FULL PALAEONTOLOGICAL HERITAGE IMPACT ASSESSEMENT REPORT ON THE SITE OF THE PROPOSED KEBRAFIELD ROODEPOORT COLLIERY TO BE LOCATED ON PORTION 17 OF THE FARM ROODEPOORT 151 IS, NEAR PULLENS HOPE, MPUMALANGA PROVINCE

13 March 2014

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Prepared for:

Eco Elementum (Pty) Ltd

On Behalf of:

Kebrafield (Pty) Ltd

Prepared By:

Dr B.D. Millsteed

EXECUTIVE SUMMARY

Kebrafield (Pty) Ltd has been awarded a Mining Right over various farms. The company intends to mine coal via open cast mining methods on an area contained within a portion of the area covered by that Mining Right being approximately 60 ha of the farm Portion 17 of the farm Roodepoort 151 IS. The project falls and lies approximately 0.5 km northwest of the town of Pullens Hope, within the district municipality of the Nkangala District and the Steve Tshwete Local Municipality, Mpumalanga Province.

Eco Elementum (Pty) Ltd has been appointed by Eyethu Coal (Pty) Ltd on behalf of the applicant Kebrafield (Pty) Ltd to undertake the Scoping Environmental Impact Assessment for all the relevant listed activities. Eco Elementum (Pty) Ltd has appointed BM Geological Services to provide a Full Palaeontological Heritage Impact Assessment Report in respect of the proposed project that will form part of the final Heritage Impact assessment Report

The entire extent of the project area is underlain by Permian rocks of Vryheid Formation (Karoo Supergroup). The rocks of this formation are known to contain abundant, but sporadically distributed plant macrofossil and trace fossil assemblages throughout its extent. The site was extensively investigated by foot traverse on the 26th of February 2014, but no fossil materials were identified during the site visit. The absence of observable fossils is readily attributable to the presence of an extensive non-fossiliferous regolith cover across the project area. As the Vryheid Formation is noted for the fossil assemblages elsewhere it remains possible that scientifically and culturally significant fossils are present within the Vryheid Formation below the regolith cover within the project area.

The potential risk of any negative impact within the Vryheid Formation is categorised as moderate, however, the fossils that may be anticipated to be present within the Formation are potentially highly significant to the cultural and scientific heritage of South Africa. The possibility exists for permanent and irreversible damage of any fossils present during the mining and construction phase of the project. The palaeontological heritage of the project area may also be negatively impacted in the short term (approximately 3 years) due to fossils being made available for scientific study as a result of being covered by project infrastructure. A graveyard containing graves older than 60 years is located near the northern margin of the project area, and these are protected under the National Heritage Resources Act.

Should any undiscovered fossil materials be present within the project area they would potentially be of high scientific and cultural significance; the magnitude of any negative impact upon the fossil assemblages contained within these geological units is characterised as potentially high. However, the probability of any negative impact being caused upon the fossil assemblages occurring within the project area is assessed as

moderate within the Vryheid Formation and improbable within the regolith cover. The area of any potential negative impact caused by the project is characterised as local in extent. Permanent and irreversible negative impacts on the palaeontological heritage of the area may result from the damage, destruction or inadvertent movement of fossils resulting from the development of the open cast pits as well as any excavations associated with the project. The life of mine is planned as being three years and, as such, any negative impacts caused by the loss of availability for scientific study resulting from fossils being covered by mining infrastructure will be short term.

The project has been assessed as being socially beneficial, herein, as it would provide fuel for the production of electrical energy to a stressed South African power grid. The possibility of any negative impact on the palaeontological heritage of the project area could be minimised by a thorough examination by a palaeontologist of all mine pits and excavations performed within the Vryheid Formation as they are being performed. Should any fossil materials be identified during the construction phase, the excavations should be halted and SAHRA informed of the discovery. Should scientifically or culturally significant fossil materials exist within the project area any negative impact upon it could be mitigated by their 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.

A potential positive outcome of the suggested mitigation protocols could be that fossil materials become available for scientific study that would otherwise have been hidden beneath the regolith in the sub-cropping and deeper portions of the Vryheid Formation. Should such new palaeontological material be located as a result of this site investigation this could prove to have a positive effect on the understanding of the fossil record of South Africa and positively affect the palaeontological heritage of the country.

In summary, this study has not identified any palaeontological reason to prejudice the progression of the proposed Roodepoorte Coal Mine, subject to a series of suggested damage mitigation protocols being put in place.

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1. INTRODUCTION

Kebrafield (Pty) Ltd has been awarded a Mining Right (MP30/5/1/2/2/479 MR) over various farms. The company intends to mine coal via open cast mining methods on an area contained within a portion of the area covered by that Mining Right being approximately 60 ha of the farm Portion 17 of the farm Roodepoort 151 IS. The project falls and lies approximately 0.5 km northwest of the town of Pullens Hope, within the district municipality of the Nkangala District and the Steve Tshwete Local Municipality, Mpumalanga Province.

Eco Elementum (Pty) Ltd has been appointed by Eyethu Coal (Pty) Ltd on behalf of the applicant Kebrafield (Pty) Ltd to undertake the Scoping Environmental Impact Assessment for all the relevant listed activities. Eco Elementum (Pty) Ltd has appointed BM Geological Services to provide a Full Palaeontological Heritage Impact Assessment Report in respect of the proposed project that will form part of the final Heritage Impact assessment Report.

1 TERMS OF REFERENCE AND SCOPE OF THE STUDY

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

- Identify all palaeontological materials located in the area of the project area.
- Quantify the palaeontological heritage significance of any fossil materials identified.
- Describe the possible impact of the proposed development on the palaeontological heritage of the site, according to a standard set of conventions.
- Propose suitable mitigation measures to minimise possible negative impacts, if any are identified, on the palaeontological heritage of the site.
- Provide an overview of the applicable legislative framework.

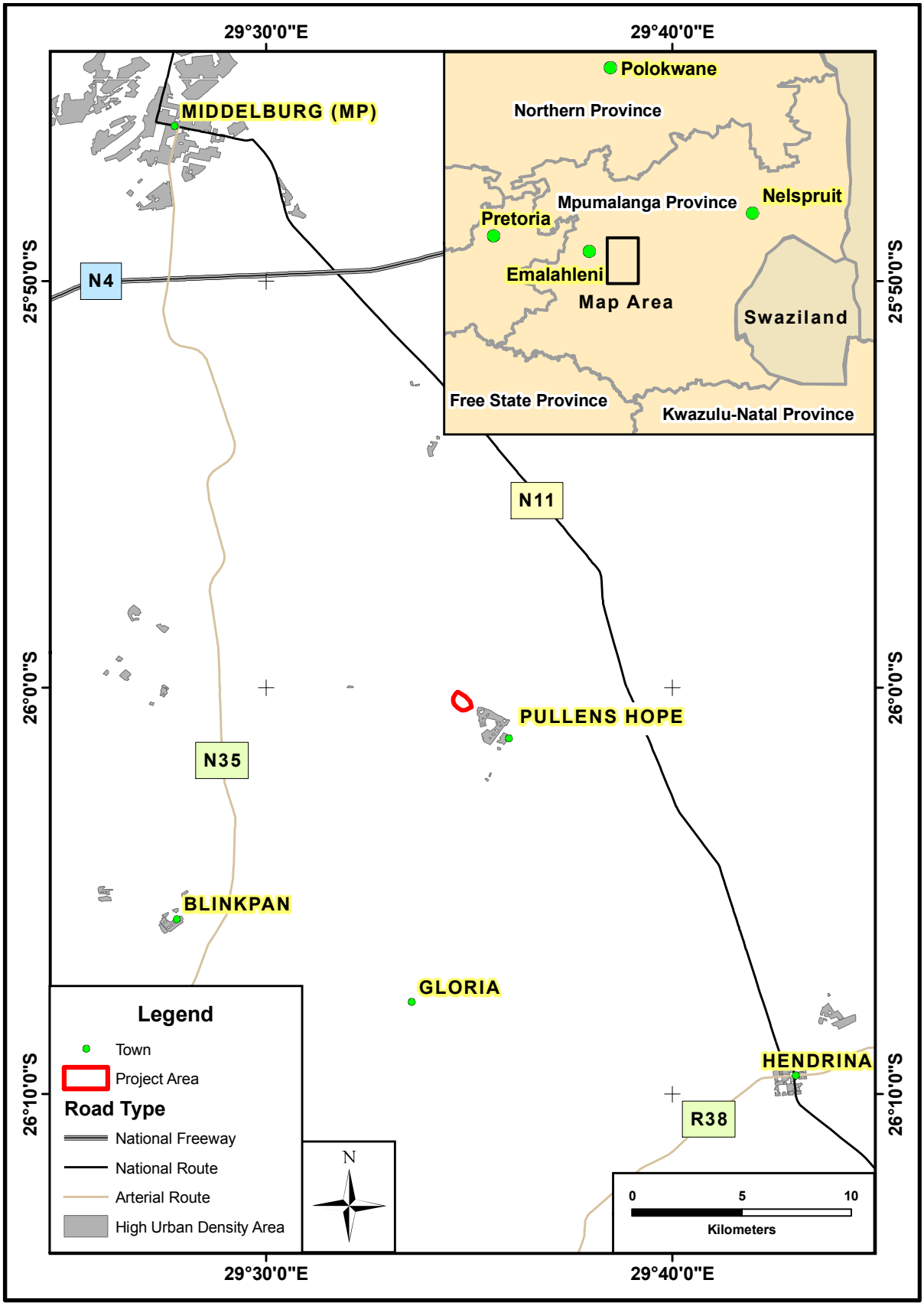

Figure 1: Location map showing the position of the proposed Roodepoorte Coal Mine project.

2 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).

2.1 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.).

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

2.2 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.

2.3 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.

2.4 The National Environmental Management Act [As amended]

This 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 is more general in its 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.

3 METHODOLOGY

It was considered that the most effective methodology for determining the fossiliferous potential of the project area was to traverse the area by foot. Given the large aerial extent of the proposed development it was impossible to visit the entire land surface of the site within an acceptable timeframe. It was decided that the most appropriate methodology was to traverse the area by foot, and to ensure that a representative coverage of the project area was achieved.

The study area was visited on the 26th of February 2014 by Dr B.D. Millsteed. The path of the foot traverse was recorded as a trackway on a hand-held GPS and is indicated in Figure 2. Photographs were taken and observations made were taken at a number of locations (see data waypoint locations in Figure 2). The location of the photographs and observation points was recorded using a hand-held GPS.

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), and is a member of the Palaeontological Society of South African and the Geological Society of South Africa.

5 ACCESS AND INDEPENDENCE

The area to be impacted by the proposed mining operations was supplied to BM Geological Services as a .kml file. The research was conducted completely free of any hindrance; access was freely available to all portions of the study area and the field visit was able to be conducted wherever it was deemed necessary for the satisfactory completion of the study.

A linear, approximately north-south oriented, wetland occurs within the eastern half of the project area (Figures 2 and 3). No foot traverse of this wetland area was undertaken as potentially fossiliferous geological units were evident (the entire area being heavily vegetated and submerged beneath water). In addition, a detail foot traverse was considered unnecessary as no disruption of the wetland is anticipated within the mine plans.

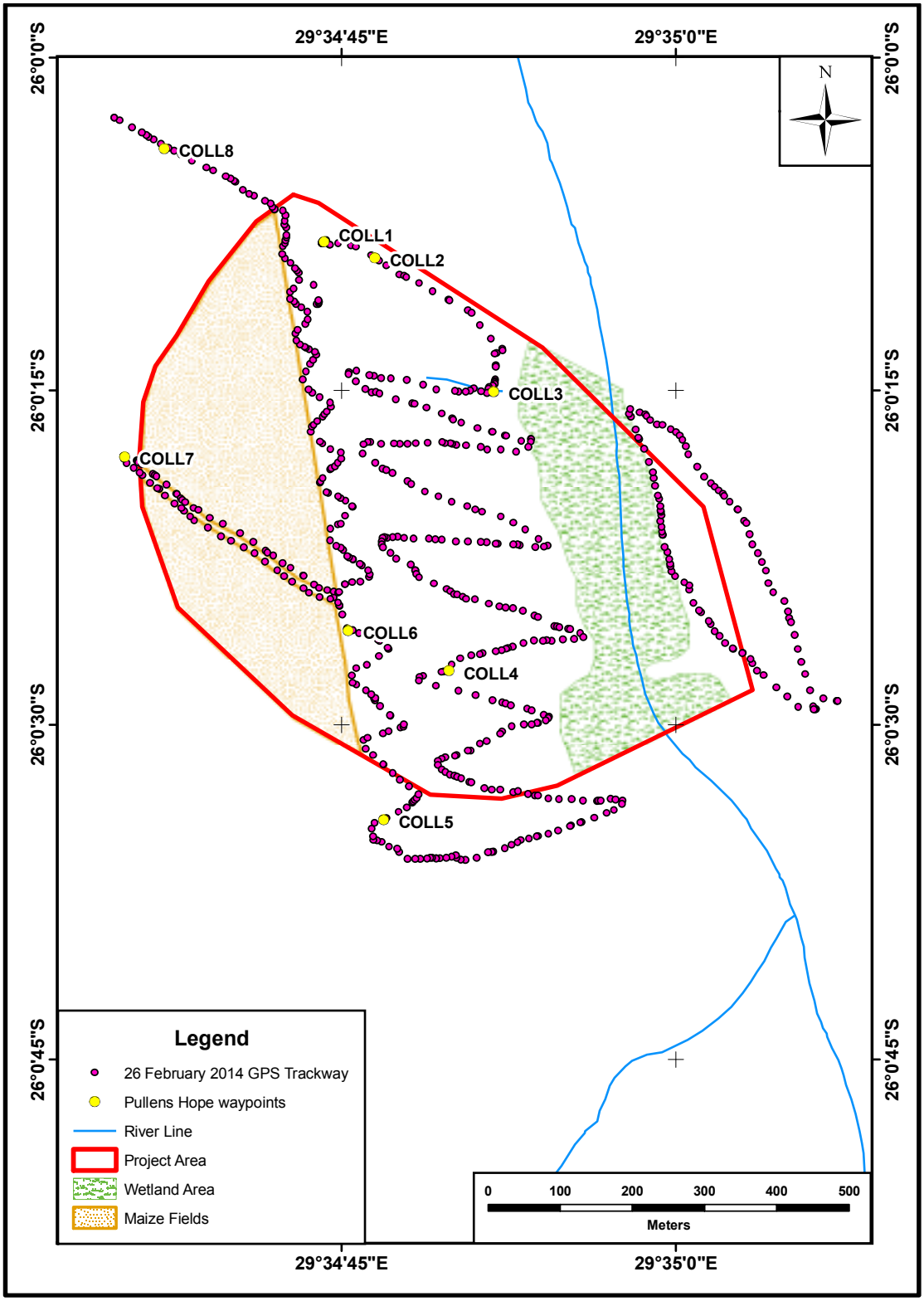

Figure 2: Map showing the location of the proposed Roodepoorte Coal Mine and its immediate environs, the extent of maize fields occurring within the project area, the wetland (as interpreted from Google earth imagery), the GPS trackway representing the location of the foot traverse conducted of the area and the location of waypoints at which data was collected.

Figure 3: View of the wetland occurring in the eastern portion of the project area looking east (waypoint Coll3, Figure 2).

The western extent of the project area was extensively covered by maize fields at the time of the site investigation (Figures 4 and 5). No detailed foot traverse was undertaken within these fields as it was assessed as unnecessary. This decision was based on the fact that foot traverses were conducted along the eastern and northern margins of the fields, as well as one traverse through the central portions of the cultivation area (Figure 2). During the conduct of these traverses it was possible to extensively observe the land surface underlying the maize plants between the widely spaced rows of plants. The land surface uniformly consists of extensively ploughed, clay-rich sandy regolith (Figure 6). The regolith appears to be unfossiliferous, but even if fossils were originally present they would have been destroyed by the ploughing activities that are integral to the cultivation of the fields. Thus, despite the fact that the maize fields were not extensively investigated by foot, extensive observation of this area was conducted during the site visit.

Figure 4: View of maize field occurring in the western portion of the project area (waypoint Coll6, Figure 2). The view is towards the west.

Figure 5: View of maize field occurring in the western portion of the project area (waypoint Coll7, Figure 2). The view is towards the north-east.

Figure 6: View of the clay-rich sandy regolith underlying the maize fields within the project area. The regolith has been heavily ploughed as part of the cultivation process and any fossils that may have originally been present would have been destroyed, damaged or inadvertently moved.

Dr Millsteed was retained as an independent consultant to conduct this 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 Kebrafield (Pty) Ltd, Eyuthu Coal (Pty) Ltd or the proposed Roodepoorte Coal Mine.

6 GEOLOGY AND FOSSIL POTENTIAL

Figure 7 shows that the region underlying the three project areas is underlain by Permian sedimentary rocks of the Vryheid Formation, Karoo Supergroup. A summary of the characteristics of this geological unit and its fossiliferous potential follows. It was evident during the inspection of the project area that the entire extent of the land surface is covered with unfossiliferous regolith.

6.1 Vryheid Formation

6.1.1 Geology

The Main Karoo Basin consists of a retro-arc foreland basin filled with a lithological succession ranging in age from the Late Carboniferous to the Middle Jurassic (Johnson *et al*., 2006). The basin-fill sequence wedges out northwards over the adjacent Kaapvaal Craton.

In the Main Karoo Basin of South Africa the Vryheid Formation is a sandstone and coal-rich stratigraphic unit that interfingers with (i.e., is transitional with and partially time equivalent to) the overlying Volkrust and underlying Pietermarizburg Formations; both of which are both are predominantly argillaceous (Figure 8). Genetically the formation can be divided into lower fluvial-dominated deltaic interval, a middle fluvial interval (the coal-bearing zone) and an upper fluvial-dominated deltaic interval (Johnson *et al*., 2006). The thickness and frequency of the sandstone units increases from the base of the formation, reaching their maximum in the middle fluvial interval and then decrease again towards the overlying Volksrust Formation. To the south and south-east the Vryheid Formation grades laterally into undifferentiated, deep-water argillites of the Ecca Group (Figure 8).

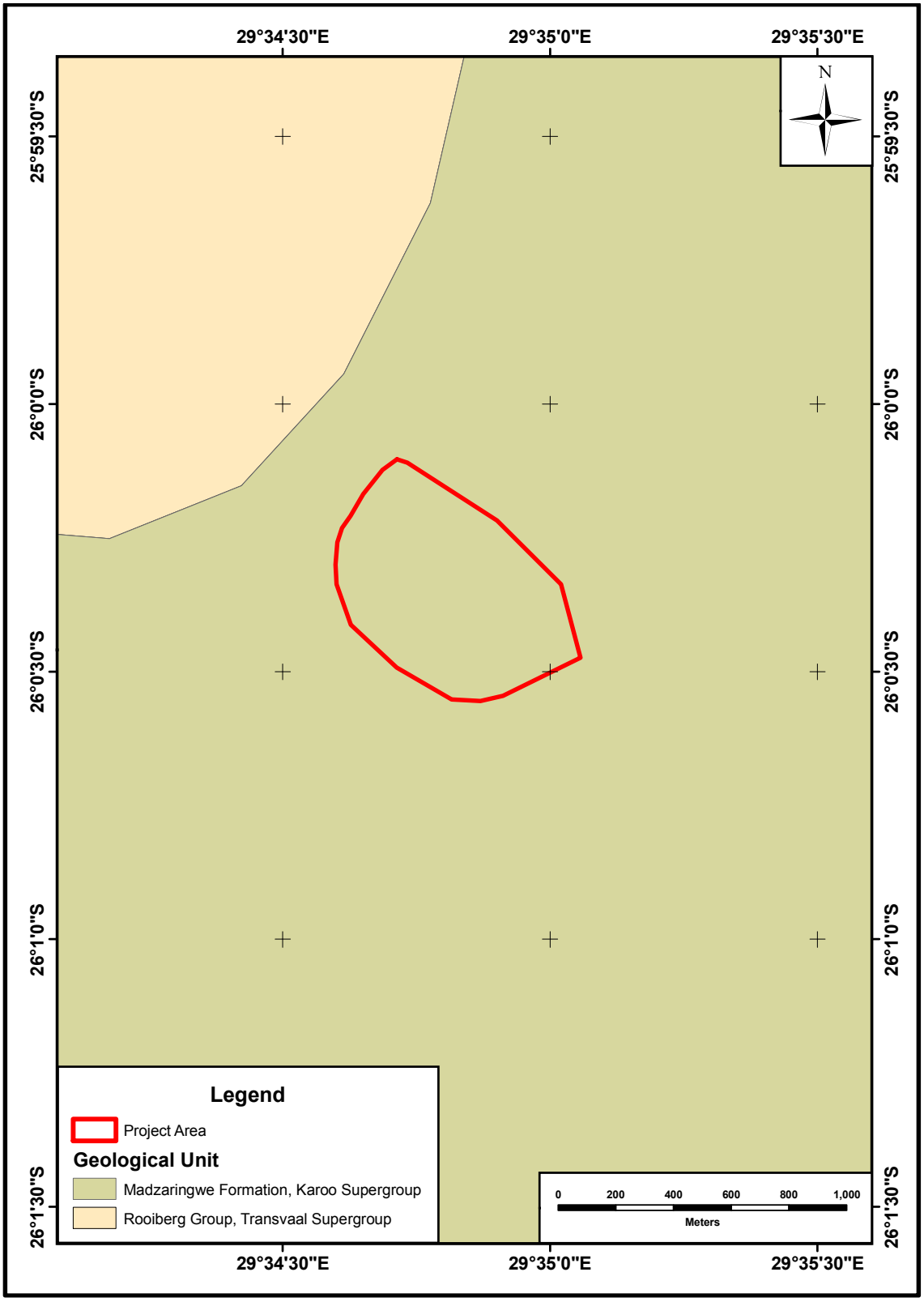

Figure 7: Map of the geology underlying the project area and its surrounding environs.

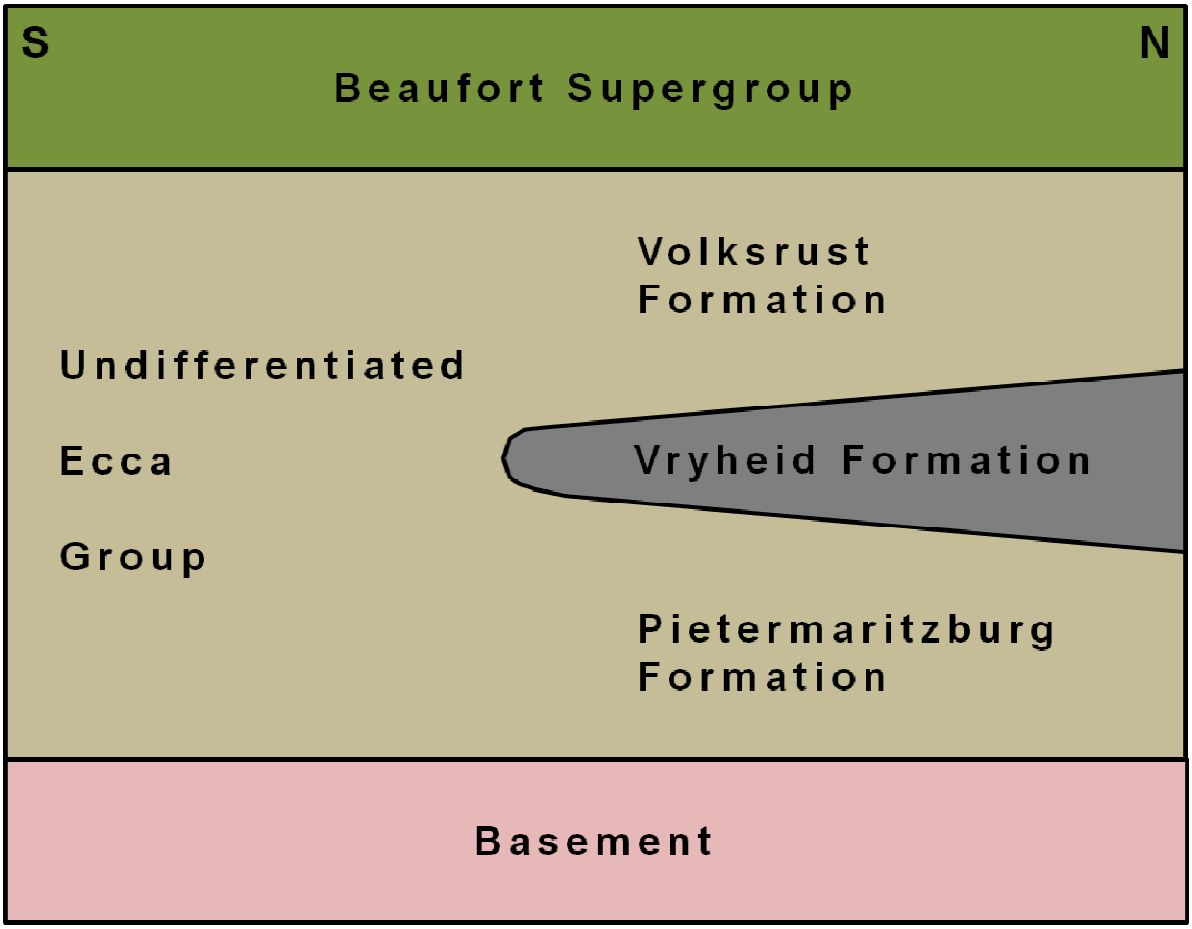

Figure 8: Schematic north-south oriented stratigraphic section of the Ecca Group in the north-east corner of the Karoo Basin. The Volksrust and Pietermaritzburg Formations can only be recognised when the Vryheid Formation forms part of the vertical sequence. In the north and north-western portions of the basin the Pietermaritzburg Formation was not deposited and the coal-bearing strata of the Vryheid Formation rest directly upon the basement.

The Vryheid Formation is one of sixteen (16) recognised stratigraphic units that constitute the Permian Ecca Group. During the deposition of the Ecca Group the basin was dominated by a large sea (the salinity levels of this water body remain unresolved). The exception to this model was the deposition of the coal-bearing strata of the Vryheid Formation along the northern margin during an episode of deltaic progradation into the basin.

Deposition of the Vryheid Formation was terminated by a basin-wide transgression that drowned the Vryheid deltas and their coal swamps resulting in the deposition of the deep water sediments of the Volksrust Formation.

6.1.2 Palaeontological potential

The most conspicuous and common components of the palaeontological record of the Ecca Group in general are the plant macrofossils of the *Glossopteris* flora. Two large and conspicuous leaf form taxa dominate the *Glossopteris* flora; these being *Glossopteris* and *Gangamopteris*. Within the upper Ecca (containing the Vryheid Formation) *Gangamopteris* has ceased to occur with only *Glossopteris* present (Anderson and McLauchlan, 1976). The palaeobotanical record of the Ecca Group is diverse and the literature describing it is voluminous (numerous papers having been published by E. Plumstead, H. Anderson, J. Anderson, E. Kovaks-Endrődy and M. Bamford amongst others). A comprehensive review of the flora in the Karoo Basin literature is, accordingly, beyond the scope of this study, but a thorough review of the palaeobotanical content of the Ecca Group in general and the Vryheid Formation in particular is presented in Bamford (2004). In that summary it is indicated that the Vryheid Formation can be expected to contain the plant macrofossils *Buthelezia*, *Sphenophyllum*, *Rangia*, *Phyllotheca*, *Schizoneura*, *Sphenopteris*, *Noeggerathiopsis*, *Taeniopteris*, *Pagiophyllum* and *Benlightfootia* and the wood taxa *Australoxylon* and *Prototaxoxylon*. In addition to the above records can be added the observations of Tavener-Smith *et al*., (1988) where it was noted that both *Glossopteris* and *Vertebraria* occur within the palaeontological record of the formation.

In portions of the formation that are typified by low thermal alteration abundant assemblages of palynomorph plant microfossils (including acritarchs) can be expected (Anderson, 1977).

Jubb and Gardiner (1975) report the presence of fragmentary fish fossils within the Ecca sequence of southern Africa; these being *Coelacanthus dendrites* from the Somkele coal-field of northern Natal and *Namaicthys digitata* from correlative strata in the Senge Coal-fields of Zimbabwe. While fish faunas are obviously rare and none have been reported from the Vryheid Formation the possibility remains that they may be present.

Animal body fossils are rare within the Ecca Group in general (excepting the time equivalent faunas of the Whitehill Formation). However, no reptile fossils have been identified within the Vryheid Formation.

Hobday and Tavener-Smith (1975) reviewed trace fossil assemblages identified within the Vryheid Formation. Within that fossil assemblage they identified two forms (*Helminthiopsis* and *Taphrelminthopsis* within horizontally laminated siltstones and mudstones that represent part of the deep water *Nerites* community.

7 ENVIRONMENT OF THE PROPOSED PROJECT SITE

The project area is large; being approximately 60 ha and lies within a wide, shallow valley, with both sides of the project area sloping gently towards a wetland located in the valley axis (Figure 9). A small graveyard is located near the northern margin of the project area (waypoint Coll1, Figure 2 and Figures 10-13). Inspection of several of the headstones revealed that they bear dates of burial from the years 1919 and 1920 (Figures 12 and 13). These graves are older than 60 years and are accordingly protected under the National Heritage Resources Act (see Section 3.1 above). A number of high voltage power lines traverse the project area (Figures 14 and 15) and an approximately north-south oriented dirt road traverses the central portion of the project area (Figures 16 and 19).

Mucina and Rutherford (2006) indicate that the vegetation cover of the entire project area consists of Eastern Highveld Grassland (Figure 14, 15, 17-19). The conservation status of this vegetation type is listed as endangered by Mucina and Rutherford (2006). However, as described above there is also a linear, north-south oriented wetland that occurs in the eastern portion of the project area and which lies in the valley bottom (Figure 18-19). Both The grassland and wetland are utilised for cattle grazing. The western portions of the project area are extensively utilised for agricultural cultivation (i.e., maize fields).

8 OVERVIEW OF SCOPE OF THE PROJECT

The proposed mining operations will result in the open cast mining of approximately 800 000 tons of bituminous coal over a three year period. The mining operations will exploit a single coal seam that occurs at depths up to 28 m. The mining will follow standard roll-over rehabilitation methods.

Each facility will include the following infrastructures (Figure 16):

- Two separate single open cast mining areas,
- Several new access roads,
- A new road diversion for the existing dirt road that traverses the project area,
- A run of mine (ROM) coal stockpile,
- Three topsoil dumps,
- Four overburden dumps,
- A contractor’s yard.

These infrastructure elements collectively occupy (excluding the aerial extent of the wetland) almost the entire extent of the project area.

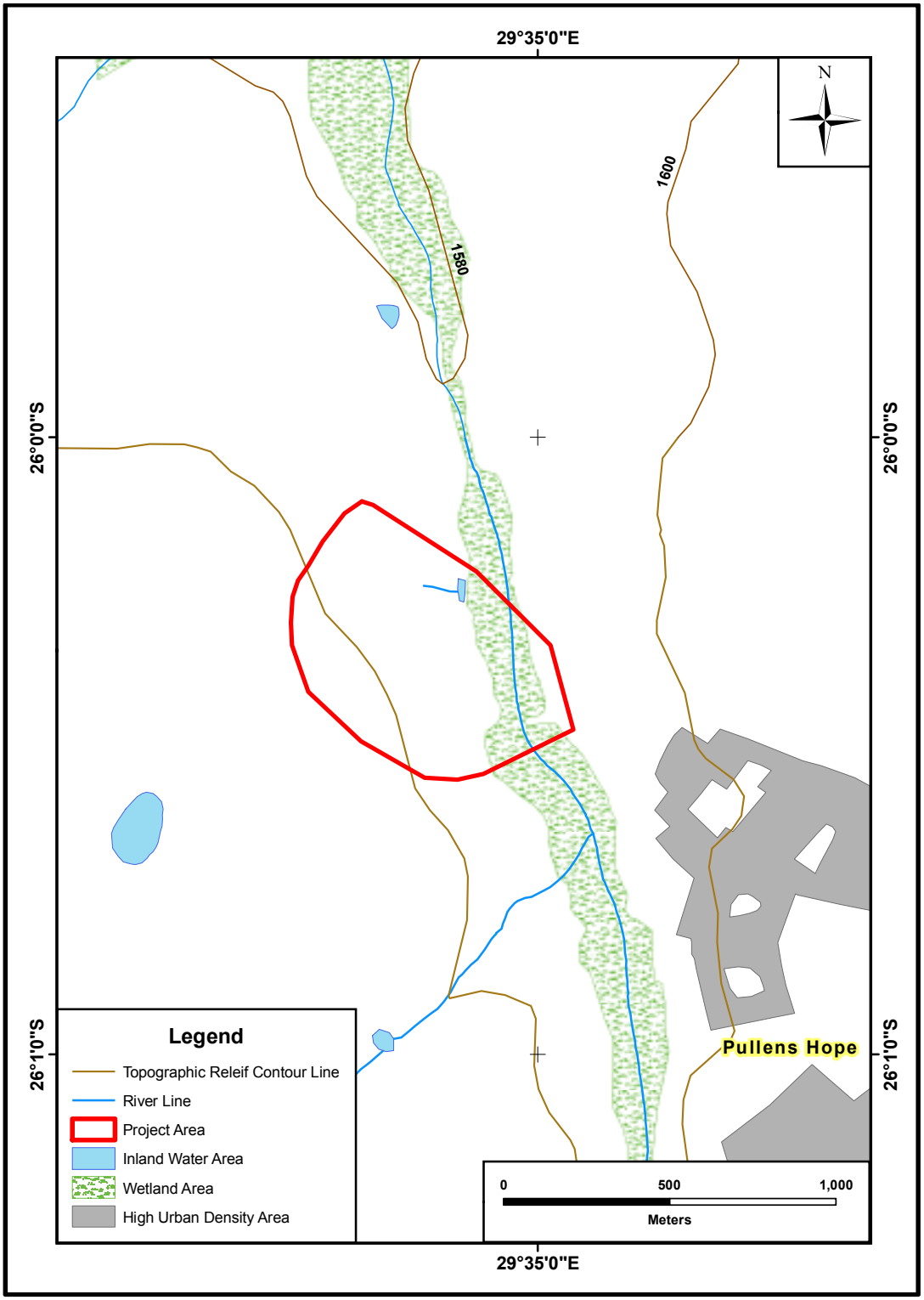

Figure 9: Map showing the environment of the project area and its immediate environs. The site lies immediately to the north-west of Pullens Hope and is situated in the bottom of a wide, gently sloping valley. A small river and its associated wetland lie within the valley floor axis. The contour interval of the topographic contours is 20 m.

Figure 10: A portion of the small graveyard located near the northern boundary of the project area (waypoint Coll1, Figure 2).

Figure 11: A portion of the small graveyard located near the northern boundary of the project area (waypoint Coll1, Figure 2). The graves in this portion of the graveyard appear to be more recent than those shown in Figure 10.

Figure 12: The headstone of Anna vd Merwe who passed away on 18/9/1920; the grave therefore appears to be over 60 years old (waypoint Coll1, Figure 2).

Figure 13: The headstone of Maria vd Merwe who passed away on 23/6/1990; the grave therefore appears to be over 60 years old (waypoint Coll1, Figure 2).

Figure 14: View of the North-south oriented high voltage power line traversing the project area (waypoint Coll2, Figure 2). The view is to the south and Kendal Power Station is visible in the background.

Figure 15: View of the east-west oriented high voltage power line traversing the project area (waypoint Coll4, Figure 2). The view is to the east and Kendal Power Station is visible in the background.

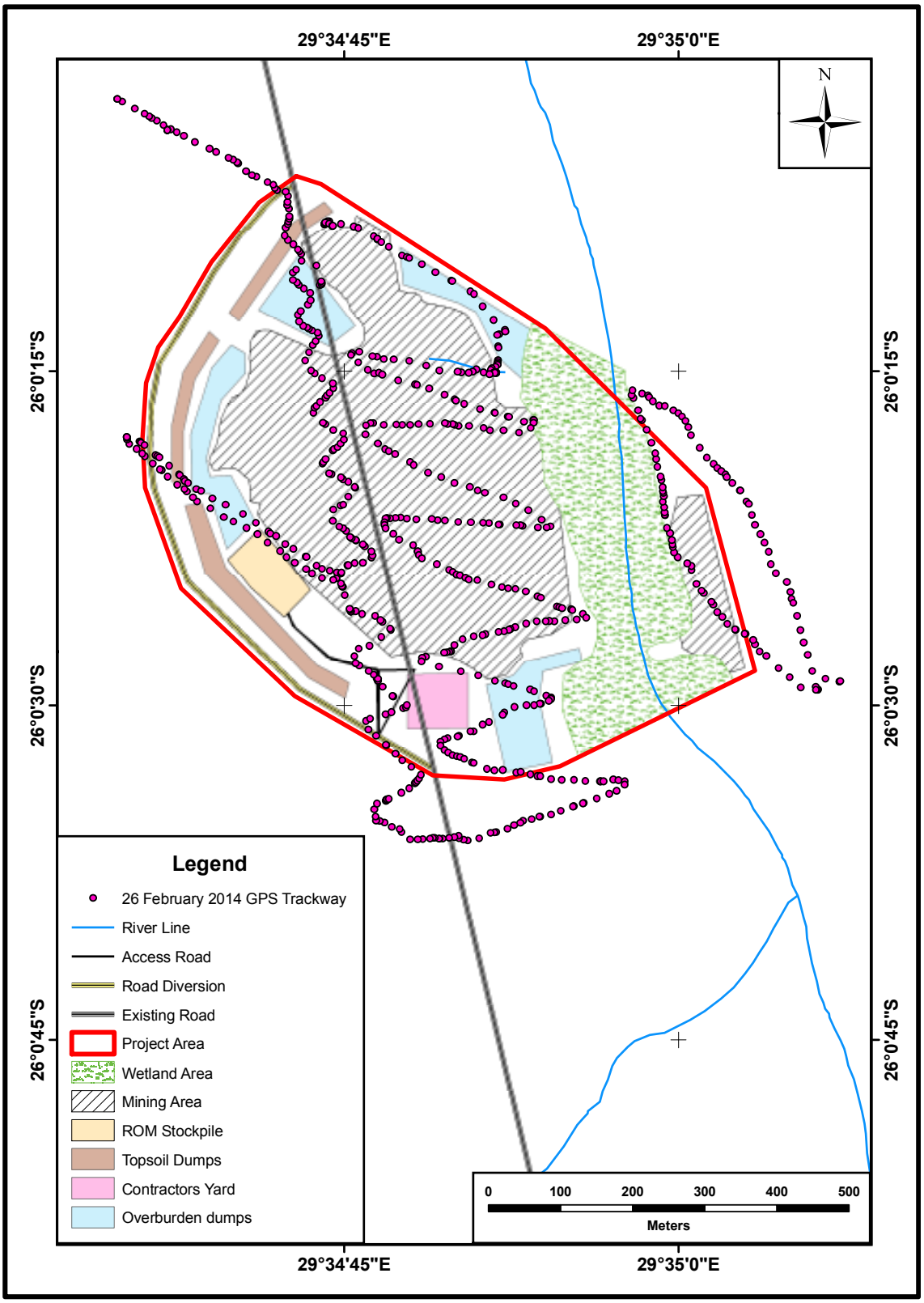

Figure 16: Map of the project area project area showing the location of the proposed open cast mine pits and other planned infrastructure elements. Shown also is the extent of the wetland area. The GPS trackway from the site inspection is overlain on the image.

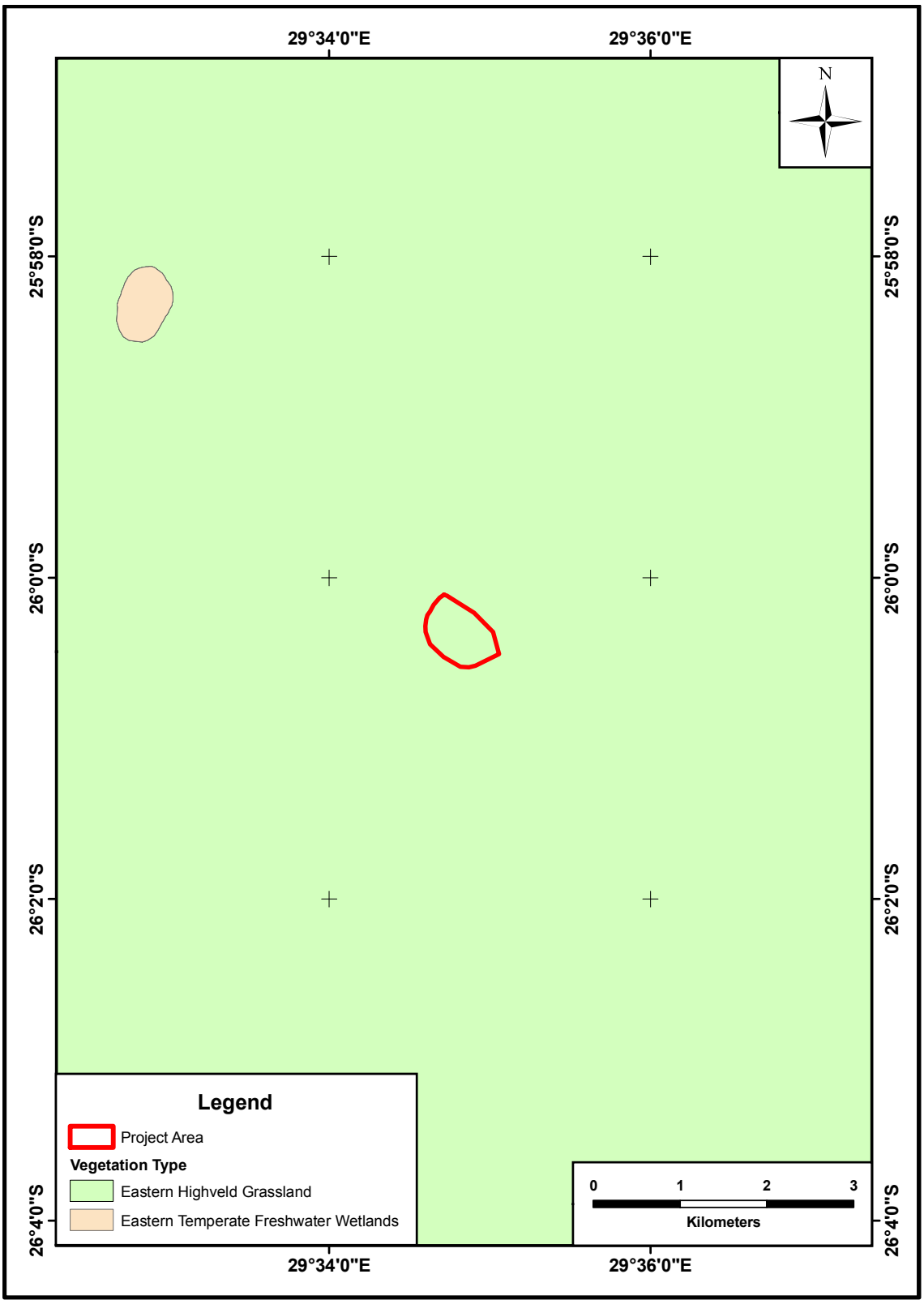

Figure 17: Map of the project area and its immediate environs showing the distribution of the vegetation veld types present within the region (After Mucina and Rutherford, 2006).

Figure 18: View of grassland of the Eastern Highveld Grassland occurring within the project area (waypoint Coll5, Figure 2).

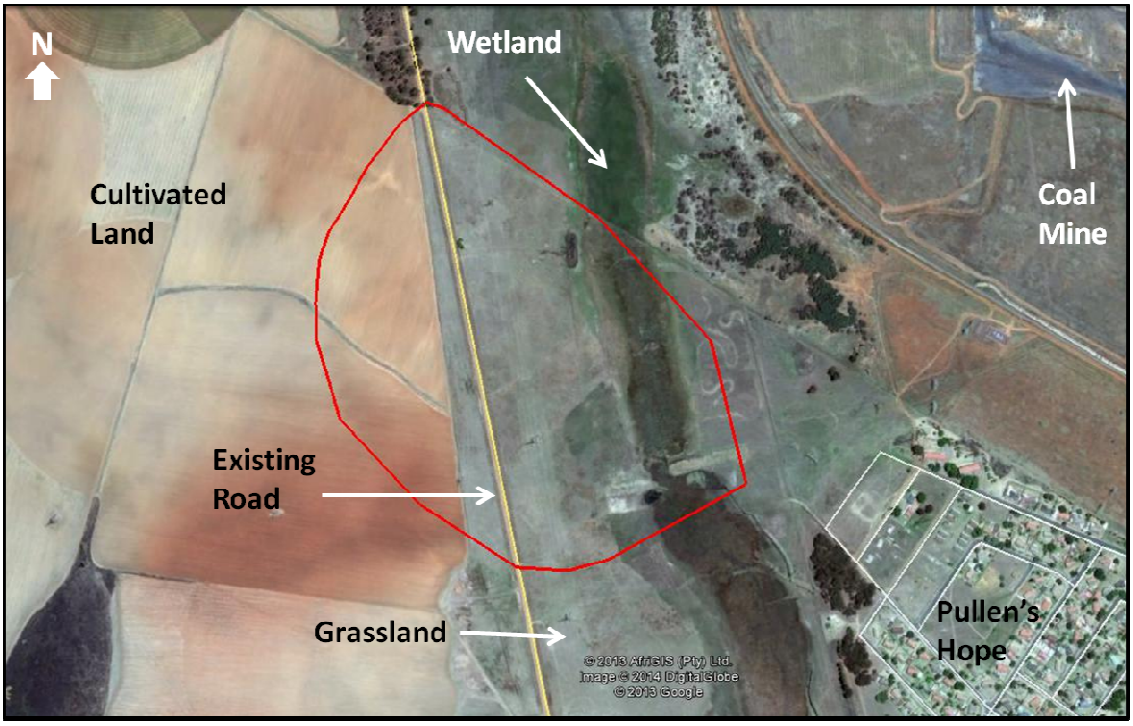

Figure 19: Google earth image of the project area (red polygon) showing the location of various environmental types and infrastructure elements in and around the area of the proposed coal mine. The site lies to the immediate south-west of an existing coal mine.

9 IMPACT ASSESSMENT

The potential impact of Kebrafield (Pty) Ltd's proposed coal mining operations 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 proposed Roodepoorte Coal Mine 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 permanent negative 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 possible source of a less permanent negative impact on the palaeontological heritage is the loss of access for scientific research to any fossil materials that become covered by the various infrastructural elements that comprise the project. The extent of the area of potential impact for the proposed coal mine 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 **short term to permanent**. This is assessment is based on the fact that, in the absence of mitigation procedures (should undiscovered fossil material be present within the area to

be affected) the damage or destruction of any palaeontological materials will be **permanent**. Permanent impact on fossil materials will potentially result from any excavations resulting from any excavations associated with the mining process as well as construction of buildings or ground clearing road building. Similarly, any undiscovered fossil materials that exist in the subsurface below the structures and infrastructural elements that will constitute the mine operations will be unavailable for scientific study for the life of the existence of those features (i.e., **short term** < 5 years as the term of the awarded Mining Right is 3 years).

9.4 Magnitude of Impact

Should fossils exist within the sedimentary rocks of the Vryheid Formation they would potentially be of high scientific importance. Accordingly, the magnitude of the impact of the proposed mining operations upon the palaeontological heritage of the area is assessed as **high**. Should the mitigation procedures suggested, herein, be performed no fossil materials of any significance should be negatively impacted and the magnitude of the resultant impacts will be **low**.

9.5 Probability of Impact

The Vryheid Formation is well known for its contained plant macrofossil and trace fossil assemblages, however, **no fossil materials were located during the conduct of the field investigation**. The lack of fossils at the land surface is readily explained by the complete coverage of the Vryheid Formation within the project area by densely vegetated, unfossiliferous regolith as well as the waters of the wetland. There remains a reasonable possibility of undiscovered fossil materials occurring within the subsurface portions of the Vryheid Formation. The probability of any negative impact upon the palaeontological heritage of the project area is categorised, herein, as **moderate**.

The regolith horizons occurring at surface have been extensively investigated and no fossil materials were identified; the regolith is accordingly assumed to be unfossiliferous. Additionally, the regolith underlying the maize fields has been extensively disturbed by ploughing. Should any fossil materials have been present within the regolith prior to the agricultural cultivation they would have been destroyed or accidently moved (and their exact location lost). Accordingly, the possibility of the mining operations causing any negative impact on the palaeontological heritage of the regolith is categorised as **negligible**.

9.6 Significance of the Impact

Should the project progress without due care to the possibility of fossils being present within the Vryheid Formation the resultant damage, destruction or inadvertent relocation any affected fossils will be permanent and irreversible. This potential for negative

impact on the palaeontological heritage is accentuated by the fact that often the plant macrofossils and trace fossils that are known to be present in this formation elsewhere often occur in dense accumulations, and as such, if any negative impact occurs it may well affect many fossils simultaneously. The delta top/fluvial/coal swamp environments that existed during the deposition of the Vryheid Formation provide an important window into the evolution of plant life during the Early Permian within the Main Karoo Basin due to the uniqueness of their terrestrial environments within the basin fill of the Main Karoo Basin at that time. Thus, any fossil materials occurring within the project area are potentially extremely scientifically and culturally significant and any negative impact on them would be of **high significance**.

The scientific and cultural significance of fossil materials is further underscored by the fact that many fossil 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 project infrastructural elements the result will potentially be the irreversible damage or destruction of the fossil(s).

The certainty of the exact *in situ* location of fossils and their precise location within the stratigraphic sequence is essential to the scientific value of fossils. The movement of any fossil material during the construction of the facility that results in the exact original location of the fossil becoming unknown will either greatly diminish or destroy the scientific value of the fossil.

9.7 Severity / Benefit Scale

The proposed project is categorised, herein, as being potentially **beneficial**. This classification is based on the intention that the project will provide fuel to facilitate the production and supply of electricity to a stressed South African power grid. The probability of a negative impact on the palaeontological heritage of the project area has been categorised as ranging between moderate in the Vryheid Formation and negligible in the regolith. The moderate likelihood of fossils within the Vryheid Formation being directly affected by the planned project must be weighed in conjunction with the severity of any negative impact that may result. Many fossil taxa are known from only a single fossil and, thus, any fossil material is potentially highly significant. This potential significance is further highlighted by the fact that the sediments of the Vryheid Formation may contain important examples of plant macrofossils of the Early Permian succession of the Main Karoo Basin. Thus, it is possible that there are fossils of scientific and cultural significance present within the sediments underlying the project area. Accordingly, the loss or damage to any single fossil or fossil locality can be potentially significant to the understanding of the fossil heritage of South Africa. As such, **although**

the likelihood of any disturbance of palaeontological materials is moderate (at worst case), the severity of any impact is potentially high. The possibility of a negative impact on the palaeontological heritage of the area can, however, be minimised by the implementation of adequate damage mitigation protocols. If damage mitigation is properly undertaken the benefit/severity scale for the project will lie within the beneficial category.

A potential secondary benefit of the project would be that the excavations resulting from the progress of the project may expose fossils materials that were hidden beneath the regolith cover or within the deeper excavations associated with the open cast pits. If the planned excavations and mine pits are inspected by a palaeontologist the possibility would be generated of being able to study and excavate fossil materials that would otherwise be lost to scientific study.

9.8 Status

Given the combination of factors discussed above, it is anticipated that as long as the adequate mitigation protocols are emplaced little to no negative effect on the palaeontological heritage of the area is anticipated. As the proposed project would supply fuel for the generation of electricity to the stressed South African national power grid the project is determined as having a **positive status** herein.

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

No fossil materials were identified within the study area during the site visit, but the possibility exists that fossils may be present within the sub-cropping and deeper portions of the Vryheid Formation. It is recommended that a close examination of all excavations and mine pits be performed by a palaeontologist while they are occurring. Should any fossil materials be identified, the relevant excavations should be halted and SAHRA informed of the discovery (as per legislation outlined in Section 3.3 herein). 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 and be made available for scientific study. Should scientifically or culturally significant fossil materials exist within the project area any negative impact upon them could be mitigated by their 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 reduction of scientific value due to a loss of the 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 and total**.

Fossils are usually scarce and sporadic in their occurrence and the chances of negatively impacting on a fossil in any particular area are generally low. The distribution of fossils assemblages contained within the Vryheid Formation is also sparse and sporadic, but plant macrofossils and trace fossil assemblages often occur as dense accumulations; the chances of any negative impact upon the Vryheid Formation fossils are considered to be higher (i.e., moderate). Any fossil material that may be contained within the strata underlying the project area is potentially of the highest scientific and cultural importance. 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

Fossils occur sporadically within geological units and their location cannot be accurately predetermined. Despite a comprehensive investigation of the project areas by foot it was impractical (within time and budgetary constraints) to visit all surface locations with the proposed Roodepoorte Mine project area. In addition, the potentially fossiliferous Vryheid Formation strata were completely obscured beneath a pervasive regolith cover. The possibility remains that there may be fossil materials occurring at the surface that were not located, or within the subsurface of the Vryheid Formation that could not be observed in the field.

12 ENVIRONMENTAL IMPACT STATEMENT

A comprehensive, foot-based investigation of the palaeontological potential of the area of the proposed Roodepoorte Coal Mine project as well as portions of the surrounding environs has been conducted. This study forms part of a Heritage Impact Assessment that is a component of a larger Environmental Impact Assessment to identify and assess all potential environmental impacts associated with the proposed project for the area as identified and to propose appropriate mitigation measures in an Environmental Management Programme.

The area reported upon herein is relatively large (approximately 60 ha). It is probable that the area that will be affected by the proposed project infrastructure and mine pits will occupy the majority of the project area, except for that portion which underlies the wetland in the valley axis. Permanent negative impacts to the palaeontological heritage of the region will potentially result throughout the total aerial and vertical extent (up to 28 m) of two open cast mine pits as well as in any excavations associated with construction or emplacement of infrastructure elements. Short term negative impacts may be produced should any fossil materials be covered by mine infrastructure and become unavailable for scientific study for the duration of the life of that infrastructure.

No fossil materials were identified within the environs of proposed Roodepoorte Coal Mine during the present study, but the Vryheid Formation is noted for the fossil assemblages it contains elsewhere. The potential risk of any negative impact within the Vryheid Formation is categorised as moderate, however, the fossils that may be anticipated to be present within the Formation are potentially highly significant to the cultural and scientific heritage of South Africa. The possibility exists for permanent and irreversible damage of any fossils present during the mining and construction phase of the project. The palaeontological heritage of the project area may also be negatively impacted in the short term (approximately < 5 years) due to fossils being made available for scientific study as a result of being covered by project infrastructure.

The potential negative impact to the palaeontological heritage of the area can be substantially mitigated by the implementation of appropriate mitigation processes. A thorough and ongoing examination should be made of all excavations by a palaeontologist as they are being performed. Should any fossil materials be identified, the relevant excavations should be halted and SAHRA informed of the discovery. 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 fossil 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.

A potential positive outcome of these mitigation protocols could be that fossil materials become available for scientific study that would otherwise have been hidden within or beneath the regolith. Should such new palaeontological material be located as a result of this site investigation this could prove to have a positive effect on the understanding of the fossil record of South Africa and positively affect the palaeontological heritage of the country.

The social benefits of the Roodepoorte Coal Mine have been assessed and has been classified as beneficial, herein, as the projects aim to provide a fuel source for the production of electrical energy to the South Africa power grid. The power generation capacity of South Africa is presently under significant pressure. As such **this study has not identified any palaeontological reason to prejudice the progression of the mining project subject to adequate mitigation programs suggested, herein, being put in place**.

13 RECOMENDATIONS

The following recommendations are made for the future conduct of the project in order to reduce the potential for any negative impact on the area to an absolute minimum:

- Regular inspections should be made by a palaeontologist of all mining areas, as well as any excavations and construction sites during the development of the project to ascertain if any fossil materials have been uncovered.
- Should any fossil material be located during the proposed inspections the relevant portion of the excavations should be halted and SAHRA informed of the discovery.
- Should any fossil material be identified a palaeontologist should be contacted to evaluate the material and advise on its scientific importance and, if necessary, excavation or preservation.
- A report by an archaeologist detailing recommendations concerning the graveyard located in the north of the project area should form part of the final Heritage Impact Assessment Report.

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