modderfontein and Gamma Substation have yielded a few sites of palaeontological interest. These include concentrations of cranial and post-cranial remains of large-bodied, heavily-tusked dicynodonts (possibly *Rhachiocephalus*), helical and inclined tetrapod burrows which are probably attributable to small-bodied dicynodonts, as well as lenticular channel sandstone bodies densely packed with moulds of woody plant axes as well as tongue-shaped glossopterid leaves (Almond in prep., 2022).

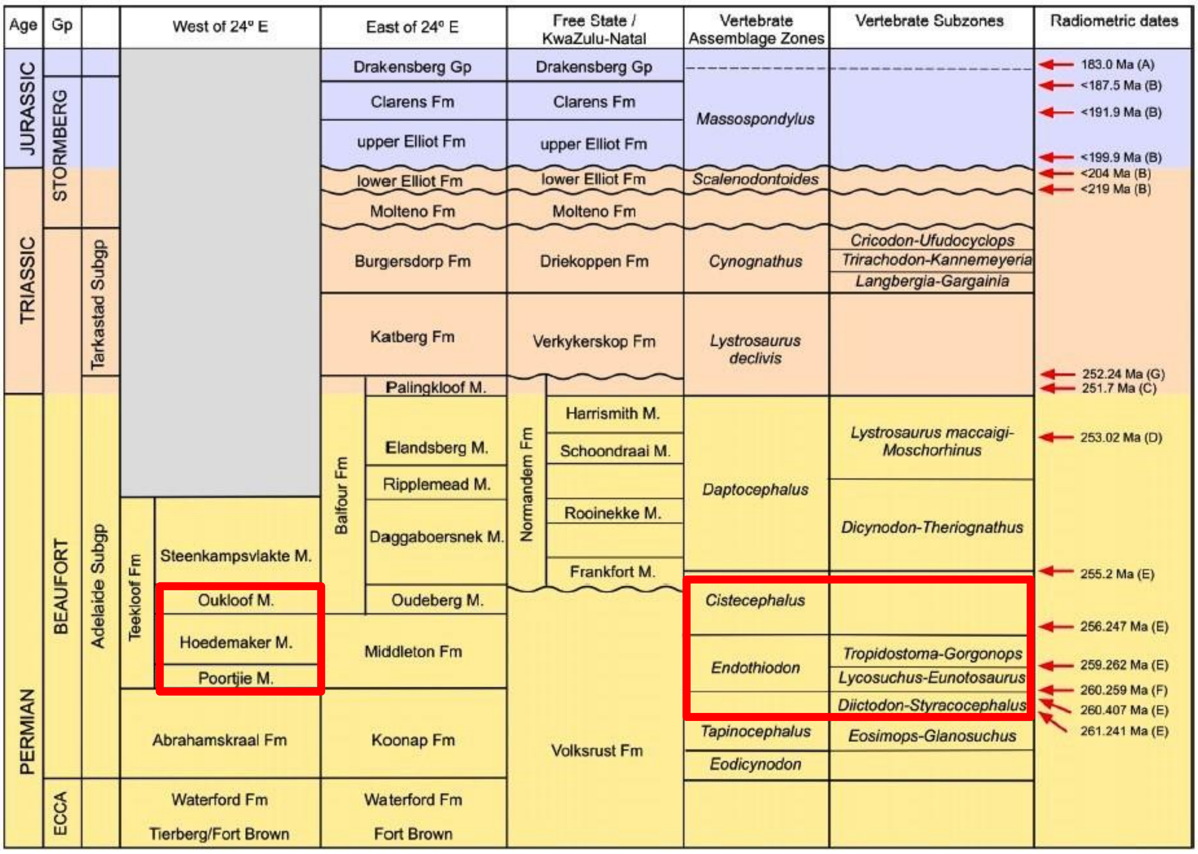

Figure 5-33: Chart showing the latest, revised fossil biozonation of the Lower Beaufort Group of the Main Karoo Basin (abstracted from Smith* et al. *2020). Rock units and fossil assemblage zones mapped or inferred within the Gamma Gridline Corridor project area are outlined in red respectively. However, the detailed mapping of these lithostratigraphic and biostratigraphic units within the present project area is unresolved at present (see text for discussion).

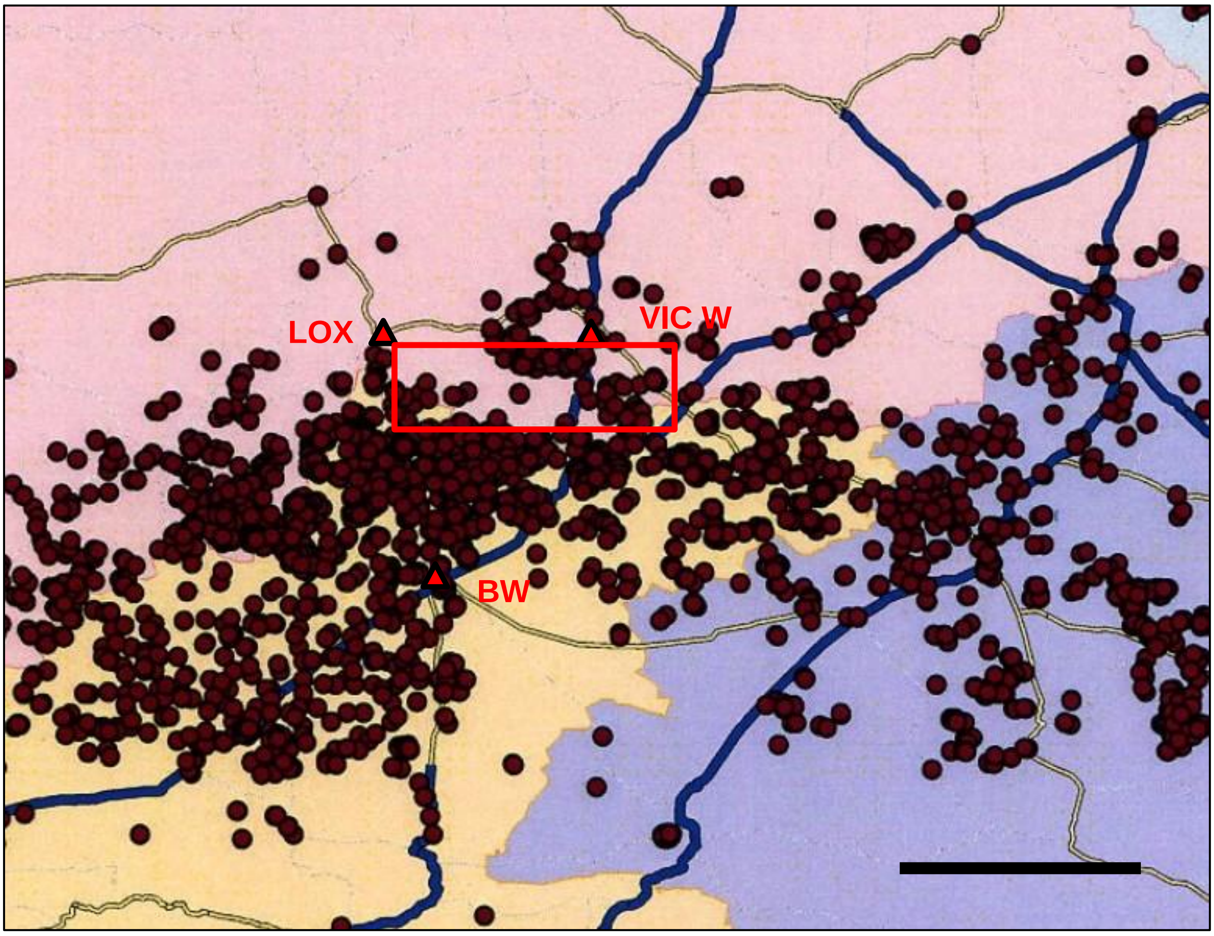

Figure 5-34: Distribution map of recorded vertebrate fossil sites within the Lower Beaufort Group of the Great Karoo between Loxton (LOX), Victoria West (VIC W) and Beaufort West (BW), showing the very **approximate** ***outline of the study area for the Gamma Gridline within the red rectangle (map abstracted from Nicolas 2007). Note the abundance of known fossil sites close to the N1 to the northeast of Three Sisters and south of Victoria West reflects in part the long history (> 100 years) of fossil collection by both academics as well as knowledgeable amateurs at sites close to Biesiespoort Station. Scale bar = 10 km. N towards the top of the image.***

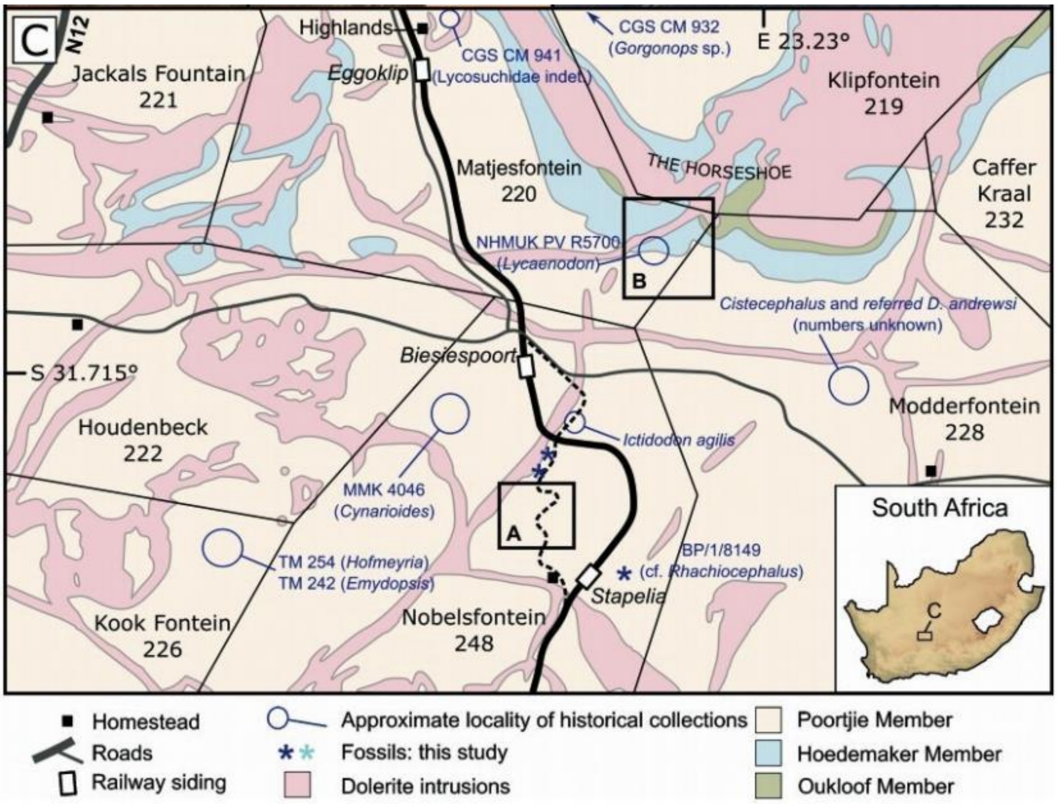

Figure 5-35: Map compiled by Day & Rubidge (2020a) illustrating the location of key historical sites of Beaufort Group fossil vertebrates in the vicinity of Biesiespoort Station, within the Noblesfontein WEF and Modderfontein WEF project areas and close to the eastern end of the Gamma Gridline Corridor. The lithostratigraphic mapping show here reflects the published geological map which may require substantial revision (See text for discussion).

Beaufort lithostratigraphy			Beaufort biostratigraphy	
			Nuweveld Escarpment	Victoria West
BEAUFORT GROUP	Teekloof Formation	Javanerskop Member	Lower *Daptocephalus*	
		Steenkampsvlakte Member		
		Oukloof Member	*Cistecephalus*	Lower *Daptocephalus*
		Hoedemaker Member	*Tropidostoma*	*Cistecephalus*
		Poortjie Member	*Pristerognathus*	*Tropidostoma* *Pristerognathus*
	Abrahamskraal Formation		*Tapinocephalus*	*Tapinocephalus*

Figure 2. Relationship of Karoo biostratigraphy to the lithostratigraphy along the Nuweveld. Escarpment and in the Victoria West area. Nuweveld relationships based on Rubidge (1995), with amendments from Day *et al.* (2015) and Viglietti *et al.* (2016, 2017).

Figure 5-36: Table from Day and Rubidge (2020a) illustrating possible differences in the distribution of Lower Beaufort Group fossil assemblage zones in relation to the lithostratigraphy along the well-studied Nuweveld Escarpment versus ***the less well understood Victoria West region. Some of these real or apparent contrasts can only be resolved by detailed geological re-mapping and palaeontological surveying.***

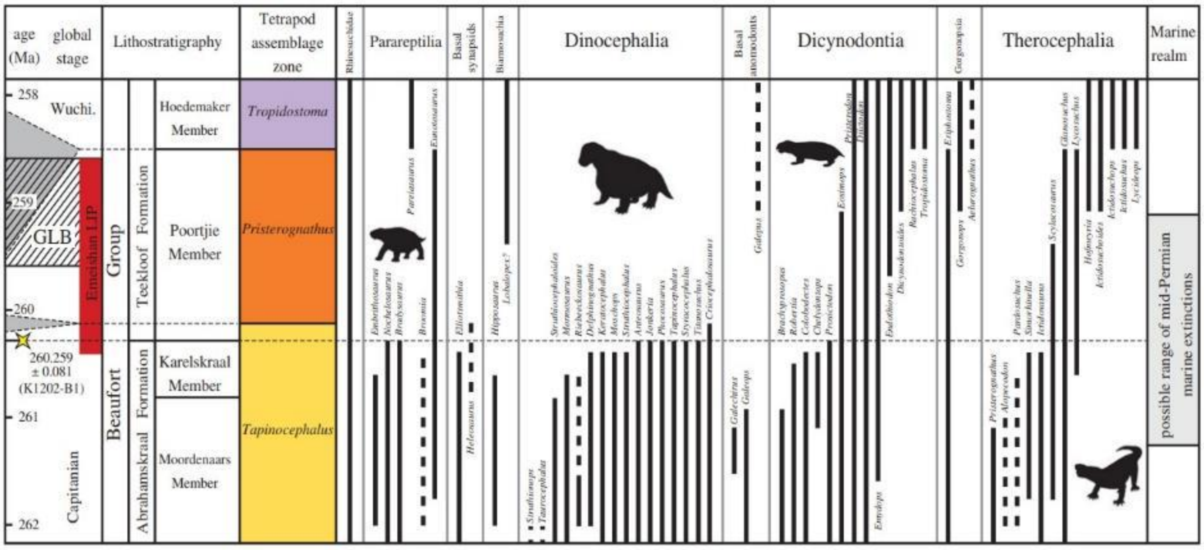

Figure 5-37: Chart showing the ranges of known terrestrial tetrapod genera from the Middle to Late Permian of the Main Karoo Basin (From Day* et al. *2015b). The boundary between the Abrahamskraal and Teekloof Formations is associated with a catastrophic extinction event at the end of the Middle Permian / Capitanian Stage (c. 260 Ma) that has been dated here on the basis of a tuff horizon close to the contact of the Karelskraal and Poortjie Members (yellow star). Key victims of the extinction event were almost all the large-bodied dinocephalians and pareiasaur parareptiles as well as many (but not all) dicynodonts and therocephalians.

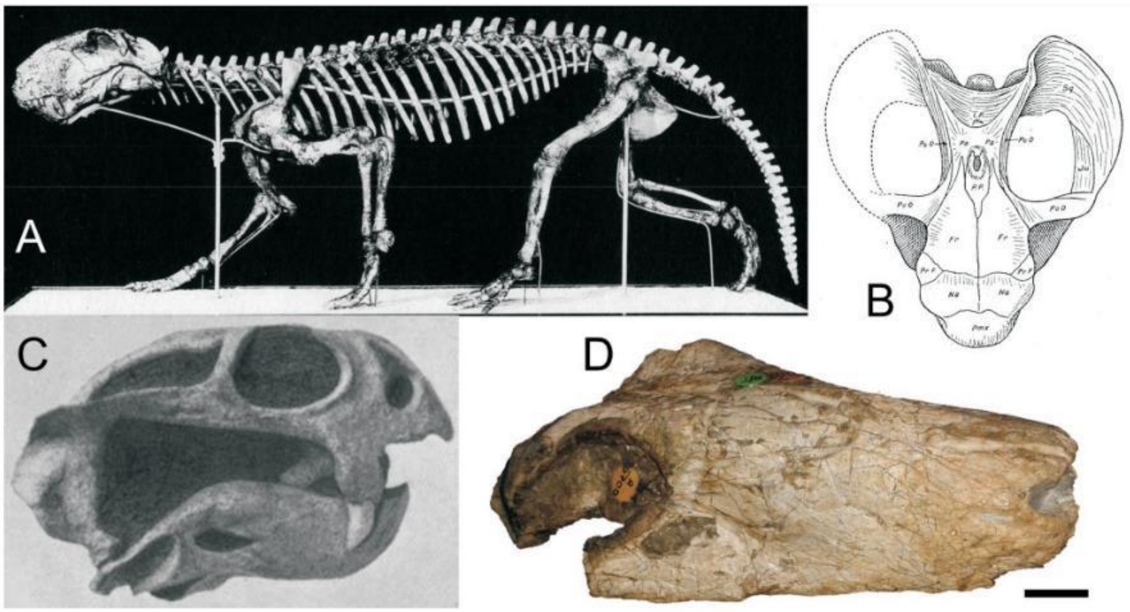

Figure 3. Some historical collections from Biesiespoort area. **A**, Mounted skeleton of the holotype of *Lycaenops ornatus* Broom (AMNH FARB 2240), from Colbert (1948). **B**, Illustration of the allegedly lost holotype of *Bainia peavoti* Broom (MMK 4237; = *'Aulacephalodon' peavoti*), from Broom (1921). **C**, Photograph of referred specimen of *Dicynodon sollasi* Broom (= *Diictodon feliceps*), from Janensch (1952a). **D**, Photograph of the holotype of *Lycaenodon longiceps* Broom (NHMUK PV R 5700). Scale bar equals: 2 cm.

Figure 5-38: Image from Day and Rubidge (2020a) illustrating holotype specimens of Teekloof Formation therapsids ("mammal-like reptiles") that have been collected near Biesiespoort. They include carnivorous gorgonopsians (one of the most complete skeletons known) as well as small- to large-bodied herbivorous dicynodonts.

6 SENSITIVITY MAPPING

The Lower Beaufort Group bedrocks cropping out over the great majority the Gamma Gridline Corridor project area are generally assigned a Very High Palaeosensitivity (Almond & Pether 2008, SAHRIS palaeosensitivity map). Provisional sensitivity mapping by the DFFE Screening Tool assigns a Very High palaeosensitivity to the Lower Beaufort Group sediments, a Medium palaeosensitivity to substantial deposits of Late Caenozoic alluvium associated with major drainage lines and Zero palaeosensitivity to Karoo dolerite intrusions (Figure 6-1).

Previous experience within renewable energy project areas in this region of the Upper Karoo (*cf* Figure 6-2) as well as the recent palaeontological heritage drive-through of the Gamma Grid corridor indicate that, in practice, most of the area is of Low Palaeosensitivity. This is largely due to widespread cover by unfossiliferous superficial sediments and near surface weathering as well as dolerite intrusion (See numerous site photos provided in Section 5). Good exposures of potentially fossiliferous, consolidated older alluvial deposits were not encountered during the drive-through, even along larger water courses such as the Soutrivier. Fossil sites of significant scientific and conservation value are usually sparsely scattered, although occasional high concentrations of well-preserved vertebrate remains may be found in areas of good bedrock (especially mudrock) exposure (*cf* Nuweveld and Hoogland WEF project areas). Based on the recent site visit, such mudrock exposures are scarce within the grid connection. Most - but not all - previously recorded fossil sites of scientific importance within the corridor outlined in Section 5.3 of this report will have already been collected. The potential for further, *unrecorded* sites of high palaeosensitivity within the largely understudied project area remains significant, however; such fossil sites are generally highly localized, unpredictable and can only be recognized through palaeontological fieldwork. This explains the need for a targeted pre-construction palaeontological walkdown as well as a Chance Fossil Finds Protocol for the grid connection project (Appendix 2).

Based on previous PIA studies in the wider region as well as the reconnaissance-level drive through of the Gamma Grid corridor no specific Very High sensitivity sites or No-Go areas regarding palaeontological heritage are identified or delineated in the present combined desktop and field-based report for the Gamma Gridline Corridor with the exception of:

- the slopes of Vaalkop on Farm Leeukloof 43 (red polygon, incorporating a buffer zone, in satellite map Figure 6-2), previously identified as a Very High Palaeosensitivity research area for the Hoedemaker Member within the Nuweveld East Wind Farm project area (Almond 2020a)

The Biesiespoort Station area within the adjoining Noblesfontein WEF and Modderfontein WEF project areas (Farms Nobelsfontein 248, Matjiesfontein 220 and Modderfontein 228) (orange polygon in Fig. 6-2) is considerable historical – palaeontological as well as biostratigraphic importance. It is provisionally identified here as of High Palaeosensitivity. However, the area lies *outside* and just to the north of the Gamma Gridline Corridor. Furthermore, this High Sensitivity mapping should *not* be used to constrain the gridline routing since important fossil sites here can generally be effectively mitigated through professional palaeontological recording and collection in the Pre-construction Phase and the Chance Fossil Finds Protocol in the Construction Phase. Micro-siting of grid infrastructure to avoid significant fossil sites is an additional mitigation option but is unlikely to prove necessary.

No further palaeontological heritage constraints are proposed here regarding the final routing of the Gamma Gridline.

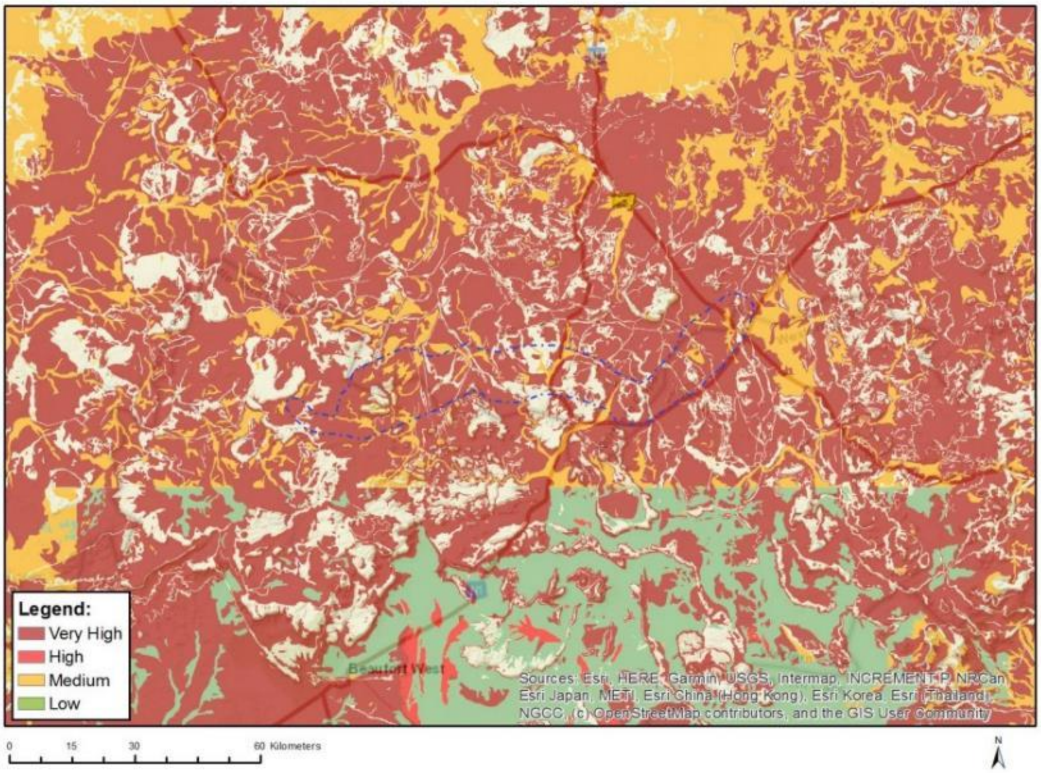

Figure 6-1: Provisional palaeosensitivity mapping of the Gamma Gridline Corridor (blue dashed polygon) by the DFFE Screening Tool (Red Cap, dated August 2022). Most of the corridor is mapped as Very High Palaeosensitivity based on the outcrop area of the Lower Beaufort Group sediments.

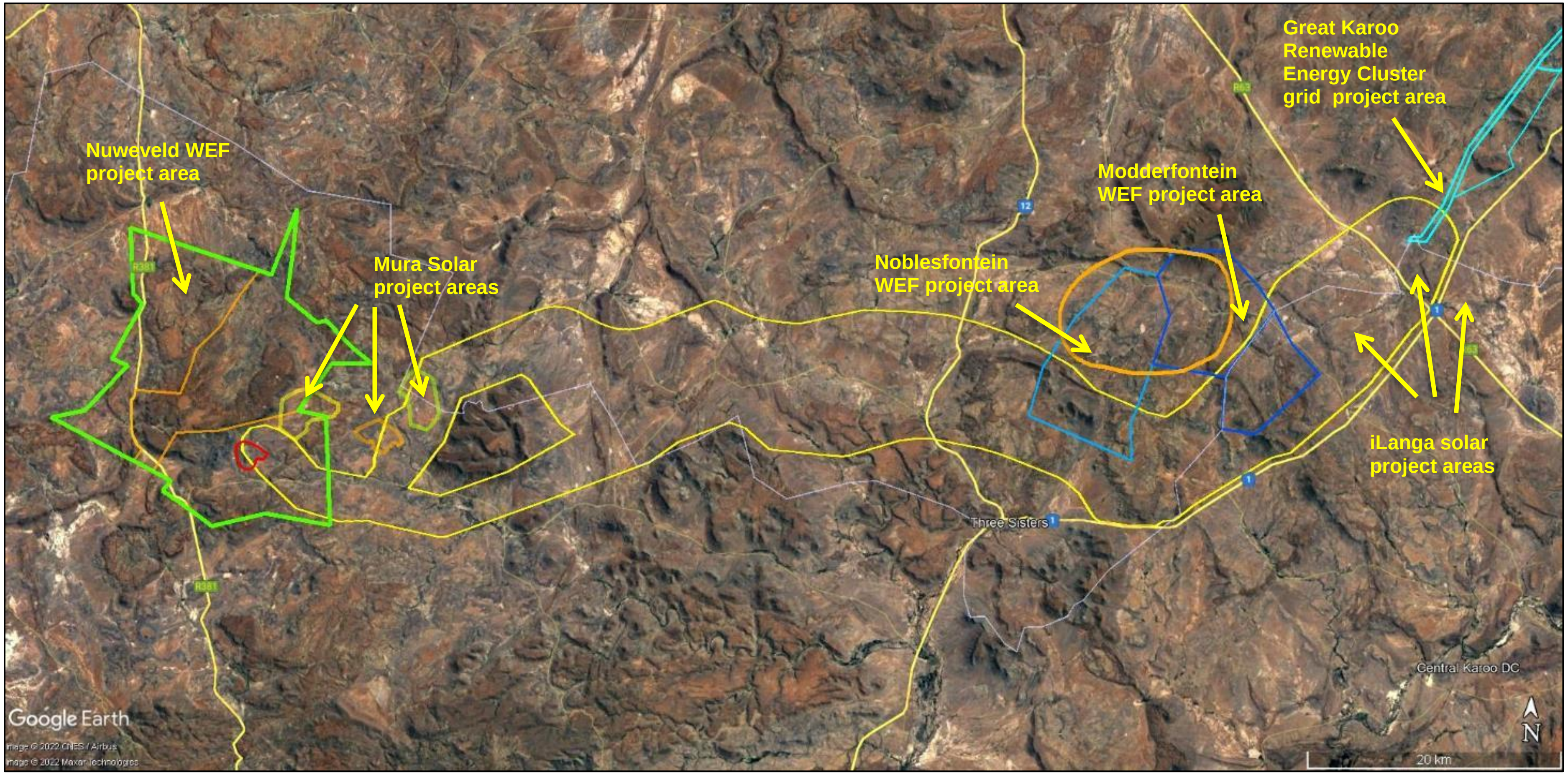

Figure 6-2: Google Earth© satellite map of the proposed Gamma Gridline Corridor (yellow polygon) showing the identified Very High Palaeosensitivity research area on the slopes of Vaalkop in the west (small red polygon) as well as the High Palaeosensitivity area around Biesiespoort in the east (orange polygon). The former should be treated as No-Go area. The latter area lies outside the grid corridor and fossil sites in such High Palaeosensitivity areas can usually be effectively mitigated in the Pre-Construction and Construction Phases. No further palaeontological heritage constraints are proposed here regarding the final routing of the Gamma Gridline. WEF, solar and grid project areas in the region for which palaeontological field data is currently available are also indicated on the satellite map.

7 SPECIALIST FINDINGS ASSESSMENT OF IMPACTS

The proposed 400 kV Gamma Gridline and associated grid connection infrastructure developments (Gamma Substation expansion, access tracks, temporary laydown areas) will entail excavations into the superficial sediment cover (soils, surface gravels, alluvium *etc*) as well as into the underlying, potentially fossiliferous Lower Beaufort Group bedrocks during the construction phase. The developments may adversely affect legally protected and scientifically important fossil heritage within the project footprint by destroying, damaging, disturbing or permanently sealing-in fossils at or beneath the ground surface that are then no longer available for scientific research or other public good. Excavations for access road cuttings as well as surface clearance for new sectors of access road (*c*. 46 ha footprint) are likely to be, by far, the most important source of impacts on palaeontological heritage, outweighing those associated with the other infrastructural developments listed above, including electrical pylon footings.

The uppermost Teekloof Formation bedrocks that will be directly impacted by the proposed grid connection developments are characterized by common but sparsely distributed fossil sites of vertebrates and other groups (*e.g.* petrified wood). Most of these sites are of limited scientific interest but they include occasional scientifically important specimens - most notably fossil vertebrate remains - whose occurrence is largely unpredictable. Many or most of the more important fossil specimens already recorded within the grid corridor will have already been collected and are accordingly not threatened by the proposed developments, so no further mitigation is required with regard to them. The potential for further, *unrecorded* sites of high palaeosensitivity within the understudied project area is substantial, however. The bedrocks within most of the project footprint are extensively mantled with Late Caenozoic colluvial, eluvial and alluvial deposits and gravely soils that are usually palaeontologically insensitive over most of the Karoo region. Concentrations of fossil mammalian remains might occur within older, calcretised alluvium but the author is unaware of any recorded sites.

Existing impacts on local palaeontological heritage resources within the Gamma Gridline Corridor project areas include (1) background, low-level damage to, or loss of, fossils exposed at the ground surface due to small-stock farming (*e.g.* vehicle activity, irrigation infrastructure, small-scale agriculture) as well as (2) on-going natural weathering and erosion processes that both destroy exposed fossil material at or near the ground surface as well as expose and prepare-out previously-buried fossils. Loss of fossils though illegal collection is a potentially important, but hopefully minor, factor at present in the wider region.

7.1 Impact assessment

Anticipated overall impacts on palaeontological heritage resources during the Construction Phase of the proposed Gamma Gridline and associated grid connection infrastructure are assessed in Table 7-1 below, both with and without mitigation, using the supplied impact rating methodology. Impact significance is are assessed as LOW (NEGATIVE) before mitigation and also LOW (NEGATIVE) following the recommended mitigation (see Table 7-1 and Section 8). Negative impacts on palaeontological heritage resources must be mitigated in the Pre-Construction and Construction Phases. This should lead to an appreciable reduction in impact significance. Residual negative impacts following mitigation would be partially offset by an improved palaeontological data base and fossil collections due to mitigation (positive impacts). Confidence levels for this assessment are

Medium since most of the project area is unstudied while several field-based palaeontological impact assessment studies have previously been carried out here.

Once constructed, the Operational and De-commissioning Phases of the grid connection infrastructure developments will not involve further significant impacts on palaeontological heritage, so these are not assessed separately here.

7.2 Alternatives

Due to the comprehensive iterative design process that has been undertaken to inform the location of the refined grid connection corridor as well as the preliminary gridline routing presented in the BAR, no site or layout alternatives will be assessed.

However, the development of a powerline within the refined corridor (outside of No-Go areas) is assessed against the '**No-Go' alternative**. The 'No-Go' alternative is the option of not constructing the project where the *status quo* would prevail.

In the case of the No-Go Option - *i.e.* no Gamma Gridline and associated grid connection developments - the current processes exerting an impact on local palaeontological heritage, as outlined at the beginning of this section, will continue to operate at low levels. Furthermore, the potential benefit of an improved palaeontological data base and fossil collections for the region due to mitigation would be foregone. The impact significance of the No-Go alternative has therefore provisionally been rated as VERY LOW (NEGATIVE).

7.3 Cumulative Impacts

Cumulative impact "means the past, current and reasonably foreseeable future impact of an activity, considered together with the impact of activities associated with that activity, that itself may not be significant, but may be significant when added to the existing and foreseeable impacts culminating from similar or diverse activities" (NEMA EIA Reg GN R982 of 2014).

For cumulative effects analysis to be a useful tool to decision makers and stakeholders, it must be limited to effects that can be meaningfully evaluated, rather than expanded to the point where the resource or receptors are no longer significantly affected or the effects are no longer of interest to stakeholders. To this end, four important aspects require consideration prior to the evaluation of cumulative effects:

- The determination of an appropriate area of influence, i.e. spatial and, to a lesser extent, temporal boundaries for evaluation of cumulative effects of the project;
- Identification of Valued Environmental and Social Components (VECs);
- External natural and social stressors; and
- The evaluation of relevant projects for consideration in the cumulative effects analysis.

The nearest operational wind farm from the site is the Noblesfontein Wind Farm located to the north of the corridor. The South African Renewable Energy EIA Application Database (REEA) ("REEA_OR_2022_Q1") shows several renewable energy projects (and associated electrical grid connections) authorised within 30 km of the refined corridor. These projects include (Figure 7-1):

- Biesiespoort PV Facility (east of Nobelsfontein);
- Modderfontein Wind Energy Facility (south of Nobelsfontein)[4];
- Mainstream Wind and Solar Energy Facility (north and northwest of the Gamma Substation);
- Umsinde Emoyeni Wind Energy Facility Phase 2 (east of APS Betelgeuse PV Solar Project Four); and
- Ishwati Emoyeni Wind Energy Facility (east of Umsinde Emoyeni Wind Energy Facility Phase 2).

In terms of existing High Voltage lines in the area, the Kromrivier Traction / Nobelsfontein 1 132 kV line traverses the corridor near Three Sisters, and in the east the refined Gamma Corridor follows the routing of the existing Gamma / Kappa 1 765 kV and the Droerivier / Hydra 2 400 kV powerlines. Another 765 kV line is proposed by Eskom in this corridor. Further to the east, the existing Hydra / Droerivier 1 and the Droerivier / Hydra 3 400 kV lines also fall within the refined Gamma Corridor (Figure 7-1).

Renewable energy and transmission line projects of potential relevance to a palaeontological heritage cumulative impact assessment for the Gamma Gridline project are mapped in Figure 7-1. Palaeontological heritage studies for some of these projects, several of them by the present author, have already been briefly discussed in Section 5.3 of this report and are listed in the References. Full, field-based PIA studies have not been undertaken (or are not yet available) for several of the projects shown in Figure 7-1. Only projects which share the same rock units, and accordingly comparable fossil assemblages, with the Gamma Gridline project area are considered strictly relevant to the cumulative impact analysis.

Given the extensive outstanding palaeontological heritage field data for renewable energy and grid connections in the wider Upper Karoo region between Loxton and Victoria West (Section 5.3), it is not yet feasible to meaningfully assess cumulative palaeontological impacts for the proposed gridline and renewable energy developments under consideration. The cumulative impact analysis provided in Table 7-2 above is therefore necessarily provisional, pending the outcome of outstanding palaeontological field-based studies. Given the number and scale of projects concerned, as well as the high scientific and conservation significance of fossil resources in the wider region, it is concluded that the cumulative Construction Phase impact significance of the proposed Gamma Gridline and associated grid connection infrastructure development in the context of comparable renewable energy and grid connection developments in the region (within a radius of *c*. 30 km) is MEDIUM (NEGATIVE) without mitigation. This would fall to LOW (NEGATIVE) *provided that* the proposed monitoring and mitigation recommendations made for all these various renewable energy projects are consistently and fully implemented (this is unfortunately open to question). These anticipated cumulative impacts

[4] Red Cap has been advised that the Modderfontein Project will not proceed as the EA for this project has lapsed. The Aurora Power Solutions (APS) Betelgeuse PV Solar Project Four (east of the Gamma Substation) application has also lapsed.

following full mitigation lie within acceptable limits. Unavoidable residual negative impacts may be partially offset by the improved understanding of Karoo palaeontology resulting from appropriate professional mitigation. This is regarded as a positive impact for Karoo palaeontological heritage.

Table 7-1: Assessment of anticipated impacts (Construction Phase) on palaeontological heritage resources due to the proposed Gamma Gridline and associated infrastructure developments

Project phase	**Construction**			
Impact	PALAEONTOLOGICAL HERITAGE			
Description of impact	Disturbance, damage of destruction of fossils preserved at or beneath the ground surface due to surface clearance and excavations (e.g. access roads, pylon footings, laydown areas, MTS expansion)			
Mitigatability	Medium	Mitigation is possible and will notably reduce significance of impacts if fully implemented		
Potential mitigation	• Pre-construction walkdown of potentially sensitive sectors of project footprint by palaeontological specialist • Application of Chance Fossil Finds Protocol during Construction Phase • Avoidance of identified Very High Palaeosensitivity areas identified during the Screening Phase			
Assessment	**Without mitigation**		**With mitigation**	
Nature	Negative		Negative	
Duration	Permanent	Damage or loss of fossils is permanent	Permanent	Damage or loss of fossils is permanent
Extent	Very limited	Impacts limited to site	Very limited	Impacts limited to site
Intensity	Moderate	Significant loss of important fossil heritage within footprint	Low	Minor loss of important fossil heritage within footprint
Probability	Likely	Loss of scientifically valuable fossil heritage is likely	Probable	Loss of scientifically valuable fossil heritage is probable but not certain
Confidence	Medium	Most of project area is unstudied but some previous palaeontological studies have been done here	Medium	Most of project area is unstudied but some previous palaeontological studies have been done here
Reversibility	Low	Damage or loss of fossils cannot be rectified	Low	Damage or loss of fossils cannot be rectified
Resource irreplaceability	Medium	The resource is damaged irreparably but may well be represented elsewhere	Medium	The resource is damaged irreparably but may well be represented elsewhere
Significance	**LOW (NEGATIVE)**		**LOW (NEGATIVE)**	
Comment on significance	Negative impacts on palaeontological must be mitigated in the Pre-Construction and Construction Phases. This should lead to an appreciable reduction in impact significance.			

Table 7-2: Anticipated cumulative impacts (Construction Phase) on palaeontological heritage resources due to renewable energy and transmission line developments within a radius of c. 30 km around the Gamma Gridline Corridor

Project phase	**Construction**			
Impact	PALAEONTOLOGICAL HERITAGE			
Description of impact	Disturbance, damage of destruction of fossils preserved at or beneath the ground surface due to surface clearance and excavations			
Mitigatability	Medium	Mitigation is possible and will notably reduce significance of impacts if fully implemented		
Potential mitigation	• Construction phase mitigation specified for each renewable energy / grid development • Application of Chance Fossil Finds Protocol during Construction Phase • Avoidance of identified Very High Palaeosensitivity areas identified during the Screening Phase			
Assessment	**Without mitigation**		**With mitigation**	
Nature	Negative		Negative	
Duration	Permanent	Damage or loss of fossils is permanent	Permanent	Damage or loss of fossils is permanent
Extent	Very limited	Impacts limited to site	Very limited	Impacts limited to site
Intensity	High	Significant loss of important fossil heritage within footprint	Moderate	Significant but moderate loss of important fossil heritage within footprint
Probability	Almost certain / Highly probable	Loss of scientifically valuable fossil heritage is almost certain	Likely	Loss of scientifically valuable fossil heritage is likely
Confidence	Medium	Palaeontological studies available for some far from all projects.	Medium	Level of implementation of recommended mitigation for relevant projects is highly uncertain.
Reversibility	Low	Damage or loss of fossils cannot be rectified	Low	Damage or loss of fossils cannot be rectified
Resource irreplaceability	Medium	The resource is damaged irreparably but may well be represented elsewhere	Medium	The resource is damaged irreparably but may well be represented elsewhere
Significance	**MEDIUM (NEGATIVE)**		**LOW (NEGATIVE)**	
Comment on significance	Negative impacts on palaeontological must be mitigated in the Pre-Construction and Construction Phases. This should lead to an appreciable reduction in impact significance.			

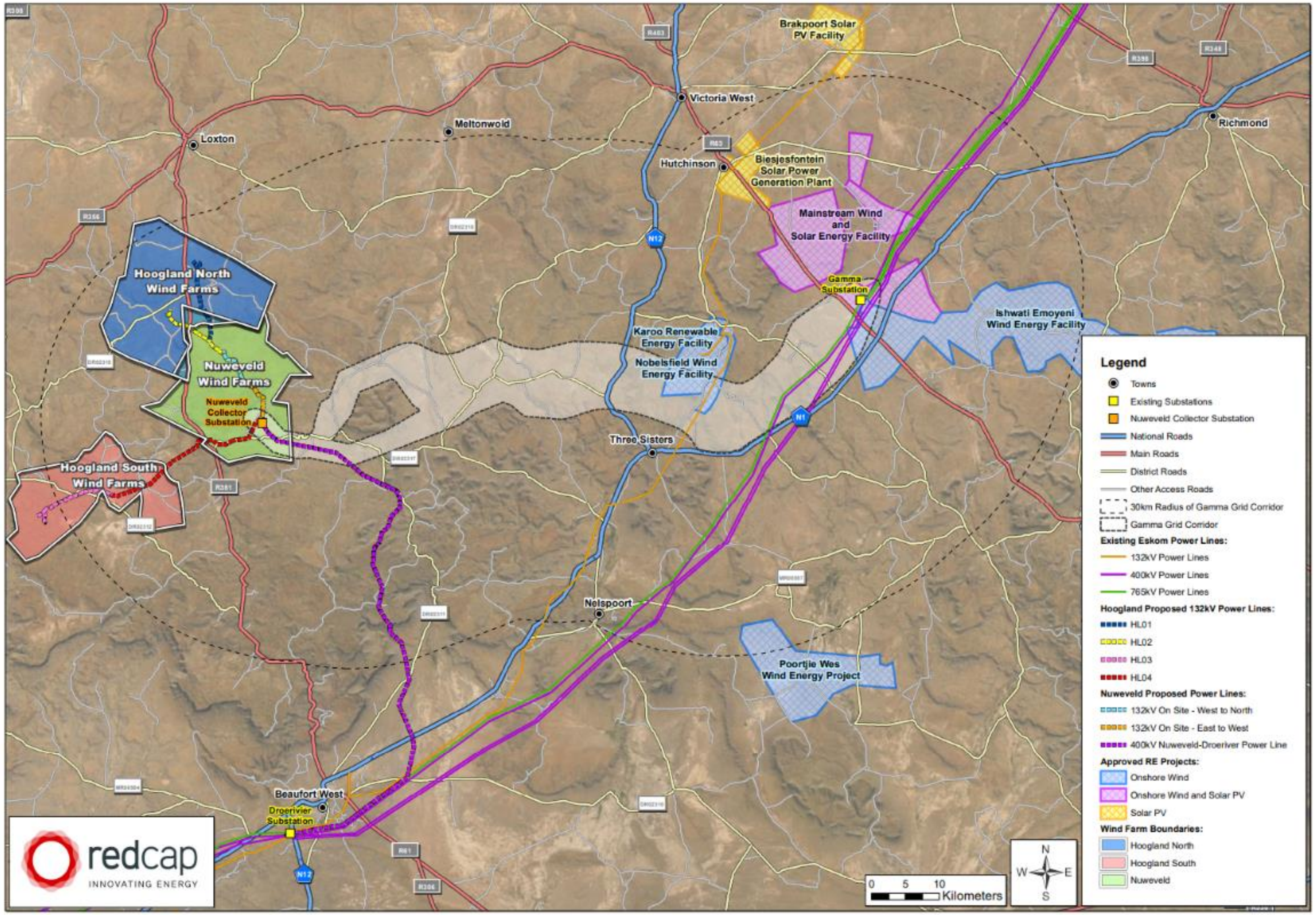

Figure 7-1: Map showing the various renewable energy and transmission line developments within a c. 30 km radius of the proposed Gamma Gridline Corridor. Palaeontological data for these projects - where available - is briefly reviewed in Section 5.3 of this report. Note that field-based palaeontological heritage reports have not been submitted for several of the renewable energy projects mapped here, despite the internationally recognised significance of Karoo palaeontology.

8 MITIGATION AND EMPR REQUIREMENTS

While negative impacts on palaeontological heritage resources will inevitably result from the proposed development, these impacts can and must be partially mitigated in the Pre-Construction and Construction Phases. This should lead to an appreciable reduction in impact significance; the magnitude of the reduction depends on what new fossil finds are made during the pre-construction walkdown and construction phase (unpredictable). Residual negative impacts following mitigation would be partially offset by an improved palaeontological data base and fossil collections due to mitigation (positive impacts). The recommended mitigation measures outlined here cover and comply with the impact management requirements contained in the generic EMPrs for overhead transmission and substation infrastructure specified in the Notice published by the DEA (now DFFE) on 22 March 2019.

Many or most of the more important fossil specimens already recorded within the grid will have already been collected and are accordingly not threatened by the proposed developments, so no further mitigation is required with regard to them. The potential for impacts on additional, *unrecorded* sites of high palaeosensitivity within the understudied project area is substantial, however. Given (1) the currently inadequate field data from the project area as well as (2) the fact that many fossils within the development footprint are hidden beneath the surface, these impacts are relatively unpredictable.

Proposed palaeontological heritage mitigation for the Gamma Gridline and associated grid connection infrastructure developments includes:

- Avoidance of No-Go / Very High Palaeosensitivity areas identified during the Screening Phase (see red polygon in satellite Map Figure 6-2 in this report). (In contrast, High Sensitivity areas identified during the proposed palaeontological walkdown can be effectively mitigated during the Pre-Construction or Construction Phases and so need not be avoided).
- A pre-construction walkdown of potentially sensitive sectors of the project footprint - as identified from satellite imagery and the existing fossil database - by a palaeontological specialist. Palaeontological sites of scientific / conservation value should be recorded and, if feasible, sampled or collected together with pertinent field data, with recommendations for further mitigation measures - if any are necessary.
- Application of a Chance Fossil Finds Protocol during the Construction Phase (See Appendix 4 for details).

The qualified palaeontological specialist involved in Pre-construction Walkdown and any further mitigation triggered by Chance Fossil Finds will need to submit an application for a Fossil Collection Permit (SAHRA) and / or a Work Plan to Heritage Western Cape (HWC). Fossil material collected must be curated in an approved palaeontological depository (*e.g.* museum / university fossil collection) together with all essential collection data. The palaeontological studies should conform to international best practice for palaeontological fieldwork and adhere as far as possible to the minimum standards for palaeontological heritage studies developed by SAHRA (2013) and HWC (2021). The palaeontological assessment reports must be submitted for consideration to the responsible Provincial Heritage Resources Agency.

These mitigation measures must be included within the EMPr for the Gamma Gridline and associated infrastructure development.

9 CONCLUSION AND SUMMARY

9.1 Summary of Findings

The project area for the Gamma Gridline and associated grid connection infrastructure is underlain by (1) potentially fossiliferous continental sediments of the Teekloof Formation (Lower Beaufort Group, Karoo Supergroup) of Middle to Late Permian age as well as by (2) a range of Late Caenozoic superficial sediments, most of which – with the possible exception of consolidated older alluvial deposits – are, at most, sparsely fossiliferous. Provisional palaeosensitivity mapping of the project area using the DFFE Screening Tool and SAHRIS suggests that this area is largely of Very High sensitivity.

Several previous field-based PIA studies for renewable energy projects within and on the margins of the grid connection corridor (Nuweveld East Wind Farm project area) indicate that vertebrate and other fossil sites of scientific and conservation value do indeed occur here, but are often sparsely distributed and unpredictable. The slopes of Vaalkop on Farm Leeukloof 43, situated at the western end of the gridline corridor, are identified as a Very High Palaeosensitivity area (i.e. No-Go areas). The Biesiespoort Station area within the adjoining Noblesfontein WEF and Modderfontein WEF project areas (Farms Nobelsfontein 248, Matjiesfontein 220 and Modderfontein 228) is considered to be a High Sensitivity area on the basis of the long history of key vertebrate fossil collection here but lies just outside and just to the north of the Gamma Gridline Corridor. The recent two and a half day palaeontological drive-through indicates that most of the gridline corridor is likely to be of Low Palaeosensitivity due to extensive cover by unfossiliferous superficial sediments, baking by dolerite intrusions and near-surface weathering. Good exposures of potentially fossiliferous, consolidated older alluvial deposits were not encountered during the drive-through, even along larger water courses such as the Soutrivier. The provisional DFFE Screening Tool mapping is therefore *contested* here. The potential for unrecorded fossil sites of high scientific / conservation significance within the Lower Beaufort Group bedrocks and older alluvial deposits cannot be excluded, however.

The proposed grid connection development will entail excavations into the superficial sediment cover as well as into the underlying, potentially fossiliferous bedrocks during the construction phase. The developments may adversely affect legally protected and scientifically important fossil heritage within the project footprint by destroying, damaging, disturbing or permanently sealing-in fossils at or beneath the ground surface that are then no longer available for scientific research or other public good. Excavations for access road cuttings as well as surface clearance for new sectors of access road (*c*. 46 ha footprint) are likely to be by far the most important source of impacts on palaeontological heritage (more than, for example, electrical pylon footings).

The significance of impacts on palaeontological heritage resources during the Construction Phase of the proposed Gamma Gridline and associated grid connection infrastructure is assessed as LOW (NEGATIVE) both before and following the recommended mitigation. The magnitude of the impact reduction depends on the scientific / conservation significance of the fossils that are found during mitigation (unpredictable). The impact significance of the No-Go Option is rated as VERY LOW (NEGATIVE). The cumulative impact significance in the context of comparable renewable energy and grid connection developments in the region (within a radius of *c*. 30 km of the Gamma Gridline Corridor) is provisionally assessed as NEGATIVE MEDIUM without mitigation. This would fall to NEGATIVE LOW *provided that* the proposed monitoring and mitigation recommendations made for all these various renewable energy projects are consistently and fully implemented (this is unfortunately open to question). These anticipated cumulative impacts following full mitigation lie within acceptable limits.

Most - but not all - previously recorded fossil sites of scientific importance within the corridor will have already been collected so mitigation with regard to these sites is not necessary. The potential for further, *unrecorded* sites of high palaeosensitivity within the understudied project area is high, however. Proposed palaeontological heritage mitigation for the Gamma Gridline and associated infrastructure development includes:

- Avoidance of Very High Palaeosensitivity areas identified during the Screening Phase (In contrast, High Sensitivity areas can be effectively mitigated during the Pre-Construction or Construction Phases and so need not be avoided).
- A pre-construction walkdown of potentially sensitive sectors of the project footprint - as identified from satellite imagery and the existing fossil database -by a palaeontological specialist. Palaeontological sites of scientific / conservation value should be recorded and, if feasible, sampled or collected together with pertinent field data, with recommendations for further mitigation measures – if any are necessary.
- Application of a Chance Fossil Finds Protocol during the Construction Phase (See Appendix 4).

The qualified palaeontological specialist involved in Pre-construction Walkdown and any mitigation triggered by Chance Fossil Finds will need to submit an application for a Fossil Collection Permit (SAHRA) and / or a Work Plan (HWC) to the relevant Provincial Heritage Resources Agency. Fossil material collected must be curated in an approved palaeontological depository (*e.g.* museum / university fossil collection) together with all essential collection data. The palaeontological studies should conform to international best practice for palaeontological fieldwork and adhere as far as possible to the minimum standards for palaeontological heritage studies developed by SAHRA (2013) and HWC (2021). The palaeontological assessment reports must be submitted for consideration to the responsible Provincial Heritage Resources Agency.

These mitigation measures must be included within the EMPr for the Gamma Gridline and associated infrastructure development.

No fatal flaws have been identified here regarding the proposed development. Provided that the mitigation measures outlined above are included within the EMPr for the development and fully implemented, there are no objections on palaeontological heritage grounds to environmental authorization of the Gamma Gridline and associated grid connection infrastructure.

9.2 Conclusion and Impact Statement

The significance of impacts on palaeontological heritage resources during the Construction Phase of the proposed Gamma Gridline and associated grid connection infrastructure is assessed as LOW (NEGATIVE) both before and following the recommended mitigation. Significant further impacts during the Operational and De-commissioning Phases are not anticipated. The impact significance of the No-Go Option is rated as VERY LOW (NEGATIVE). The cumulative impact significance is provisionally assessed as MEDIUM (NEGATIVE) without mitigation, falling to LOW (NEGATIVE) *provided that* the proposed monitoring and mitigation recommendations made for all these various renewable energy projects are consistently and fully implemented. These anticipated cumulative impacts following full mitigation lie within acceptable limits.

No fatal flaws have been identified here regarding the proposed development. Provided that the mitigation measures outlined in Section 9 of this report are included within the EMPr for the development and fully implemented, there are no objections on palaeontological heritage grounds to environmental authorization of the Gamma Gridline and associated grid connection infrastructure.

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APPENDIX 1: SHORT CV OF AUTHOR

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

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

Declaration of Independence

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

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

<table>
<tr><td colspan="3">APPENDIX 2 - CHANCE FOSSIL FINDS PROCEDURE: Gamma Gridline and associated grid connection infrastructure between Loxton and Victoria West</td></tr>
<tr><td>Province & region:</td><td colspan="2">Northern Cape (Pixley Ka-Seme District) and Western Cape (Central Karoo District)</td></tr>
<tr><td>Responsible Heritage Management Agencies</td><td colspan="2">SAHRA for N. Cape: SAHRA, 111 Harrington Street, Cape Town. PO Box 4637, Cape Town 8000, South Africa. Phone: +27 (0)21 462 4502. Fax: +27 (0)21 462 4509. Web: www.sahra.org.za
HERITAGE WESTERN CAPE for W. Cape. Protea Assurance Building, Green Market Square, Cape Town 8000. Private Bag X9067, Cape Town 8001. Tel: 021 483 9598. E-mail: ceoheritage@westerncape.gov.za</td></tr>
<tr><td>Rock unit(s)</td><td colspan="2">Teekloof Formation (Lower Beaufort Group), Late Caenozoic alluvium.</td></tr>
<tr><td>Potential fossils</td><td colspan="2">Fossil skulls, postcrania of tetrapods, amphibians, fish as well as rare petrified wood, vertebrate and invertebrate burrows within bedrocks. Mammalian bones, teeth & horn cores, freshwater molluscs, calcretised trace fossils & rhizoliths and plant material in alluvium.</td></tr>
<tr><td rowspan="5">ECO / ESO 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">Apply for Fossil Collection Permit Record / submit Work Plan to relevant Heritage Resources Agency. 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>

Appendix 3: Site Sensitivity Verification Report

CONTENTS

1. INTRODUCTION

Red Cap Energy (Pty) Ltd ('Red Cap') has received Environmental Authorisation for three wind farms and for a 400 kV grid corridor collectively known as Nuweveld Wind Farm Development, located close to Beaufort West in the Western Cape Province. The approved grid corridor links the Nuweveld projects to the Droërivier Substation ~65 km to the south of the wind farms (refer to Figure 1).

Red Cap is also proposing to develop four additional wind farms and associated grid connections, known as the Hoogland Projects. The Hoogland Wind Farms are located north and south of the Nuweveld complex, and the Hoogland grid connections will terminate at the Nuweveld Collector Substation (refer to Figure 1) and are the subject of separate applications.

To expand the capacity of Eskom grid and improve the functionality of the grid in the area, an additional 400 kV grid connection is required from the approved Nuweveld Collector Substation to the existing Gamma Substation, ~90 km to the east (the project). This additional line will improve functionality by creating a 400 kV ring-line between the Droërivier Substation, Gamma Substation and Nuweveld projects, and create opportunities for other wind farm developments (such as the proposed Hoogland projects) to tie-into the grid either at the Nuweveld Collector Substation or along the new 400 kV line. As such, the proposed new line will allow Eskom to release further renewable energy potential in an area that is becoming a renewable energy development node in South Africa, thereby helping to alleviate South Africa's power crisis.

A 300 m x 300 m expansion to the Gamma Substation (including transformers and other standard substation infrastructure) and access tracks for construction and maintenance of the line will also be required and form components of the project.

The corridor for the proposed Gamma Gridline is underlain by potentially fossiliferous sediments of the Teekloof Formation (Lower Beaufort Group, Karoo Supergroup) as well as a range of Late Caenozoic superficial sediments (alluvium, colluvium, soils *etc*) which might also contain fossils of scientific / conservation value. Provisional sensitivity mapping of the corridor by the DFFE Screening Tool as well as the SAHRIS palaeosensetivity map suggests that the majority of the site is of Very High Palaeosensitivity (Figure 2).

The project triggers activities listed in terms of the Environmental Impact Assessment (EIA) Regulations, 2014, as amended, promulgated in terms of the National Environmental Management Act (Act 107 of 1998, as amended) (NEMA). These activities require authorisation from the Department of Forestry, Fisheries and the Environment (DFFE), prior to commencement. An application for Environmental Authorisation (EA) will be submitted to the Department of Forestry, Fisheries and the Environment (DFFE) and informed by a Basic Assessment (BA) process as the project will lie wholly within a strategic transmission corridor[1] specifically identified for the placement of this infrastructure.

In accordance with GN 320 (of 2020)[2] and GN 1150 (of 2020) of the NEMA EIA Regulations of 2014, prior to commencing with a specialist assessment, a site sensitivity verification must be undertaken 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). *Natura Viva* cc, Cape Town, have been commissioned to verify the sensitivity of the Gamma Grid Connection project under these specialist protocols.

2. SITE SENSITIVITY VERIFICATION METHODOLOGY

The palaeontological sensitivity of the proposed Gramma Grid corridor was assessed using the following resources:

1. A detailed project outline, kmz files, screening report and maps provided by Red Cap;

2. A desktop review of:
(a) the relevant 1:50 000 scale topographic maps (3122CD, DA, DB, DC, DD, 3123CA, CB, CC, CD) and the 1:250 000 scale topographic map 3122 Victoria West),
(b) Google Earth© satellite imagery,
(c) published geological and palaeontological literature, including 1:250 000 geological maps (3122 Victoria West) and the relevant sheet explanation (Le Roux & Keyser 1988), as well as
(d) several previous and on-going fossil heritage (PIA) assessments for renewable energy and transmission line projects in the Karoo region between Beaufort West, Loxton and Victoria West by the author, as listed in the References under Almond;

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 and a half--day, reconnaissance-level palaeontological heritage drive-through of the Gamma Grid Corridor project area by the author on 21 to 23 September 2022. The season in which the site visit took place does not have a critical bearing on this palaeontological study. However, paleontological field studies - including the photographic recording of geological landscapes, rock exposures and fossil sites - in winter weather may be hampered by short days, low light, and rainfall while rainy or muddy conditions may constrain site access and productivity.

[1] As per the requirements of Government Notice 113 of 16 February 2018 for transmission lines falling within a strategic transmission corridor.
[2] GN 320 (20 March 2020): Procedures for The Assessment and Minimum Criteria for Reporting on Identified Environmental Themes in terms of Sections 24(5)(A) and (H) and 44 of the National Environmental Management Act, 1998, when applying for Environmental Authorisation

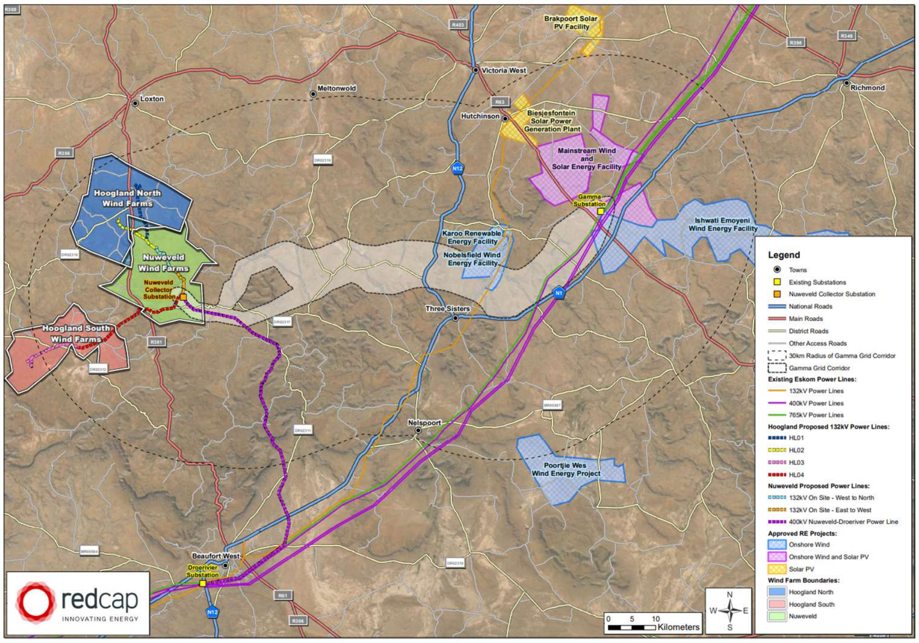

Figure 1: Map showing the location of the approved 400 kV grid connection linking the Nuweveld WEF projects to the Droërivier Substation ~65 km to the south of the wind farms as well as the proposed additional 400 kV grid connection from the Nuweveld Collector Substation to the Gamma Substation, ~90 km to the east (the project).

Figure 2: Provisional palaeosensitivity mapping of the Gamma Gridline Corridor (blue dashed polygon) by the DFFE Screening Tool (Red Cap, dated August 2022). Most of the corridor is mapped as Very High Palaeosensitivity based on the outcrop area of the Lower Beaufort Group sediments.

3. OUTCOME OF SITE SENSITIVITY VERIFICATION

The Lower Beaufort Group bedrocks cropping out over the great majority the Gamma Gridline Corridor project area are generally assigned a Very High Palaeosensitivity (Almond & Pether 2008, SAHRIS palaeosensitivity map). Provisional sensitivity mapping by the DFFE Screening Tool assigns a Very High palaeosensitivity to the Lower Beaufort Group sediments, a Medium palaeosensitivity to substantial deposits of Late Caenozoic alluvium associated with major drainage lines and Zero palaeosensitivity to Karoo dolerite intrusions (Figure 6-1).

Previous experience within renewable energy project areas in this region of the Upper Karoo as well as the recent palaeontological heritage drive-through of the Gamma Grid corridor indicate that, in practice, most of the area is of Low Palaeosensitivity. This is largely due to (1) widespread cover by unfossiliferous superficial sediments and (2) near surface weathering as well as (3) intensive dolerite intrusion. Good exposures of potentially fossiliferous, consolidated older alluvial deposits were not encountered during the drive-through, even along larger water courses such as the Soutrivier. Fossil sites of significant scientific and conservation value are usually sparsely scattered, although occasional high concentrations of well-preserved vertebrate remains may be found in areas of good bedrock (especially mudrock) exposure. Based on the recent site visit, such mudrock exposures are scarce within the grid connection. Most - but not all - previously recorded fossil sites of scientific importance within the corridor will have already been collected.

Based on previous PIA studies in the wider region as well as the reconnaissance-level drive through of the Gamma Grid corridor no specific Very High sensitivity sites or No-Go areas regarding palaeontological heritage have been identified or delineated in the combined desktop and field-based report for the Gamma Gridline Corridor with the exception of:

- the slopes of Vaalkop on Farm Leeukloof 43 (red polygon, incorporating a buffer zone, in satellite map Figure 3), previously identified as a Very High Palaeosensitivity research area for the Hoedemaker Member within the Nuweveld East Wind Farm project area (Almond 2020a).

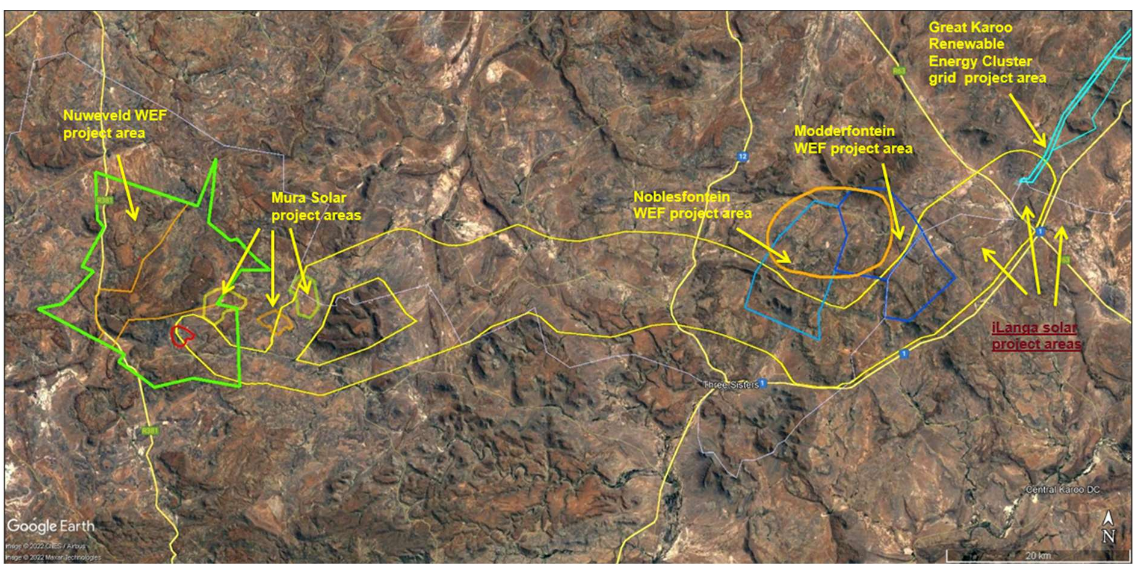

Figure 3: Google Earth© satellite map of the proposed Gamma Gridline Corridor (yellow polygon) showing the identified Very High Palaeosensitivity research area on the slopes of

Vaalkop in the west (small red polygon) as well as the High Palaeosensitivity area around Biesiespoort in the east (orange polygon). The former should be treated as No-Go area. The latter area lies outside the grid corridor and fossil sites in such High Palaeosensitivity areas can usually be effectively mitigated in the Pre-Construction and Construction Phases. No further palaeontological heritage constraints are proposed here regarding the final routing of the Gamma Gridline. WEF, solar and grid project areas in the region for which palaeontological field data is currently available are also indicated on the satellite map.

4. CONCLUSION

It is concluded that the great majority of the Gamma Grid corridor is in practice of LOW palaeosensitivity. The preliminary sensitivity mapping by the DFFE Screening Tool is accordingly *contested* here.

The potential for further, *unrecorded* sites of high palaeosensitivity within the largely understudied project area remains significant, however; such fossil sites are generally highly localized, unpredictable and can only be recognized through palaeontological fieldwork.

5. DETAILS OF SPECIALIST

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

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

Declaration of Independence

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

Dr John E. Almond

(Palaeontologist, *Natura Viva* cc)

Appendix 4: Terms of Reference

PROPOSED GAMMA GRID CONNECTION

TERMS OF REFERENCE (ToR) FOR SPECIALIST STUDIES

CONTENTS

1 INTRODUCTION

Red Cap Energy (Pty) Ltd ('Red Cap') has received Environmental Authorisation for three wind farms and for a 400 kV grid corridor collectively known as Nuweveld Wind Farm Development, located close to Beaufort West in the Western Cape Province. The approved grid corridor links the Nuweveld projects to the Droërivier Substation ~65 km to the south of the wind farms (refer to Figure 1).

Red Cap is also proposing to develop four additional wind farms and associated grid connections, known as the Hoogland Projects. The Hoogland wind farms are located north and south of the Nuweveld complex, and the Hoogland grid connections will terminate at the Nuweveld Collector Substation (refer to Figure 1).

To expand the capacity of Eskom grid and improve the functionality of the grid in the area, an additional 400 kV grid connection is required from the Nuweveld Collector Substation to the Gamma Substation, ~90 km to the east (the project). This additional line will improve functionality by creating a 400 kV ring-line between the Droërivier Substation, Gamma Substation and Nuweveld projects, and create opportunities for other wind farm developments (such as the proposed Hoogland projects) to tie-into the grid either at the Nuweveld collector substation or along the new 400 kV line. As such, the proposed new line will allow Eskom to release further renewable energy potential in an area that is becoming a renewable energy development node in South Africa, thereby helping to alleviate South Africa's power crisis.

A 300 m x 300 m expansion to the Gamma Substation (including transformers and other standard substation infrastructure) and access tracks for construction and maintenance of the line will also be required and form components of the project.

Although the gridline starts in the Western Cape (Central Karoo District Municipality and Beaufort West Local Municipality), portions of the line will traverse land in the Northern Cape (Pixley ka Seme District Municipality and Ubuntu Local Municipality).

The project triggers activities listed in terms of the Environmental Impact Assessment Regulations, 2014, as amended. These activities require authorisation from the Department of Forestry, Fisheries and the Environment (DFFE), prior to commencement. An application for Environmental Authorisation (EA) will be submitted and informed by a Basic Assessment (BA) process as the project will lie wholly within a strategic transmission corridor[1] specifically identified for the placement of this infrastructure.

The BA process will be informed by a suite of specialist studies.

Following a specialist desktop screening process and preliminary landowner negotiations, a refined grid connection corridor, within which the line will be built, has been established (refer to .kmz titled "Grid Corridor Adjustment (220620_v1) at https://www.dropbox.com/sh/l0qy9qc3scgkic6/AAAPFXLMLN19DHVrcFlTAvkVa?dl=0). The refined corridor is between 6 km and 10 km wide and extends ~ 110 km.

Following further detailed sensitivity mapping (including specialist site visits, where necessary), the corridor will be further refined and specialists will be required to assess the potential impacts of a route within the refined corridor, as well as the 300 m x 300 m expansion to the Gamma Substation within a 300 m wide assessment window around this facility.

[1] As per the requirements of Government Notice 113 of 16 February 2018 for transmission lines falling within a strategic transmission corridor.

This specialist Terms of Reference (ToR) is intended to guide specialist sensitivity mapping and assessments of the proposed gridline within the refined corridor and to ensure a consistent approach to the required suite of studies.

The specialist reporting requirements include (1) Site Sensitivity Verification Report and (2) a Specialist Assessment Report / Compliance Statement (as applicable, required in terms of GN 320 of 20 March 2020 and GN 1150 of 30 October 2020; or Appendix 6 of the EIA Regulations, 2014 if no protocols apply to the discipline).

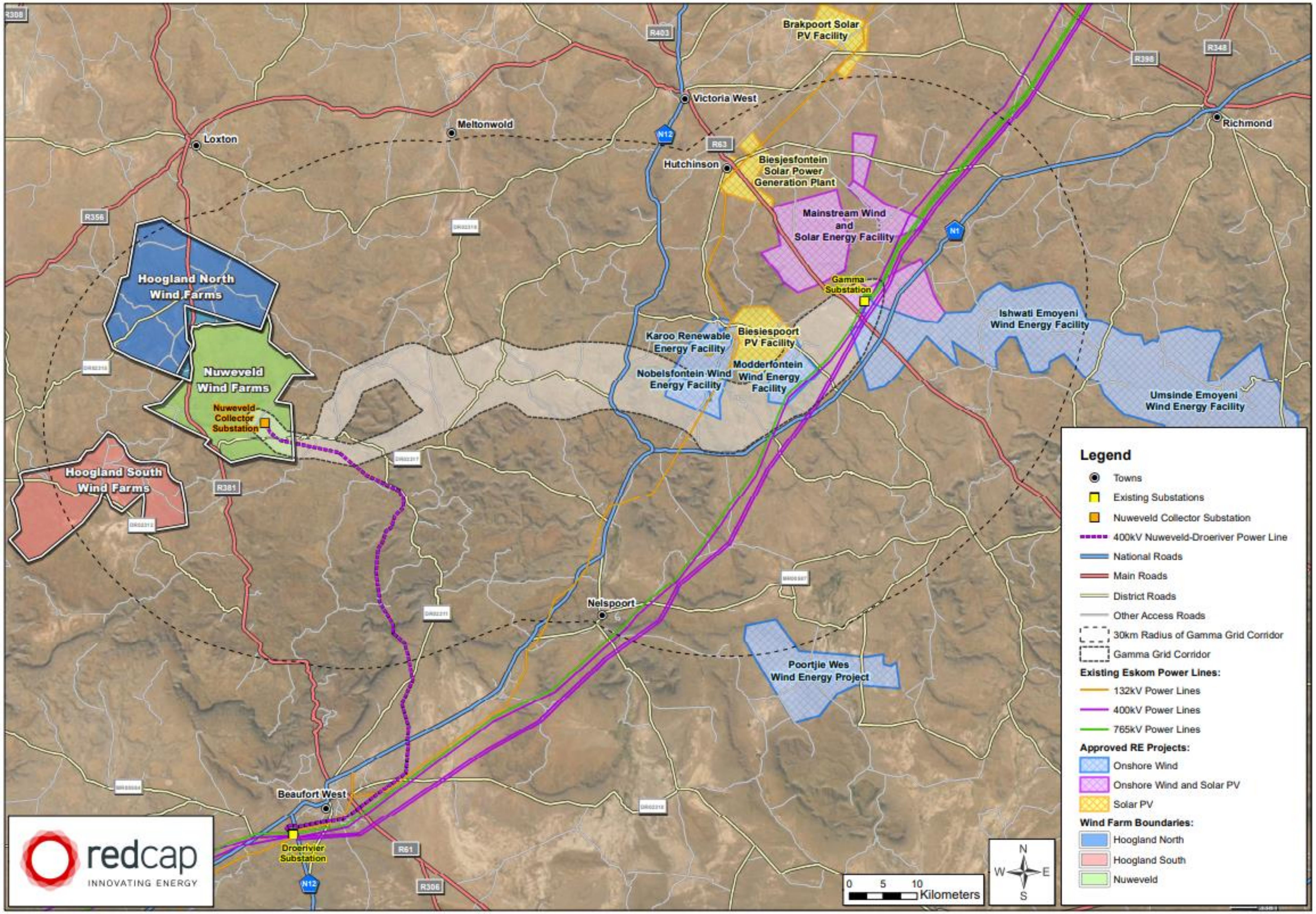

Figure 1: Locality Map of the proposed Gamma Gridline Corridor

2 PROJECT DESCRIPTION

The route of the line must be pre-negotiated with the respective landowners, which includes obtaining in-principle agreements from the landowners that the line may go over their land. This pre-negotiated, or provisional route, must be presented in the BA Report. While every effort will be made to stick to the provisional route (following post-authorisation specialist micro-siting), deviations from the route are possible. Red Cap will therefore seek to have a corridor approved for the project, with relevant conditions (most importantly, that the final route avoids No-Go areas as identified by the specialists). Therefore, the specialist input in terms of where a line may, and may not be routed within the approved corridor (i.e. No-Go areas) will be paramount.

The 400 kV gridline would have a ≤ 55m wide servitude, which may be kept clear of taller vegetation (trees) and, where required and feasible, accommodate access tracks needed for construction and maintenance.

Lattice type pylons will be used for the project. Different lattice type pylon will be required along the gridline depending on the topography and span characteristics. Most of the pylons will be cross-rope suspension towers, with self-supporting towers being used at turn points, at steep slopes or where a very large distance needs to be spanned. The technical characteristics of these pylon types are briefly described in the remainder of this section of the ToR. More detailed technical information for each pylon type is contained in the document titled “Gamma 400 kV Grind Connection Structure Types” in the shared DropBox folder.

All pylon types would attach to concrete plinths and foundations of varying sizes depending on pylon type. Guy wires with concrete anchor blocks will also be required for providing additional support and to stabilise some of the pylons/ towers.

The footprints of the 400 kV towers are conservatively assumed to be 100 m^2 each. The average span of the 400 kV line will be 400 m.

Temporary laydown areas will be identified along the power line route, with the main equipment and construction yards being based in one of the surrounding towns or at the wind farm site camp and laydown areas. It is anticipated that the total area required for the temporary laydown areas is up to 5 ha.

Existing access roads and tracks (upgraded to ± 2-4m wide where needed) will be used as far as possible and new access tracks would be established, where needed, outside of specialist identified No-Go areas – these would be 2-4 m wide (wider than 2m when side drains are needed or due to the topography). For this assessment, Red Cap conservatively assumes that 4 m wide access tracks will be required for the length of the line with an additional 5 km allowance for deviations from the gridline route[2].

2.1 Cross-Rope Suspension Tower

Tower type:	400kV Intermediate or Suspension Tower: Cross-Rope Suspension Tower
Description:	The tower consists of two main lattice supports (masts) with a steel cross rope. The masts are each supported by guyed anchors. Conductors are supported on insulators connected to the steel cross rope.

[2] For example, if the line is 110 km long (+ 5km allowance for any deviation), the disturbance footprint (in ha) assumed for access tracks will be ((0.004 km x 115 km) x 100 = 46 ha

Footprint:	Stays are positioned 17m to 27m from the tower masts at an angle. Mast foundations (x2) will each be approximately 7m^2 in extent, and anchor foundations (x4) will each be approximately 1.6 m^2 in extent (i.e. 20.4 m^2 in total).

2.2 Guyed V-Type Tower

Tower type:	400kV Intermediate or Suspension Tower: Guyed V-Type Suspension Tower
Description:	The tower consists of a main lattice triangle shape steel support tower that is installed on a centre foundation and supported by 4 x guyed anchors on the side. The structure is designed to support heavier conductor weights and can be used where longer spans are required.
Footprint:	Mast foundation will be approximately 10m^2 in extent, and anchor foundations (x4) will each be approximately 1.6 m^2 in extent (i.e. 16.4 m^2 in total). The pylon a smaller footprint than the intermediate cross rope tower.

2.3 Self-Supporting Suspension Tower

Tower type:	400kV Intermediate or Suspension Tower: Self-Supporting Suspension Tower
Description:	The tower consists of a self-supporting lattice structure design fully supported by four tower legs. No guyed anchors are required for this design. Conductors are supported on insulators connected to a steel lattice cross-arm. The structure in general bulky, and more visible than the cross-rope suspension tower but has a smaller footprint. This structure will only be used where the footprint space is limited and at turn-points.
Footprint:	The footprint of the tower is determined by the distances between the outer legs on the ground which are supporting the tower. This forms a square (disturbance footprint) of approximately 67 m^2 (0.007 ha) in extent. Tower leg foundations (x4) will each be approximately 17.6 m^2 in extent (i.e. 70.6 m^2 in total).

2.4 Transition Self-Supporting Suspension Tower

Tower type:	Transposition Tower: Self-Supporting Suspension Tower
Description:	Required in the case where phasing needs to be swopped along the line. Normally maximum of 3 x towers required across a distance >100km. The tower consists of a self-supporting lattice structure with 4 tower legs. Insulators are supported from a steel lattice delta type cross-arm/beam.
Footprint:	Tower leg foundations (x4) will each be approximately 21.2 m^2 in extent (i.e. 84.8 m^2 in total).

2.5 Inline and Angle Strain Self-Supporting Tower

Tower type:	400kV Inline and Angle Strain Self-Supporting Tower
Description:	The tower consists of a self-supporting lattice structure design fully supported by four tower legs. No guyed anchors are required for this design. Conductors are supported on insulators connected to a steel lattice cross-arm. The structure in general bulky, and more visible than the cross-rope suspension tower but has a smaller footprint. This structure will only be used where the footprint space is limited and at turn-points.
Footprint:	Tower leg foundations (x4) will each be approximately 21.2 m^2 in extent (i.e. 84.8 m^2 in total).

3 SPECIALIST DELIVERABLES

Red Cap anticipates the following deliverables and due dates from each specialist:

1. Desktop sensitivity layers for refined corridor (concluded);
2. Updated sensitivity layers following site inspections (22 July 2022); and
3. SSVRs and compliance statements or assessment reports (as required – 19 August 2022).

4 SPECIALIST REPORTING REQUIREMENTS

4.1 Sensitivity Mapping

Taking cognisance of identified sensitivity presented in the Screening Tool Report, specialists must map environmental sensitivities and associated developmental No-Go areas that should be avoided. This will allow the most environmentally favourable alternative to be identified, in the form of an environmentally preferred corridor. This information will also assist in the identification of the provisional route and guide selection of mitigation measures in certain areas.

Specialists are to identify likely No-Go, high-sensitive, medium-sensitive and low-sensitive areas within the refined corridor and a 300 m perimeter around the Gamma Substation based on the categories defined in Table 4-1.

These sensitivity layers will inform the development of consolidated No-Go maps and will be used to determine the provisional line routing to be presented in the BA report.

Table 4-1: Sensitivity categories to be used during baseline and impact assessment and associated mapping input

No-Go	Areas or features that are considered of such sensitivity or importance that any adverse effects upon them may be regarded as a fatal flaw.
High	Areas or features that are considered to have high sensitivity. Development in these areas must be avoided as far as practically possible and must remain within any acceptable limits of change as determined by the specialist. Development should also comply with any other restrictions or mitigation measures identified by the specialist.
Medium	Medium sensitivity areas are considered to be developable; however, the nature of the effects should remain within any acceptable limits of change as determined by the specialist. Development should also comply with any other restrictions or mitigation measures identified by the specialist.

Low	Low sensitivity areas that are considered to be developable however specialists may still wish to define acceptable limits of change should they deem this necessary.

Experience has indicated that in some circumstances the line itself would have a different effect (aerial impacts) on a receptor or resource if compared to the pylons and access roads (footprint impacts). This has implications for the development restrictions that should be applied. An example is the ecological impact of powerline development – rare and or sensitive habitats represent constraints to pylon placement (footprint impact) as opposed to a constraint to line placement. The habitat would therefore constitute a No-Go for pylons, but not a No-Go for the line, and by moving the pylons outside of this area, the line could still be developed over the habitat.

On this basis, we propose the following mapping approach for the grid connection mapping guided by the nature of the effects of each infrastructure type in relation to each discipline:

Specialist	Type of impact	Title of sensitivity map
Terrestrial ecology Aquatic Palaeontology Agriculture Heritage	Potential terrestrial impacts from footprints of roads / pylons.	'Sensitivity map for Pylons and access roads'
Visual Avifauna	Potential impacts from the line and roads and pylons are different and would have different development restrictions. Thus, two sensitivity maps for the grid connection would be required.	1- 'Sensitivity map for Overhead line (excluding pylons and access roads)' 2- 'Sensitivity map for Pylons and access roads'
Traffic Socio-economic	N/A	N/A

4.2 Site Sensitivity Verification Report (SSVR) and Specialist Assessment Report Templates

The main deliverables are as follows:

1. Site Sensitivity Verification Report (SSVR) – attached as separate document; and
2. Specialist Assessment Report – attached as separate document; or
3. Compliance Statement – see Section 4.2.3 below.

Based on the verified sensitivity of themes for which reporting protocols have been promulgated in terms of GN320 of 2020 and GN1150 of 2020, either a specialist assessment (Section 4.2.2 below) or compliance statement (Section 4.2.3 below) will be required.

For themes where specialist reporting protocols have not been promulgated specialist reports must meet the requirements of Appendix 6 of the EIA Regulations, 2014.

SSVR and Assessment Report templates have been provided to promote consistency and ensure all components are included; however, it is not mandatory to use the specific specialist report template/s if the same content is included in your own template.

Red Caps assumptions with regard to specialist reporting requirements are summarised in 5 below.

4.2.1 SSVR Template

Note: It is mandatory that Terrestrial Biodiversity, Plant theme, Animal theme, Aquatic Biodiversity, Agriculture, Heritage and Palaeontology specialists submit a SSVR according to GN 320 of March 2020.

4.2.2 Assessment Report Template

The template includes generic project information. Alternatively generic project information can be copied and pasted into your own template that meets the requirements of GN320 of 2020, GN1150 of 2020 and/or Appendix 6 of the EIA Regulations, 2014.

In summary, the key content is as follows:

1. A table cross referencing how the requirements for specialist reports have been adhered to according to GN320 of 2020, GN1150 of 2020 and/or Appendix 6 of the EIA Regulations, 2014 (as amended);
2. Details and expertise of specialist who prepared report;
3. Executive summary;
4. Scope and purpose of the report;
5. Project description;
6. Relevant legislation and guidelines, including the requirement for any permits;
7. Methodology including an indication of the quality and age of the data, details of field work, consultations, gaps in information and uncertainties;
8. Baseline environment;
9. Sensitivity mapping (showing the sensitivity of the corridor for the development of an overhead transmission line and also for pylons and access roads) – see Section 4.1;
10. Impact assessment, including assessment of the No-Go alternative – see Section 4.3;
11. Mitigation and EMPr requirements – note that development of the project must comply with the impact management requirements contained in the generic EMPrs for overhead transmission and substation infrastructure (included in shared DropBox folder), specialists should therefore draw mitigation measures from this document as far as possible, supplemented by non-standard or site-specific mitigation ;
12. Cumulative impact assessment – see Section 4.4; and
13. Conclusion / impact statement on the acceptability of the project/s.

4.2.3 Compliance Statement

As specified in the respective protocols, the compliance statement must:

1. Be applicable to the preferred site and proposed development footprint;
2. Verify the sensitivity of the site; and
3. Indicate whether or not the proposed development will have any impact / unacceptable impact on the resource.

The compliance statement must contain, as a minimum, the following information:

1. The contact details of the specialist, their SACNASP registration number, their field of expertise and curriculum vitae;
2. A signed statement of independence by the specialist (i.e. specialist declaration form - attached as a separate document);
3. Baseline profile (including sensitive environments/habitats and important corridors/processes etc.) and/or sensitivity mapping as required by the applicable protocol;

4. Methodology including details of site inspection, any modelling or calculations required by the protocol, or any associated design recommendations that have applied to reduce impacts;
5. A substantiated statement from the specialist on the acceptability, or not, of the proposed development and a recommendation on the approval, or not, of the proposed development.
6. Any conditions to which this statement is subjected;
7. In the case of a linear activity, confirmation from the specialist that, in their opinion, based on the mitigation and remedial measures proposed, the land can be returned to the current state within two years of completion of the construction phase;
8. Where required, proposed impact management outcomes and actions to achieve these outcomes and/or any monitoring requirements for inclusion in the EMPr; and
9. A description of the assumptions made and any uncertainties or gaps in knowledge or data.

4.3 Impact Rating Methodology

The impacts of the proposed development (during the Construction, Operation and Decommissioning phases) are to be assessed and rated according to the methodology described below.

Specialists will be required to make use of the impact rating matrix provided (in Excel format) for this purpose.

The assessment of the significance of impacts for a proposed development is by its nature, a matter of judgement. To deal with the uncertainty associated with judgement and ensure repeatable results, impacts must be rated using a standardised methodology.

This section outlines the method for assessing the significance of the potential environmental and social impacts of the project. For each predicted impact, criteria are ascribed, and these include the nature (positive or negative), the intensity; the duration; and the extent, as well as the probability (likelihood). The methodology is quantitative, whereby professional judgement is used to identify a rating for each criterion based on a seven-point scale (refer to Table 4-2); and the significance is auto-generated using a spreadsheet through application of the calculations (included in the shared DropBox folder as Gamma Grid_BA_Impact Assessment.xls).

The assessment methodology is to be adopted by all specialists working on the project to ensure a standardised method of assessment across all disciplines. Where specialists require finer scale ratings or disagree with the auto-calculated impact significance rating, they have the opportunity to comment in the impact assessment table.

Note that “impacts” of project effects that are beneath the levels of perception and / or are inconsequential (i.e. have an intensity of zero), must be classified as “insignificant” and not formally rated using the assessment methodology described below.

4.3.1 Calculations

For each predicted impact, certain criteria are applied to establish the likely **significance** of the impact, firstly in the case of no mitigation being applied and then with the most effective mitigation measure(s) in place.

These criteria include the **intensity** *(*size or degree scale), which also includes the **nature** of impact, being either a positive or negative impact; the **duration** (temporal scale); and the **extent** (spatial scale). These numerical ratings are used in an equation whereby the **consequence** of the impact can be calculated. Consequence is calculated as follows:

Consequence = type x (intensity + duration + extent)

To calculate the significance of an impact, the probability (or likelihood) of that impact occurring is applied to the consequence.

Significance = consequence x probability.

Table 4-2: Assessment criteria for the evaluation of impacts

Criteria	Numeric Rating	Category	Description
Duration	1	Immediate	Impact will self-remedy immediately
	2	Brief	Impact will not last longer than 1 year
	3	Short term	Impact will last between 1 and 5 years
	4	Medium term	Impact will last between 5 and 10 years
	5	Long term	Impact will last between 10 and 15 years
	6	On-going	Impact will last between 15 and 20 years
	7	Permanent	Impact may be permanent, or in excess of 20 years
Extent	1	Very limited	Limited to specific isolated parts of the site
	2	Limited	Limited to the site and its immediate surroundings
	3	Local	Extending across the site and to nearby settlements
	4	Municipal area	Impacts felt at a municipal level
	5	Regional	Impacts felt at a regional level
	6	National	Impacts felt at a national level
	7	International	Impacts felt at an international level
Intensity	1	Negligible	Natural and/ or social functions and/ or processes are negligibly altered
	2	Very low	Natural and/ or social functions and/ or processes are slightly altered
	3	Low	Natural and/ or social functions and/ or processes are somewhat altered
	4	Moderate	Natural and/ or social functions and/ or processes are moderately altered
	5	High	Natural and/ or social functions and/ or processes are notably altered
	6	Very high	Natural and/ or social functions and/ or processes are majorly altered
	7	Extremely high	Natural and/ or social functions and/ or processes are severely altered
Probability	1	Highly unlikely / None	Expected never to happen
	2	Rare / improbable	Conceivable, but only in extreme circumstances, and/or might occur for this project although this has rarely been known to result elsewhere
	3	Unlikely	Has not happened yet but could happen once in the lifetime of the project, therefore there is a possibility that the impact will occur

Criteria	Numeric Rating	Category	Description
	4	Probable	Has occurred here or elsewhere and could therefore occur
	5	Likely	The impact may occur
	6	Almost certain / Highly probable	It is most likely that the impact will occur
	7	Certain / Definite	There are sound scientific reasons to expect that the impact will definitely occur

Based on the consequence and probability of the impact occurring, the impact would fall into a significance category of very low (1 – 35), low (36 – 72), medium (73 – 108) or high (109 – 147) as described in Table 4-3.

Table 4-3: Interpretation of significance

Interpretation of Significance		
High -	High +	These beneficial or adverse effects are considered to be very important considerations and are likely to be material for the decision-making process. In the case of negative impacts, substantial mitigation will be required.
Medium -	Medium +	These beneficial or adverse effects may be important but are not likely to be key decision-making factors. The cumulative effects of such issues may become a decision-making issue if leading to an increase in the overall adverse effect on a particular resource or receptor. In the case of negative impacts, mitigation will be required.
Low -	Low +	These beneficial or adverse effects may be experienced on the receiving environment, but natural or socio-economic processes are likely to continue. They are unlikely to be critical in the decision-making process but could be important in the subsequent design of the project. In the case of negative impacts, some mitigation is likely to be required.
Very Low -	Very Low +	These beneficial or adverse effects will not have an influence on the decision, neither will they need to be taken into account in the design of the project. In the case of negative impacts, mitigation may not necessarily be required.
Insignificant		Any effects are beneath the levels of perception and inconsequential, therefore not requiring any consideration.

When assessing impacts, broader considerations must also be considered, including the level of confidence in the assessment rating; the reversibility of the impact; and the irreplaceability of the resource as set out in Table 4-4, Table 4-5 and Table 4-6, respectively.

Table 4-4: Definition of confidence ratings.

Category	Description
Low	Judgement is based on intuition
Medium	Determination is based on common sense and general knowledge
High	Substantive supportive data exists to verify the assessment

Table 4-5: Definition of reversibility ratings.

Category	Description
Low	The affected environment will not be able to recover from the impact - permanently modified
Medium	The affected environment will only recover from the impact with significant intervention
High	The affected environmental will be able to recover from the impact

Table 4-6: Definition of irreplaceability ratings.

Category	Description
Low	The resource is not damaged irreparably or is not scarce
Medium	The resource is damaged irreparably but is represented elsewhere
High	The resource is irreparably damaged and is not represented elsewhere

4.4 Cumulative Impact Assessment

Cumulative impact "means the past, current and reasonably foreseeable future impact of an activity, considered together with the impact of activities associated with that activity, that itself may not be significant, but may be significant when added to the existing and foreseeable impacts culminating from similar or diverse activities" (NEMA EIA Reg GN R982 of 2014).

For cumulative effects analysis to be a useful tool to decision makers and stakeholders, it must be limited to effects that can be meaningfully evaluated, rather than expanded to the point where the resource or receptors are no longer significantly affected or the effects are no longer of interest to stakeholders. To this end, four important aspects require consideration prior to the evaluation of cumulative effects:

- The determination of an appropriate area of influence, i.e. spatial and, to a lesser extent, temporal boundaries for evaluation of cumulative effects of the project;
- Identification of Valued Environmental and Social Components (VECs);
- External natural and social stressors; and
- The evaluation of relevant projects for consideration in the cumulative effects analysis.

The nearest operational wind farm from the site is the Noblesfontein Wind Farm located to the north of the corridor. The South African Renewable Energy EIA Application Database (REEA) ("REEA_OR_2022_Q1") shows several renewable energy projects (and associated electrical grid connections) authorised within 30 km of the refined corridor. These projects include (see Figure 1):

- Biesiespoort PV Facility (east of Nobelsfontein);
- Modderfontein Wind Energy Facility (south of Nobelsfontein)[3];
- Mainstream Wind and Solar Energy Facility (north and northwest of the Gamma Substation);
- Aurora Power Solutions (APS) Betelgeuse PV Solar Project Four (east of the Gamma Substation);
- Umsinde Emoyeni Wind Energy Facility Phase 2 (east of APS Betelgeuse PV Solar Project Four); and
- Ishwati Emoyeni Wind Energy Facility (east of Umsinde Emoyeni Wind Energy Facility Phase 2).

[3] Red Cap has been advised that the Modderfontein Project will not proceed as the EA for this project has lapsed.

In terms of existing High Voltage lines in the area, the Kromrivier Traction / Nobelsfontein 1 132 kV live traverses the corridor near Three Sisters, and in the east the refined Gamma Corridor follows the routing of the Gamma / Kappa 1 765 kV and the Droerivier / Hydra 2 400 kV powerlines. Another 765 kV line is proposed by Eskom in this corridor. Further to the east, the Hydra / Droerivier 1 and the Droeriview / Hydra 3 400 kV lines also fall within the refined Gamma Corridor (see Figure 1).

The IFC (2012) defines Cumulative Impact Analysis (CIA) as a process of (a) analysing the potential impacts and risks of proposed developments in the context of the potential effects of other human activities and natural environmental and social external drivers on the chosen VECs over time, and (b) proposing tangible measures to avoid, reduce, or mitigate such cumulative impacts and risk to the extent possible.

As standard impact assessment considers project impacts with existing stressors (i.e. the change to the baseline environmental or social condition), the key task for CIA is to ascertain how the potential impacts of a proposed development might combine, cumulatively, with the potential / future impacts of the other anticipated or ongoing human activities and other natural stressors (such as droughts or extreme climatic events). These cumulative impacts (collective future impacts) should be identified and assessed using the impact assessment methodology described in Section 4.4 above.

4.5 Assessment of Alternatives

Due to the comprehensive iterative design process undertaken to identify the corridor and the provisional alignment within the corridor, no alignment/site alternatives are being considered.

The grid corridor and associated line will be assessed against the No-Go alternative. The No-Go alternative is the option of not constructing the project where the status quo would prevail.

5 SPECIALIST SPECIFIC DELIVERABLES

Each specialist may have a different set of deliverables and may include:

1. **Site Sensitivity Verification Report** in terms of GN 320 of 20 March 2020 and/or GN 1150 of 30 October 2020; and
2. **Assessment Report:**
    a. **Specialist Assessment Report** / **Compliance Statement** as applicable in terms of GN 320 of 20 March 2020 and/or GN 1150 of 30 October 2020 (where applicable the Species Environmental Assessment Guideline may apply[4]); or
    b. Compliance with **Appendix 6** of the EIA Regulations, 2014 (as amended) if no protocols apply to the discipline.

Please ensure that your report submission also includes the following:

1. Data for the sensitivity layers;
2. Excel spreadsheet of impact ratings; and
3. A copy of the specialist's Curriculum Vitae (CV), signed specialist declaration and proof of professional registration (where applicable).

Refer to the Section 5.1 below for specifics for each specialist. Templates for the SSV Report and Assessment Report are provided as separate documents.

[4] Species Environmental Assessment Guideline. Guidelines for the implementation of the Terrestrial Fauna and Terrestrial Flora Species Protocols for environmental impact assessments in South Africa. South African National Biodiversity Institute, Pretoria. Version 2.1 2021.

5.1 Specialist Deliverables

Site Sensitivity Verification Report	Level of impact assessment and relevant legislation		
SSV Report in terms of GN 320 of 20 March 2020	**Compliance Statement in terms of GN 320 / GN 1150 of 20 March 2020**	**Specialist Assessment Report in terms of GN 320 March 2020 / GN 1150 of Oct 2020**	**Appendix 6 of EIA Regulations, 2014**
Terrestrial Biodiversity			
x		x	
Plant theme			
x	x (to be confirmed)		
Animal theme			
x		x (to be confirmed)	
Aquatic			
x		x	
Birds			
			x
Agriculture			
x	x		
Heritage			
x			x
Palaeo			
x			x
Visual			
			x
Social			
			x (*)
Geotechnical			
			x
Traffic			
			x (*)

*** Not officially required as per Screening Tool but included at developer request**

6 SUBMISSION REQUIREMENTS

6.1 Deadlines

The following deadlines apply to specialist deliverables:

1. Updated sensitivity layers following site inspections by **22 July 2022**;
2. Draft Site Sensitivity Verification Report and Compliance Statement / Specialist Report by **19 August 2022**; and
3. CEN intends for BA report for the project to be finalised by **30 September 2022**.

6.2 Report / data formats

1. All specialist reports must be provided in MS Word format; and
2. Delineated areas of sensitivity must be provided in either ESRI shape file format or Google Earth KML format. Sensitivity classes must be included in the attribute tables with a clear indication of which areas are 'No-Go' areas.