BM GEOLOGICAL SERVICES

DESKTOP PALAEONTOLOGICAL HERITAGE IMPACT ASSESSMENT REPORT IN RESPECT OF A PROPOSED LAYER FACILITY ON PORTION 1 OF THE FARM LOUTERBRONNEN 250, THEUNISSEN, FREE STATE PROVINCE

27 July 2018

Prepared for:

Heritage Contracts and Archaeological Consulting CC

On behalf of:

Eggstra (Pty) Ltd

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On Behalf of:

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Prepared By:

Dr B.D. Millsteed

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EXECUTIVE SUMMARY

Eggstra (Pty) Ltd has applied for environmental authorisation to develop a layer facility on Portion 1 of the farm Louterbronnen 250, near Theunissen, Theunissen Magisterial District, Lejweleputswa District Municipality, Masilonyana Local Municipality, Free State Province. The project area can be located within the confines of 1:50 000 Topographic Map 2826BC. Two alternative project areas have been identified and will be termed Alternative Project Area 1 and Alternative Project Area 2 herein. Both areas lie ca. 1.5 km to the east of Theunissen, with Alternative Project Area 2 being located ca. 430 m south of Alternative Site 1.

Eggstra (Pty) Ltd has appointed Greenmined Environmental to apply for an environmental authorisation for this project. Greenmined Environmental has appointed Heritage Contracts and Archaeological Consulting CC, as independent consultants, to conduct the Heritage Impact Assessment component of the reporting process. Heritage Contracts and Archaeological Consulting CC has retained BM Geological Services to provide a desktop Palaeontological Heritage Impact Assessment Report in respect of the proposed project that will form part of the final Heritage Impact Assessment Report.

Both Alternative Project Areas 1 and 2 both sites occupy an area of ca. 2 ha. Any negative effects emanating from the project will be local in nature, being restricted to the development area. It is anticipated, herein, that most infrastructural elements will only directly affect the surface of the site to a relatively shallow depth (< 1 m) and that only a small proportion of the entire 2 ha of the project area will be impacted by the developments. It is anticipated, herein, that the project will consist predominantly of infrastructure elements that will negatively impact upon the underlying geology to a depth of < 1 m; these infrastructure elements consist of:

- Layer sheds and associated foundations.
- Access roads.
- Excavations for power, water and sewage lines.
- Vegetable gardens

Two stratigraphic units are identified as underlying the project site, these being, in descending stratigraphic order:-

1. Cainozoic regolith
2. Adelaide Subgroup

The entire extent of both of the alternative project areas is underlain by potentially fossiliferous sediments of the Late Permian sediments of the Adelaide Subgroup. The potential for a negative impact upon the palaeontological heritage of these strata has been assessed as low, but the scientific and cultural significance of any fossils contained

is high. The presence of a pervasive Cainozoic regolith horizon underlying the project area and overlying the Adelaide Subgroup rocks has also been interpreted. The fossiliferous potential of this unit is assessed as being negligible. The probability of a negative impact of the project on the fossil heritage of the area has been assessed as low for the Adelaide Subgroup and negligible for the regolith. Any damage to fossil material that occurs during the excavation and construction phase of the project would be permanent and irreversible.

The potential negative impact to the palaeontological heritage of the area can be minimised by the implementation of appropriate mitigation processes. It is recommended that a close examination of all excavations be made while they are occurring as this is when any fossil materials present within the Adelaide Subgroup would be exposed. Should the excavations be found to affect the regolith only (i.e., they do not encounter bedrock) then no further action is required. However, should the excavations encounter bedrock a site visit by a palaeontologist should is required. Should any fossil materials be identified, the excavations should be halted and SAHRA informed of the discovery (as required in Section 3.3 above). A significant potential benefit of the examination of the excavations associated with the construction of the project is that currently unobservable fossils may be uncovered. As long as the construction process is closely monitored it is possible that potentially significant fossil material may be made available for scientific study.

Should scientifically or culturally significant fossil material exist within the project area any negative impact upon it could be mitigated by its excavation (under permit from SAHRA) by a palaeontologist and the resultant material being lodged with an appropriately permitted institution. In the event that an excavation is impossible or inappropriate the fossil or fossil locality could be protected and the site of any planned construction moved.

This desktop study has not identified any palaeontological reason to prejudice the progression of this project, subject to the suggested mitigation programs being put in place.

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Eggstra (Pty) Ltd has applied for environmental authorisation to develop a layer facility on Portion 1 of the farm Louterbronnen 250, near Theunissen, Theunissen Magisterial District, Lejweleputswa District Municipality, Masilonyana Local Municipality, Free State Province (Figure 1). The project area can be located within the confines of 1:50 000 Topographic Map 2826BC. Two alternative project areas have been identified and will be termed Alternative Project Area 1 and Alternative Project Area 2 herein. Both areas lie ca. 1.5 km to the east of Theunissen, with Alternative Project Area 2 being located ca. 430 m south of Alternative Site 1 (Figure 2); both sites occupy an area of ca. 2 ha.

Eggstra (Pty) Ltd has appointed Greenmined Environmental to apply for an environmental authorisation for this project. Greenmined Environmental has appointed Heritage Contracts and Archaeological Consulting CC, as independent consultants, to conduct the Heritage Impact Assessment component of the reporting process. Heritage Contracts and Archaeological Consulting CC has retained BM Geological Services to provide a desktop Palaeontological Heritage Impact Assessment Report in respect of the proposed project that will form part of the final Heritage Impact Assessment Report.

2 TERMS OF REFERENCE AND SCOPE OF THE STUDY

The terms of reference for this study were as follow: -

- Conduct a desktop assessment of the potential impact of the proposed project on the palaeontological heritage of the project area.
- Describe the possible impact of the proposed development on the palaeontological heritage of the site, according to a standard set of conventions.
- Quantify the possible impact of the proposed development on the palaeontological heritage of the site, according to a standard set of conventions.
- Provide an overview of the applicable legislative framework.
- Make recommendations concerning future work programs as, and if, necessary.

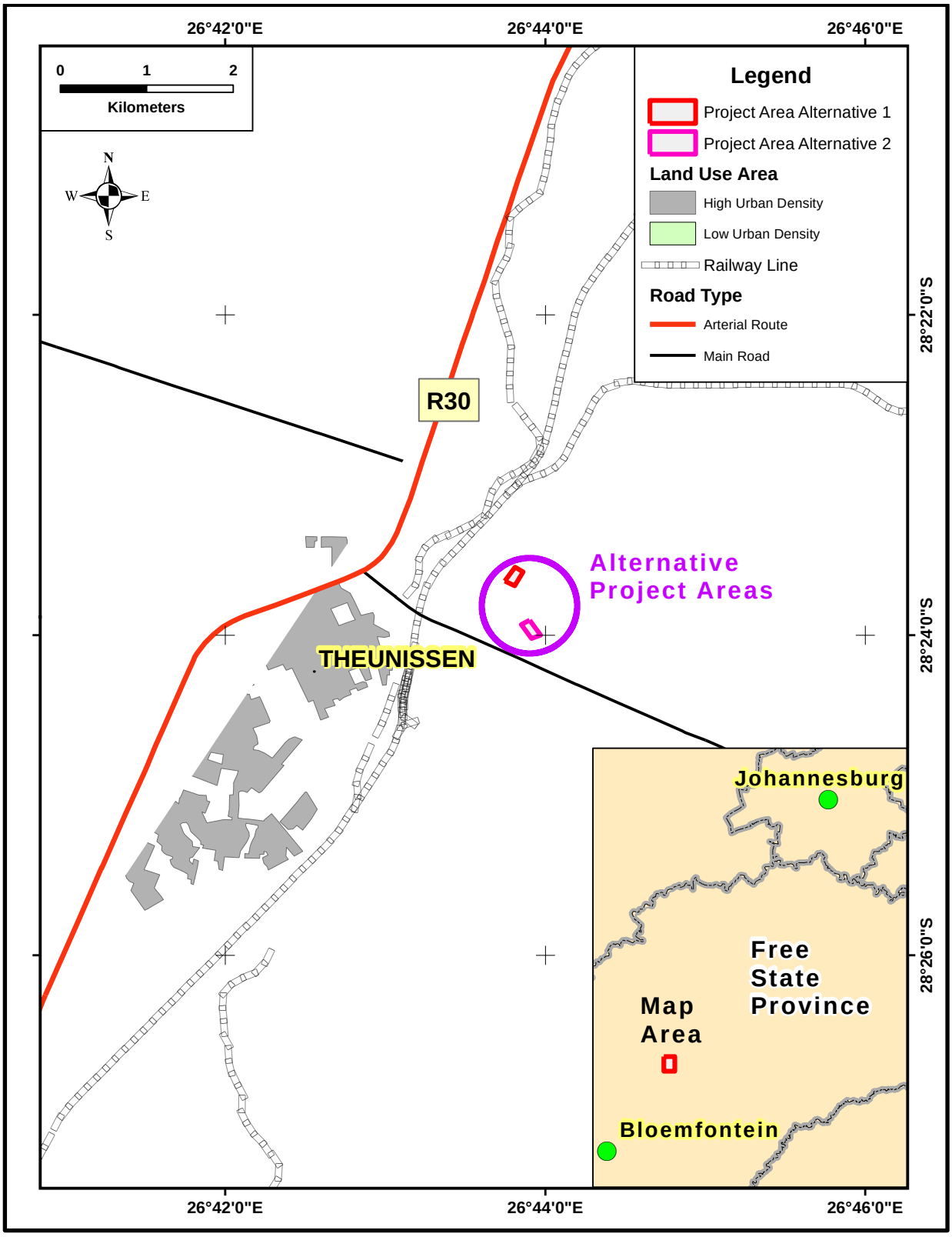

Figure 1: Location map showing the locations of the proposed layer facility Project Area Option 1 and Project Area Option 2.

Figure 2: Google earth image of the area underlying Alternative Project Area 1 (red polygon) and Alternative project Area 2 (purple polygon) and the surrounding environs.

3 LEGISLATIVE REQUIREMENTS

South Africa's cultural resources are primarily dealt with in two Acts. These are the National Heritage Resources Act (Act 25 of 1999) and the National Environmental Management Act (Act 107 of 1998).

3.1 The National Heritage Resources Act

The following are protected as cultural heritage resources by the National Heritage Resources Act:

- Archaeological artefacts, structures and sites older than 100 years.
- Ethnographic art objects (e.g. prehistoric rock art) and ethnography.
- Objects of decorative and visual arts.
- Military objects, structures and sites older than 75 years.
- Historical objects, structures and sites older than 60 years.
- Proclaimed heritage sites.
- Grave yards and graves older than 60 years.
- Meteorites and fossils.
- Objects, structures and sites or scientific or technological value

The Act also states that those heritage resources of South Africa which are of cultural significance or other special value for the present community and for future generations must be considered part of the national estate and fall within the sphere of operations of heritage resources authorities. The national estate includes the following:

- Places, buildings, structures and equipment of cultural significance.
- Places to which oral traditions are attached or which are associated with living heritage.
- Historical settlements and townscapes.
- Landscapes and features of cultural significance.
- Geological sites of scientific or cultural importance.
- Sites of Archaeological and palaeontological importance.
- Graves and burial grounds.
- Sites of significance relating to the history of slavery.
- Movable objects (e.g. archaeological, palaeontological, meteorites, geological specimens, military, ethnographic, books etc.).

3.2 Need for Impact Assessment Reports

Section 38 of the Act stipulates that any person who intends to undertake an activity that falls within the following:

- The construction of a linear development (road, wall, power line, canal etc.) exceeding 300 m in length.
- The construction of a bridge or similar structure exceeding 50 m in length.
- Any development or other activity that will change the character of a site and exceed 5 000 m^2 or involve three or more existing erven or subdivisions thereof.
- Re-zoning of a site exceeding 10 000 $m^{2.}$
- Any other category provided for in the regulations of SAHRA or a provincial heritage authority.

must at the very earliest stages of initiating such a development, notify the responsible heritage resources authority and furnish it with details regarding the location, nature and extent of the proposed development. If there is reason to believe that heritage resources will be affected by such development, the developer may be notified to submit an impact assessment report. A Palaeontological Impact Assessment (PIA) only looks at the potential impact of the development palaeontological resources of the proposed area to be affected.

3.3 Legislation Specifically Pertinent to Palaeontology*

*****Note: Section 2 of the Act defines "palaeontological" material as "any fossilised remains or fossil trace of animals or plants which lived in the geological past, other than fossil fuels or fossiliferous rock intended for industrial use, and any site which contains such fossilised remains".

Section 35(4) of this Act specifically deals with archaeology, palaeontology and meteorites. The Act states that no person may, without a permit issued by the responsible heritage resources authority (national or provincial):

- Destroy, damage, excavate, alter, deface or otherwise disturb any archaeological or palaeontological site or any meteorite.
- Destroy, damage, excavate, remove from its original position, collect or own any archaeological or palaeontological material or object or any meteorite.
- 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
- Bring onto or use at an archaeological or palaeontological site any excavation equipment or any equipment that assists in the detection or recovery of metals or archaeological and palaeontological material or objects, or use such equipment for the recovery of meteorites.

- Alter or demolish any structure or part of a structure which is older than 60 years as protected.

The above mentioned palaeontological objects may only be disturbed or moved by a palaeontologist, after receiving a permit from the South African Heritage Resources Agency (SAHRA). In order to demolish such a site or structure, a destruction permit from SAHRA will also be needed.

Further to the above point, Section 35(3) of this Act indicates that "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". Thus, regardless of the granting of any official clearance to proceed with any development based on an earlier assessment of its impact on the Palaeontological Heritage of an area, the development should be halted and the relevant authorities informed should fossil objects be uncovered during the progress of the development.

3.4 The National Environmental Management Act [as amended]

The National Environmental Management Act does not provide the detailed protections and administrative procedures for the protection and management of the nation's Palaeontological Heritage as are detailed in the National Heritage Resources Act, but this act is more general in is application. In particular Section 2(2) of the Act states that environmental management must place people and their needs at the forefront of its concerns and, amongst other issues, serve their cultural interests equitably. Further to this point section 2(4)(a)(iii) states that disturbances of sites that constitute the nation's cultural heritage should be avoided, and where it cannot be avoided should be minimised and remedied.

Section 23(1) indicates that a general objective of integrated environmental management is to identify, predict and evaluate the actual and potential impact of activities upon the cultural heritage. This section also highlights the need to identify options for mitigating of negative effects of activities with a view to minimising negative impacts.

In order to give effect to the general objectives of integrated environmental management outlined in the Act the potential impact on cultural heritage of activities that require authorisation or permission by law must be investigated and assessed prior to their implementation and reported to the relevant organ of state. Thus, a survey and evaluation of cultural resources must be done in areas where development projects that will potentially negatively affect the cultural heritage will be performed. During this

process the impact on the cultural heritage will be determined and proposals for the mitigation of the negative effects made.

4 RELEVENT EXPERIENCE

Dr Millsteed holds a PhD in palaeontology and has previously been employed as a professional palaeontologist with the Council for Geoscience in South Africa. He is currently the principle of BM Geological Services and has sufficient knowledge of palaeontology and the relevant legislation required to produce this Palaeontological Impact Assessment Report. Dr Millsteed is registered with the South African Council for Natural Scientific Professions (SACNASP), is a member of the Palaeontological Society of South African and the Association of Australasian Palaeontologists and is also a Fellow of the Geological Society of South Africa.

5 INDEPENDENCE

Dr Millsteed was contracted as an independent consultant to conduct this desktop Palaeontological Heritage Impact Assessment study and shall receive fair remuneration for these professional services. Neither Dr Millsteed nor BM Geological Services has any financial interest in either Eggstra (Pty) Ltd, the proposed laying facility, nor any companies or individuals associated with the project.

6 GEOLOGY AND FOSSIL POTENTIAL

Figure 3 shows that the project area (including both Project Area Option 1 and Project Area Option 2) is completely underlain by Late Permian sedimentary rocks of the Adelaide Subgroup. Evidence suggests that a reasonably pervasive layer of Cainozoic regolith overlies the Rocks of the Adelaide Subgroup, and presumably forms most of the land surface underlying the project area. A brief description of the geology of the area Adelaide Subgroup and the Cainozoic regolith and their potential palaeontological contents is provided below.

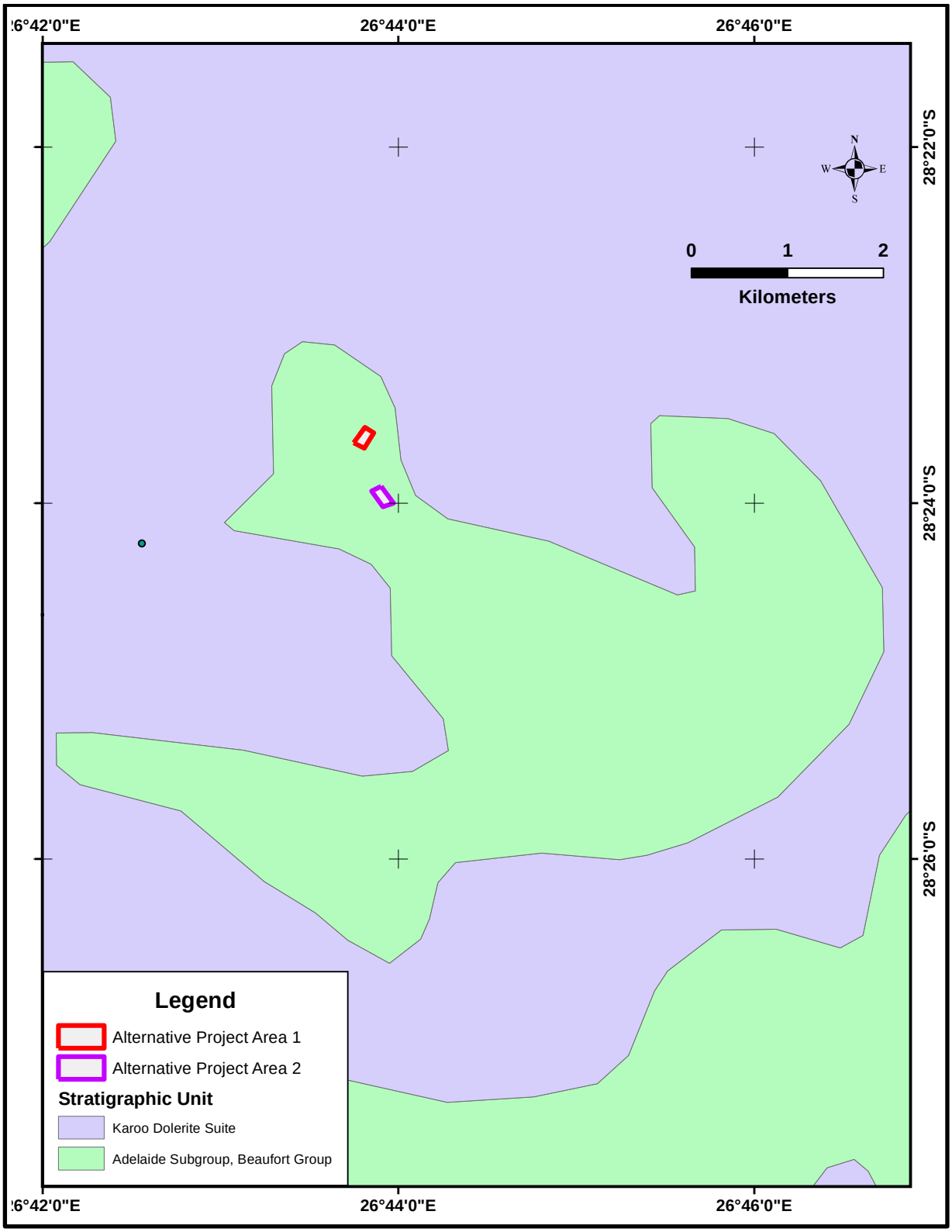

Figure 3: Map of the bed rock geology of the two alternative project areas and their surrounding environs.

6.1 Cainozoic regolith

6.1.1 Geology

The historical thornveld vegetation cover of the area (see Section 7 below) suggests the presence of a pervasive- to nearly-pervasive regolith cover underlying both Option Area 1 and Option Area 2. The presence of a pervasive regolith horizon is further evinced by written communication received from Heritage Contracts CC that the company's representative (Mr J. Van der Walt) has conducted an archaeological investigation upon the areas underlying Project Area Option 1 and Project Area Option 2. As part of the process of developing the heritage Impact Assessment Report that this report will form a component. Mr Van der Walt indicated that no bedrock was observed to crop out anywhere within the project option areas. Mr Van der Walt is a highly experienced heritage worker and an archaeologist of impeccable professional standards and standing and I accordingly accept this description of the area.

It is unlikely that any regolith present will have originated from fluvial transport processes as only small, ephemeral drainage lines are located anywhere near the site. It is considered, herein, most likely that any regolith present will have been formed by *in situ* decomposition of the underlying sediments of the Adelaide Subgroup.

6.1.2 Palaeontological potential

If the regolith present beneath the project area was derived from *in situ* decomposition of the underlying sediments of the Adelaide Subgroup then any fossil materials present within the bedrock will also have been destroyed during the processes of weathering and decomposition of the bedrock that formed the regolith.

6.2 Adelaide Subgroup

6.2.1 Geology

The project area is completely underlain by Late Permian sedimentary rocks of the Adelaide Subgroup, Beaufort Group (Figure 3). In the southern and central portions of the Main Karoo Basin the Adelaide Subgroup is differentiated into two distinct stratigraphic sequences which are located either side of the line of longitude of 24° east. To the east of that dividing line the Adelaide Subgroup consists of (in order of decreasing stratigraphic age) the Koonap, Middelton and Balfour Formations. To the west of 24° east the Adelaide subgroup is subdivided into a lower Abrahamskraal and an upper Teekloof Formations. In the north-eastern region of the basin (which contains the project area) only a single formation, the Normandien Formation, is present (Groenewald, 1984, 1990; Figure 4).

In general, the Adelaide Subgroup consists of alternating bluish-grey, greenish-grey or greyish-red mudrocks and grey, very fine- to medium-grained lithofeldspathic sandstones (South African Committee for Stratigraphy, 1980). Sandstones generally constitute 20-30% of the total thickness of the sequence, but maybe as high as 60% and as low as 10%. Deposition within the northern part of the basin varies from that in the remainder of the basin in that coarse- to very coarse-grained sandstones or even granulestones are common within the Normandien Formation and the mudstones of the Adelaide Subgroup are generally massive and blocky weathering except in parts of the Normandien Formation and Daggaboersnek Member where horizontal lamination is common and rhythmites are common (Johnson *et al*., 2006). The sediments of the Normandien Formation are further differentiated from the remainder of the Adelaide Subgroup in that thin coal beds are occasionally present in the lower part (Botha and Linstrőm, 1984; Groenewald, 1984). Historically the lower 200 m – 450 m of lacustrine and deltaic sediments of the Adelaide Subgroup in the north-east of the basin (including the area in and around Estcourt and underlying the project area) was termed the Estcourt Formation.

Genetically the Normandien Formation differs from the strata coeval in the southern and central portions of the Karoo Basin in that deposition took place within more southerly oriented depositional systems rather than the west-north-westerly fluvial transport systems exhibited in the south (Cole and Wipplinger, 2001). The depositional system was initially lacustrine and deltaic with progradation to the east and changed upwards into fluvial meandering under drier conditions (Cole and Wipplinger, 2001).

6.2.2 Palaeontological potential

The project area falls within the distribution of the *Dicynodon* Assemblage Zone (Kitching, 1995; Figure 5). The fossil record of this biostratigraphic zone is diverse and includes 62 species of synapsid reptiles, six species of captorhinid reptiles, two species of eosuchian reptiles, two fish genera (*Namaicthys* and *Athersonia)*, two amphibians (*Laccocephalus* and *Rhinesuchus*) and the mollusc *Palaeomutela* (Kitching, 1995). A total of 34 genera of insects have been described from western Natal Province (Riek, 1973, 1976a, 1976b). Trace fossils including arthropod trails and worm burrows have also been recorded from this biostratigraphic unit (Kitching, 1995).

It may be expected that this sequence may also contain plant fossils (including silicified wood) belonging to the *Glossopteris* flora (Johnson *et al*., 2006). Bamford (2004) indicates that this sequence contains the fossil wood genera *Agathoxylon* and *Australoxylon*.

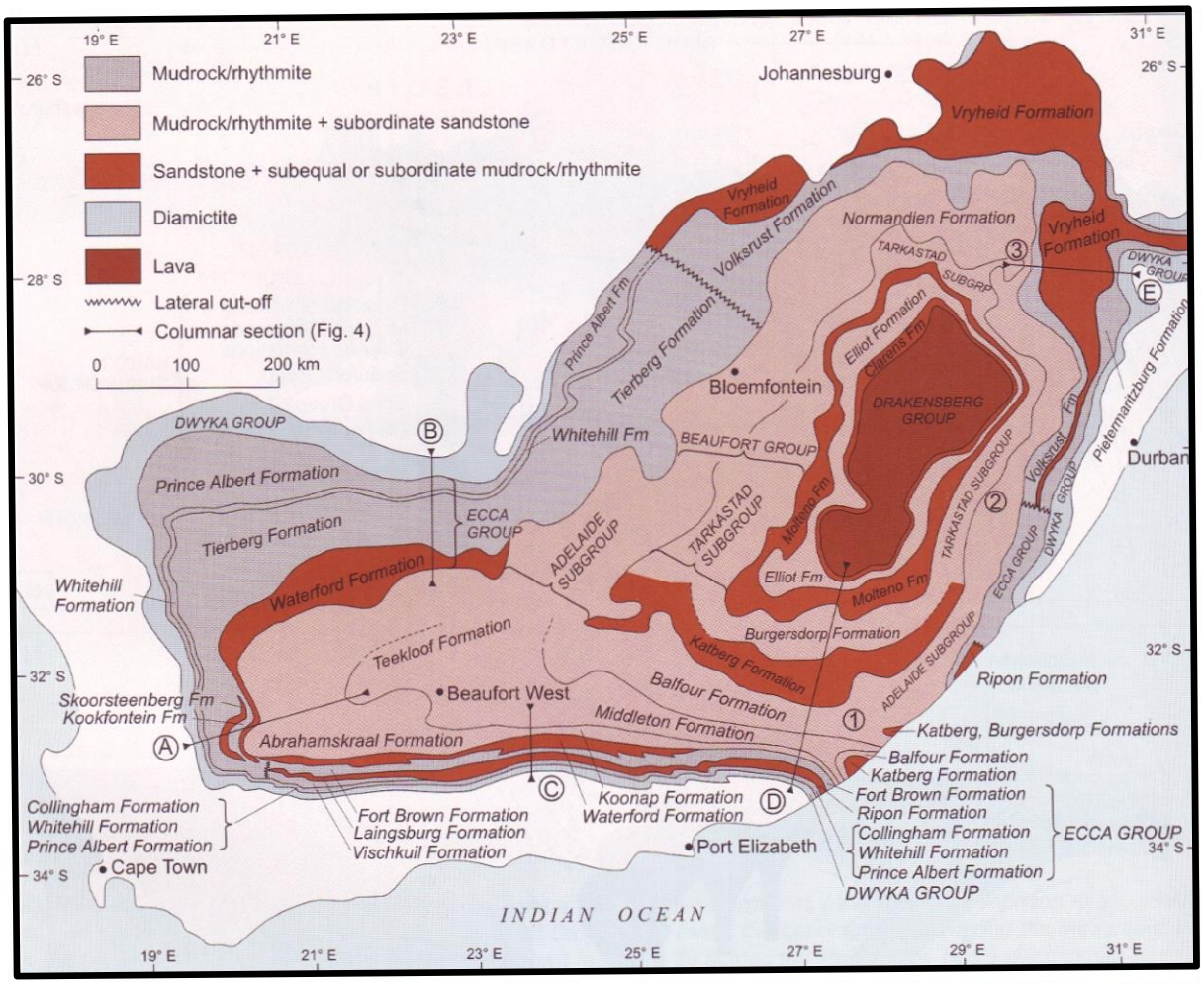

Figure 4: Schematic geological map of the Main Karoo Basin showing the location of the various stratigraphic subdivisions of the Adelaide Subgroup as well as the major lithological characteristics of each major stratigraphic unit (Johnson *et al*., 2006).

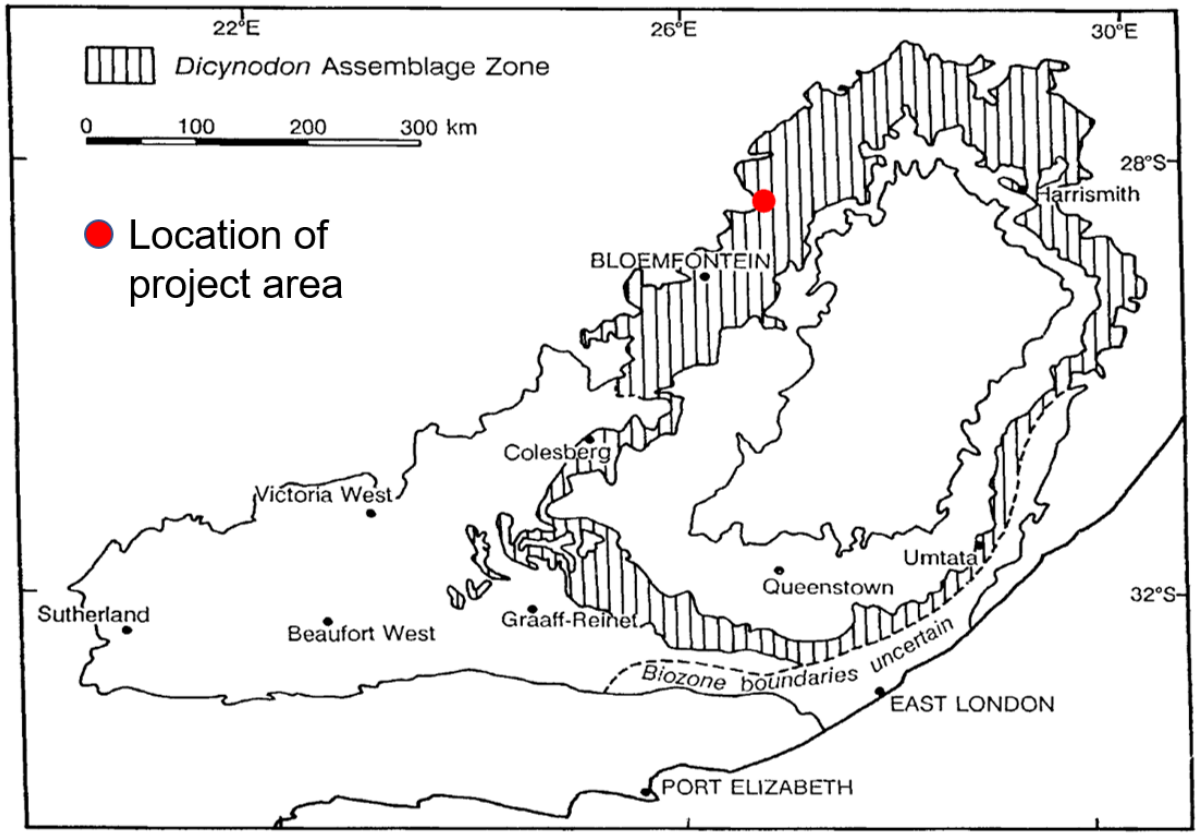

Figure 5: Map of the Main Karoo Basin showing the distribution pattern of the *Dicynodon* Assemblage Zone and the location of the project area. Indicated also is the outcrop distribution of the basal contact of the Beaufort Group (modified from Kitching, 1995).

7 ENVIRONMENT OF THE PROPOSED PROJECT SITE

Two separate, but closely spaced, areas have been identified as options for the location of this project. These two areas are termed Project Area Option 1 and Project Area Option 2 herein.

Project Area Option 1

Alternative Project Area 1 covers an area of just under 2 ha. Examination of Google earth imagery of the project area (Figure 6) indicates that the landowner currently uses the greater part of the footprint area earmarked for the proposed development for agricultural purposes, in particular grazing, while a smaller portion near the northern boundary of the area includes an existing layer house, store room and silo (ca. 0.2 ha in extent; Figure 6). The area in the immediate environs of these built structures has been historically cleared (Figure 6), but the majority of the area remains as uncleared

grassland. The implementation of this project requires the construction of additional layer houses and associated infrastructure.

Project Area Option 2

Alternative Area 2 covers an area of approximately 2 ha. Examination of Google earth imagery (Figure 7) of the project area indicates that the landowner currently uses the full extent of Alternative Project Area 2 for agricultural purposes, presumably grazing. It appears that the area may have also been ploughed at some historical time and utilised for cultivation and is, accordingly, disturbed.

The entire extent of the project area was originally underlain vegetation cover of the Central Free State Grassland veld type (Mucina and Rutherford, 2006; Figure 8). Mucina and Rutherford (2006) describe the conservation status of the Central Free State Grassland veld type as being threatened. It is apparent from Figure 6 that very little, if any, of the original vegetation cover of the remains extant in the northern extent of Project Area Alternative 1 (near the built structures). Similarly, if the extent of Project Area Alternative 2 has been historically cultivated the vegetation present there now will not be in is original pristine state.

It is evident from Figure 9 that both of the two alternative project areas lie approximately 1.5 km from the eastern outskirts of Theunissen. The area underlying both projects alternative sites and the surrounding environs are a topographically featureless, gently south-east sloping land surface. Both alternative project areas are located between north-west to south-east trending ephemeral river lines, but no significant drainage features traverse either site.

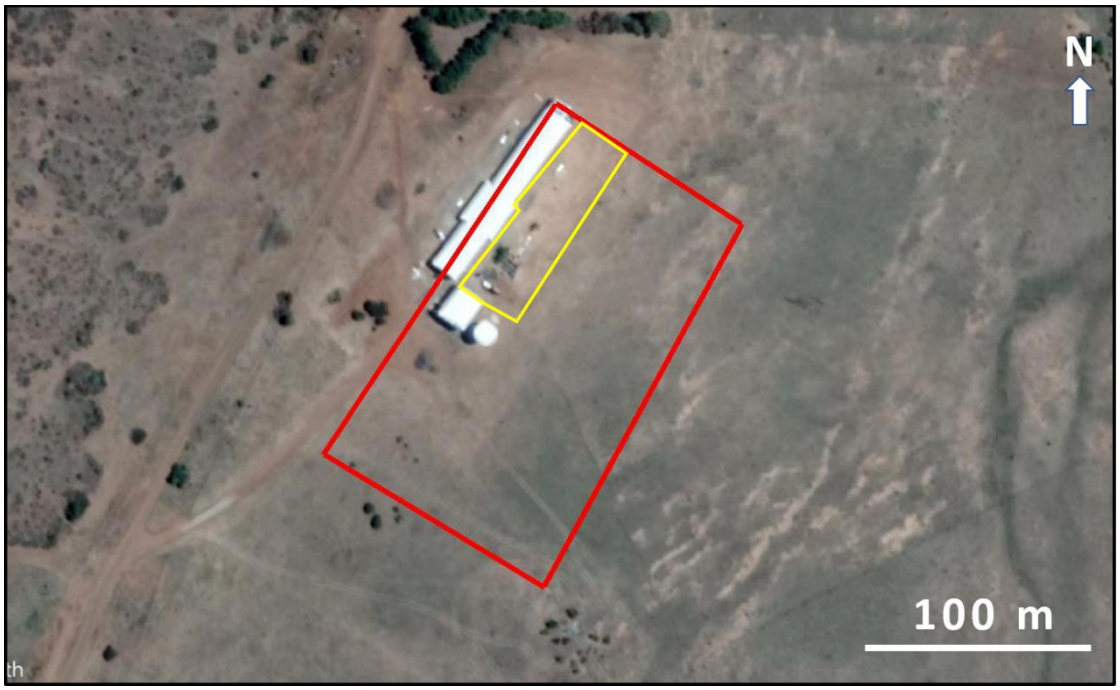

Figure 6: Google Earth image of Alternative Project Area 1 (the red polygon) and its environs. The area that has been historically flattened and disturbed by building activities is demarcated by the yellow polygon. The built structures nearby are existing housing for chickens and its associated infrastructure.

Figure 7: Google Earth image of Alternative Project Area 2 (the purple polygon) and its environs. The faint northwest-southeast oriented striations evident in the image are interpreted to be the result of historical ploughing (cultivation) of the area.

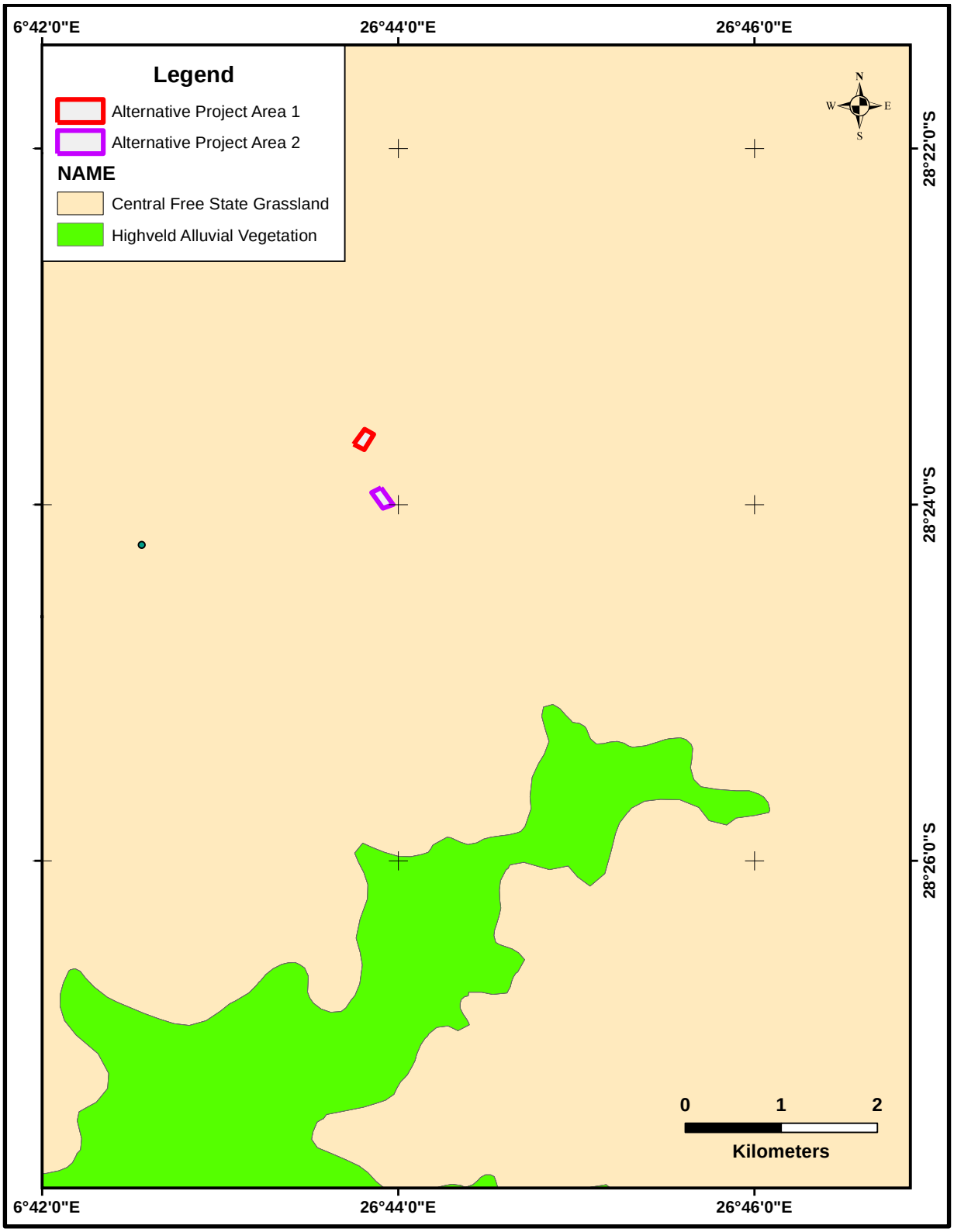

Figure 8: Vegetation types underlying the two alternative project areas and their surrounding environs (modified from Mucina and Rutherford, 2006).

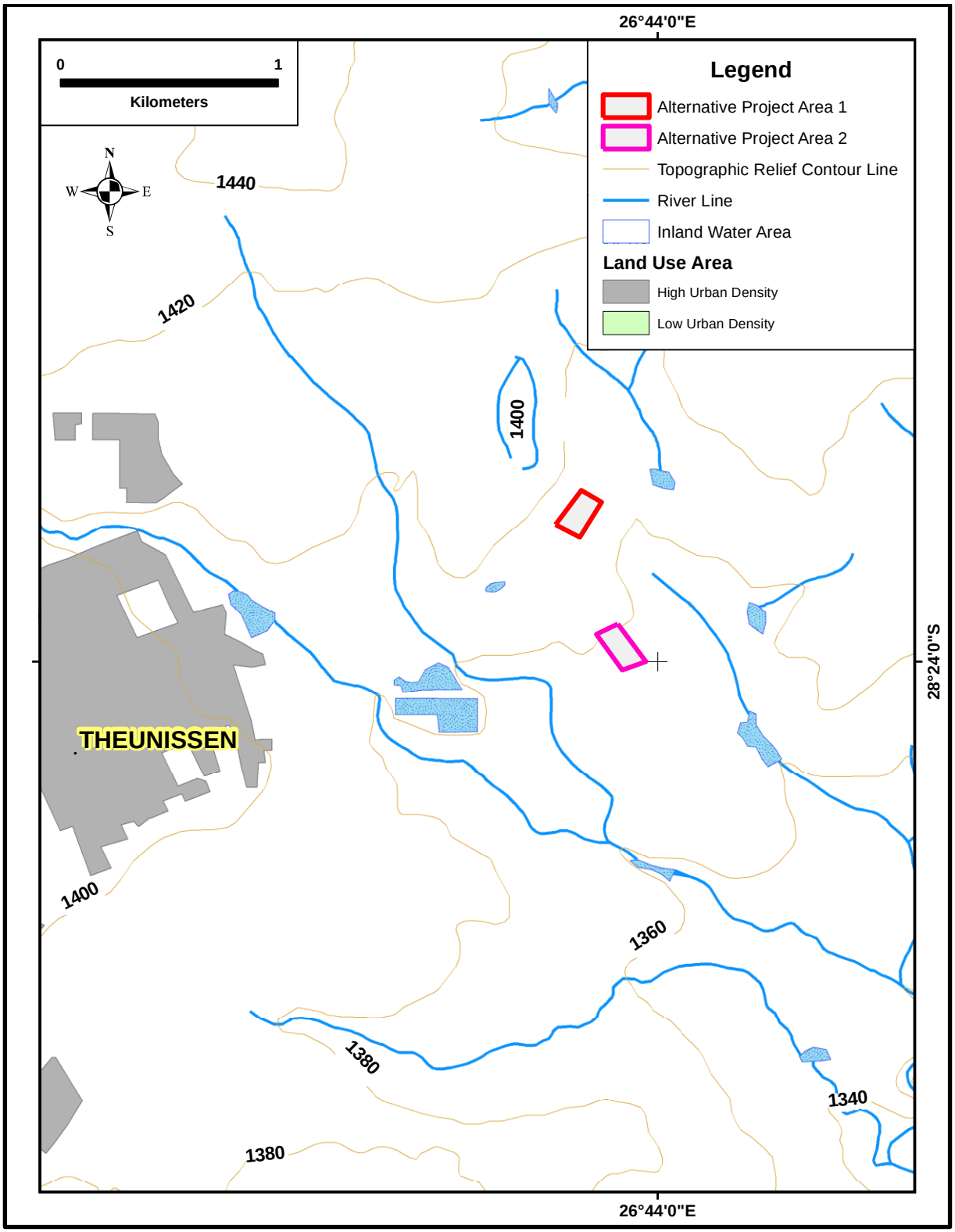

Figure 9: The environment of the area underlying the two alternative project areas and their surrounding environs. The topographic relief contour interval for the map is 20 m.

8 OVERVIEW OF SCOPE OF THE PROJECT

The exact nature of the built infrastructure elements proposed for the layer facility are unknown to the author. However, in general the implementation of this project requires the construction of additional layer houses and associated infrastructure. It is anticipated, herein, that the project will consist predominantly of infrastructure elements that will negatively impact upon the underlying geology to a depth of < 1 m; these infrastructure elements consist of:

- Layer sheds and associated foundations.
- Access roads.
- Excavations for power, water and sewage lines.
- Vegetable gardens

The following impact assessment (Section 9) is made in the light of these assumptions.

9 IMPACT ASSESSMENT

The potential impact of Eggstra (Pty) Ltd's proposed layer facility is categorised below according to the following criteria:-

9.1 Nature of Impact

The potential negative impacts of the proposed project on the palaeontological heritage of the area are:

- Damage or destruction of fossil materials during the construction of project infrastructural elements to a maximum depth of those excavations. Many fossil taxa (particularly vertebrate taxa) are known from only a single fossil and, thus, any fossil material is potentially highly significant. Accordingly, the loss or damage to any single fossil can be potentially significant to the understanding of the fossil heritage of South Africa and to the understanding of the evolution of life on Earth in general. Where fossil material is present and will be directly affected by the building or construction of the projects infrastructural elements the result will potentially be the irreversible damage or destruction of the fossil(s).
- Movement of fossil materials during the construction phase, such that they are no longer *in situ* when discovered. The fact that the fossils are not *in situ* would either significantly reduce or completely destroy their scientific significance.
- The loss of access for scientific study to any fossil materials present beneath infrastructural elements for the life span of the existence of those constructions and facilities.

9.2 Extent of impact

The possible extent of the impact of the proposed project on the palaeontological heritage of South Africa is restricted to the damage, destruction or accidental relocation of fossil material caused by the excavations and construction of the necessary infrastructure elements forming part of the project. The **extent of the area of potential impact is, accordingly, categorised as local** (i.e., restricted to the project site).

9.3 Duration of impact

The anticipated duration of the identified impact is assessed as potentially **long term to permanent**. This is assessment is based on the fact that, in the absence of mitigation procedures (should fossil material be present within the area to be affected) the damage or destruction of any palaeontological materials will be permanent. Similarly, any fossil materials that exist below the structures and infrastructural elements that will constitute the power generation facility will be unavailable for scientific study for the life of the existence of those features.

9.4 Probability of impact

It is pertinent to realise that fossils are generally scarce and sporadic in their occurrence and, as such, the probability of any development affecting a fossil at any particular point on the land surface in relatively low. The Adelaide Subgroup is potentially fossiliferous, but the land surface underlying each of the alternative project areas is small (<2 Ha), the depth of any negative impact caused by anticipated excavations is shallow (maximum <1 m) and the total surface area of the area that will be built upon within the selected 2 ha site is minimal. Accordingly, the total volume of the rock and regolith to be negatively impacted upon by the project is relatively small. Given the small volume of rock to be impacted upon and the generally scarce and sporadic nature of the expected fossil types the probability of any fossils contained within any Adelaide Subgroup strata being negatively affected is assessed as **low**.

The presence of a Cainozoic regolith cover underlying the project area is interpreted herein (see Section 6.1.1 above). It is anticipated that this regolith is derived from *in situ* decomposition of the underlying Adelaide Subgroup sediments. As such, any fossil materials that may have been present in the progenitor bedrock will have been destroyed in the weathering processes that produced the regolith. The probability of any fossil materials being originally present within the regolith is **negligible**.

9.5 Significance

Should the project progress without due care to the possibility of fossils being present within either the bedrock or regolith the resultant damage, destruction or inadvertent relocation any affected fossils will be permanent and irreversible. This is significant as fossil materials occurring within the project area are potentially **highly scientifically significant**. However, if adequate mitigation processes are put into place then the potential for damage to any fossil material can be minimised. Accordingly, the significance of the proposed project on the palaeontological heritage of the area is categorised as low if appropriate mitigation procedures are put into place.

10 DAMAGE MITIGATION, REVERSAL AND POTENTIAL IRREVERSABLE LOSS

The degree to which the possible negative effects of the proposed project can be mitigated, reversed or will result in irreversible loss of the palaeontological heritage can be determined as discussed below.

10.1 Mitigation

Both of the alternative project areas appear to bear a comprehensive regolith cover. It was indicated in Section 7 above and illustrated in Figure 6 that part of this regolith cover appears to have been partially historically extensively disturbed in Alternative Project Area Option 1 and completely historically disturbed in Alternative Project Area 1. The implication of the heavily disturbed nature of the land surface is that any fossils that may have existed and which would have been observable at surface will have been destroyed as a result of the historical building and land clearing operations. Subsequently, even if fossil materials had been originally present at the land surface none would be expected to be observable during the conduct of a site inspection by a palaeontologist. It was also noted in Section 6.1.1 above that an earlier archaeological site investigation has indicated that there are no bedrock outcrops observable in either of the alternative project areas. The conduct of a field-based Full Palaeontological Impact Assessment Study by a palaeontologist prior to the commencement of construction is accordingly not recommended herein. Rather it is recommended that a close examination of all excavations be made while they are occurring as this is when any fossil materials present within the Adelaide Subgroup would be exposed.

Should the excavations be found to affect the regolith only (i.e., they do not encounter bedrock) then no further action is required. However, should the excavations encounter bedrock a site visit by a palaeontologist should is required. Should any fossil materials be identified, the excavations should be halted and SAHRA informed of the discovery (as required in Section 3.3 above). A significant potential benefit of the examination of the excavations associated with the construction of the project is that currently unobservable

fossils may be uncovered. As long as the construction process is closely monitored it is possible that potentially significant fossil material may be made available for scientific study.

Should scientifically or culturally significant fossil material exist within the project area any negative impact upon it could be mitigated by its excavation (under permit from SAHRA) by a palaeontologist and the resultant material being lodged with an appropriately permitted institution. In the event that an excavation is impossible or inappropriate the fossil or fossil locality could be protected and the site of any planned construction moved.

10.2 Reversal of damage

Any damage to, or the destruction of, palaeontological materials or the reduction of their scientific value due to a loss of their original location is **irreversible**.

10.3 Degree of irreversible loss

Once a fossil is damaged, destroyed or moved from its original position without its geographical position and stratigraphic location being recorded the **damage is irreversible**.

By their nature fossils are usually scarce and sporadic in their occurrence and the chances of negatively impacting on a fossil in any particular area are low. However, any fossil material may be of the greatest scientific importance; this is particularly true of vertebrate fossils in which many taxa are known from only one fossil. Thus, the potential always exists during construction and excavation within potentially fossiliferous rocks for the permanent and irreversible loss of extremely significant or irreplaceable fossil material. This said, many fossils are incomplete in their state of preservation or are examples of relatively common taxa. As such, just because a fossil is present it is not necessarily of great scientific value. Accordingly, not all fossils are necessary significant culturally of scientifically significant and the potential degree of irreversible loss will vary from case to case. The judgement on the significance of the fossil must be made by an experienced palaeontologist.

11 ASSUMPTIONS, UNCERTAINTIES AND GAPS IN KNOWLEDGE

The information provided within this report was derived from a desktop study of available maps and scientific literature; no direct observation was made of the area as the result of a site visit. In particular, the discussion of the geological units occurring within the project area (and as such the basis of understanding the fossiliferous potential of the area) was derived from the published 1:250 000 geological maps of the area. The accuracy of 1:250 000 geological maps is often variable; some areas being compiled

from air photo interpretation or remote sensing procedures. The possibility of the presence of additional geological units being present within the project area cannot be disregarded.

The presence and mode of formation of the Cainozoic regolith interpreted to be underlying the project area has been hypothesised from available evidence and the authors knowledge of the area and not by direct observation.

Details concerning the type of the various built infrastructure elements that will comprise this project as well as the planned resultant vertical disruption to the land surface were unknown to the author at the time of compilation of this report. Assumptions concerning the types of infrastructure elements that will be required for this project, and their effects on the bed rock, have been assumed using comparison to those present in similar layer facilities in South Africa.

12 ENVIRONMENTAL IMPACT STATEMENT

A desktop study has been conducted on the site of the proposed construction of a layer facility on Portion 1 of the farm Louterbronnen 250, near Theunissen, Theunissen Magisterial District, Lejweleputswa District Municipality, Masilonyana Local Municipality, Free State Province. The project area can be located within the confines of 1:50 000 Topographic Map 2826BC. Two alternative project areas have been identified and will be termed Alternative Project Area 1 and Alternative Project Area 2 herein. Both areas lie ca. 1.5 km to the east of Theunissen, with Alternative Project Area 2 being located ca. 430 m south of Alternative Site 1; both sites occupy an area of ca. 2 ha. Any negative effects emanating from the project will be local in nature, being restricted to the development area. It is anticipated, herein, that most infrastructural elements will only directly affect the surface of the site to a relatively shallow depth (< 1 m).

The entire extent of the project area is underlain by potentially fossiliferous sediments of the Late Permian sediments of the Adelaide Subgroup. The potential for a negative impact upon the palaeontological heritage of these strata has been assessed as low, but the scientific and cultural significance of any fossils contained is high. The presence of a pervasive Cainozoic regolith horizon underlying both of the alternative project areas and overlying the Adelaide Subgroup rocks has been interpreted. The fossiliferous potential of this unit is assessed as being negligible. The probability of a negative impact of the project on the fossil heritage of the two areas has been assessed as low for the Adelaide Subgroup and negligible for the regolith. Any damage to fossil material that occurs during the excavation and construction phase of the project would be permanent and irreversible.

The potential negative impact to the palaeontological heritage of the area can be minimised by the implementation of appropriate mitigation processes. The significant

portions of the land surface underlying either alternative project area have been extensively historically disturbed by ploughing and land clearing activities. It was also noted in Section 6.1.1 above that an earlier archaeological site investigation has indicated that there are no bedrock outcrops observable in either of the alternative project areas. These two observations collectively make it appropriate that the conduct of a field-based Full Palaeontological Impact Assessment Study by a palaeontologist prior to the commencement of construction is accordingly not recommended herein. Rather it is recommended that a close examination of all excavations be made while they are occurring as this is when any fossil materials present within the Adelaide Subgroup would be exposed.

Should the excavations be found to affect the regolith only (i.e., they do not encounter bedrock) then no further action is required. However, should the excavations encounter bedrock a site visit by a palaeontologist should is required. Should any fossil materials be identified, the excavations should be halted and SAHRA informed of the discovery (as required in Section 3.3 above). A significant potential benefit of the examination of the excavations associated with the construction of the project is that currently unobservable fossils may be uncovered. As long as the construction process is closely monitored it is possible that potentially significant fossil material may be made available for scientific study.

Should scientifically or culturally significant fossil material exist within the project area any negative impact upon it could be mitigated by its excavation (under permit from SAHRA) by a palaeontologist and the resultant material being lodged with an appropriately permitted institution. In the event that an excavation is impossible or inappropriate the fossil or fossil locality could be protected and the site of any planned construction moved.

This desktop study has not identified any palaeontological reason to prejudice the progression of this project, subject to the suggested mitigation programs being put in place.

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