DESKTOP PALAEONTOLOGICAL HERITAGE IMPACT ASSESSEMENT REPORT ON THE SITE OF A PROPOSED COAL-FIRED POWER PLANT TO BE KNOWN AS THE UMBANI POWER PLANT ON A SITE NEAR KRIEL, MPUMALANGA PROVINCE

Prepared for:

Savannah Environmental (Pty) Ltd

On Behalf of:

ISS Global Mining (Pty) Ltd

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EXECUTIVE SUMMARY

ISS Global Mining (Pty) Ltd is proposing to establish a coal-fired power station with a total generating capacity of 500 MW. The project area, which will contain the power generation infrastructure, is proposed to be located within Portions 1 and 9 of the Farm Dorstfontein 71 IS, adjacent to the existing Dorstfontein East Coal Mine. Portions 1 and 9 of the Farm Dorstfontein 71 IS collectively occupy an area of approximately 945 ha. The project site is located approximately 5 km east of Kriel and 27 km north-west of Bethal, Kriel Magisterial District, Emalahleni Local Municipality, Mpumalanga Province.

ISS Global Mining (Pty) Ltd has appointed Savannah Environmental (Pty) Ltd, as independent consultants, to undertake a Scoping and Environmental Impact Assessment to identify and assess all potential environmental impacts associated with the proposed project for the area as identified, and propose appropriate mitigation measures in an Environmental Management Programme (EMPr). Savannah Environmental (Pty) Ltd appointed Heritage Contract and Archaeological Consulting CC, as independent consultants, to undertake a Scoping Heritage Impact Assessment to identify and assess all potential heritage impacts associated with the proposed project for the area as identified and propose appropriate mitigation measures in an EMPr. Heritage Contract and Archaeological Consulting CC has appointed 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.

The project area is extensively underlain by Permian sedimentary rocks of the Vryheid Formation, but a large portion of the northern half of the project area is dominated by outcrops of Palaeoproterozoic igneous rocks of the Rooiberg Group and the Lebowa Granite Suite.

The probability of a negative impact on the fossil heritage of the area can be quantified in the following manner. The probability of a negative impact on the palaeontological heritage of the Vryheid Formation is moderate due to the generally scarce and erratic distribution of fossils within the unit; but both plant macrofossils and trace fossils tend to occur in prolific numbers where they do occur. Any negative impact upon the fossil assemblages contained within this geological unit is characterised as potentially scientifically and culturally significant. It is pertinent to note that the area of any potential negative impact caused by the project is characterised as local in extent. Similarly, the zone of permanent disruption is vertically restricted to the maximum depth of any excavations associated with the proposed constructions. The rocks of the Selons River Formation (Rooiberg Group) and the Lebowa Granite Suite are considered to be unfossiliferous. Thus, the proposed project poses no probability of any negative impact upon the palaeontological heritage of these two units.

The project has been assessed as being socially beneficial, herein, as it would provide energy to a stressed South African power grid. A series of recommendations are

outlined herein that, if implemented, would minimise the possibility of any negative impact on the palaeontological heritage of the project area. 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.

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

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1.1

2 INTRODUCTION

ISS Global Mining (Pty) Ltd is proposing to establish a coal-fired power station with a total generating capacity of 500 MW. The project area, which will contain the power generation infrastructure, is proposed to be located within Portions 1 and 9 of the Farm Dorstfontein 71 IS, adjacent to the existing Dorstfontein East Coal Mine. Portions 1 and 9 of the Farm Dorstfontein 71 IS collectively occupy an area of approximately 945 ha. The project site is located approximately 5 km east of Kriel and 27 km north-west of Bethal, Kriel Magisterial District, Emalahleni Local Municipality, Mpumalanga Province.

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3 TERMS OF REFERENCE AND SCOPE OF THE STUDY

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

- 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.

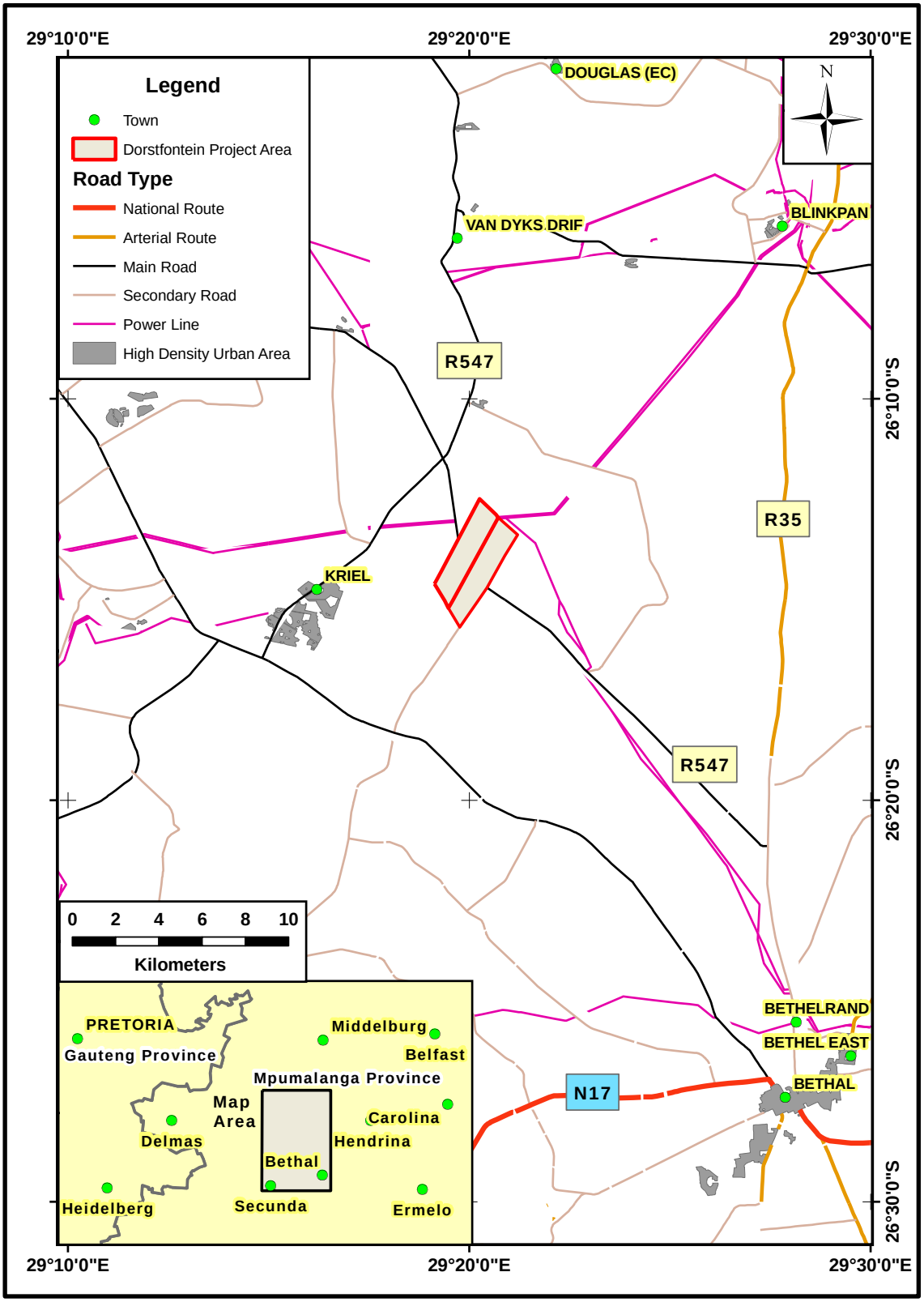

Figure 1: Location map showing the position of the proposed ISS Global Mining (Pty) Ltd's coal-fired power station project.

4 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).

4.1 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:

4.2 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 300m 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.

4.3 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.

4.4 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 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.

5 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 also a member of the Palaeontological Society of South African and the Geological Society of South Africa.

6 INDEPENDENCE

Dr Millsteed was contracted 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 either ISS Global Mining (Pty) Ltd or the proposed power generation facility.

7 GEOLOGY AND FOSSIL POTENTIAL

Figure 2 shows that the project area is extensively underlain by Permian sedimentary rocks of the Vryheid Formation. Precambrian bedrocks of the Selons River Formation and the Lebowa Granite Suite crop out over much of the northern half of the project area. A summary of the characteristics of the geological units and their fossiliferous potentials follows.

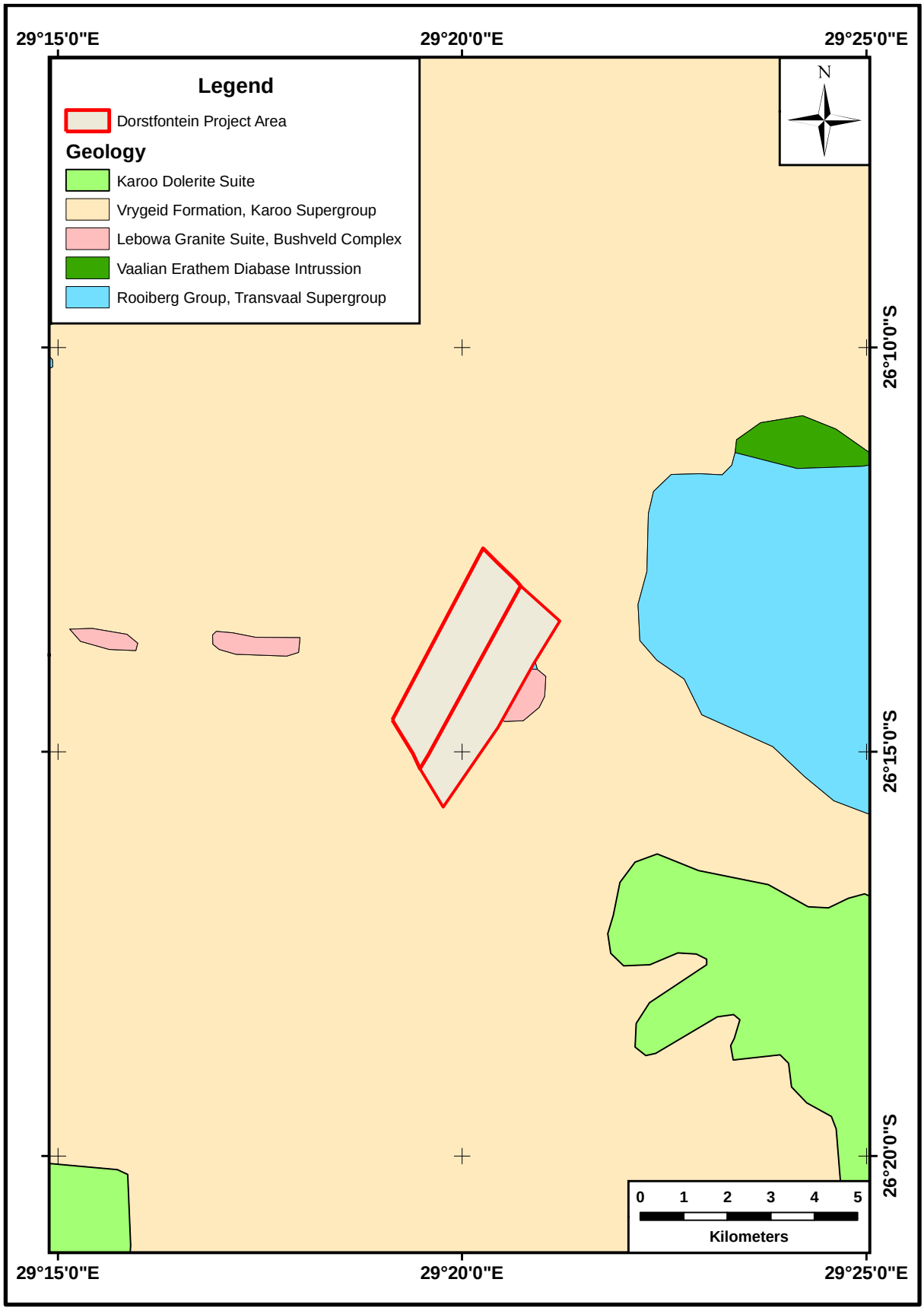

Figure 2: Map of the geology underlying the project area and its surrounding environs.

7.1 Selons River Formation

7.1.1 Geology

The Selons River Formation constitutes the Rooiberg Group in the southeastern portion of the group's aerial extent. The Rooiberg Group comprises volcanic units that are up to 400 m thick, together with interbedded, thin, laterally extensive sedimentary strata (Buchanan, 2006). The Rooiberg Group stratigraphically underlies the intrusive rocks of the Bushveld Complex with which it collectively forms the Bushveld Magmatic Province (BMP). The rocks of the BMP have been isotopically dated as being between 2061 ± 2 Ma and 2052 ± 48 Ma (Buchanan, 2006) placing their formation within the Palaeoproterozoic.

7.1.2 Palaeontological potential

The only identifiable fossil materials present within the Palaeoproterozoic lithological succession of South Africa are the stromatolite assemblages present within carbonate sedimentary successions. The Palaeoproterozoic age of the Selons River Formation coupled with its non-carbonate lithologies cumulatively suggest a negligible potential for the preservation of any palaeontological materials.

7.2 Lebowa Granite Suite

7.2.1 Geology

The Lebowa Granite Suite forms part of the economically important Bushveld Complex. The suite consists of mineralogically and texturally differentiated granites that occur as four distinguishable types; these being the Nebo, Bobbejaankop, klipkloof and Makhuto Granites. The Nebo Granite constitutes the bulk of the acid phase of the Bushveld complex and is present as 2-3 km thick sheets of coarse-grained, pink granite. The Bobbejaankop Granites are predominantly red coloured, medium-grained rocks occurring in the upper part of the Nebo Granite. The Klipkloof Granites occur as irregular sills and dykes of pink to grey coloured, medium-grained granite within the Nebo and Bobejaankop Granites. The Makhuto Granite is the youngest of the various granite types and occurs as stocks and pipes of medium-grained, grey granite within the all of the other granite types (Cawthorn *et al*., 2006).

An isotopic age of 2054 ± 2 Ma has been obtained from the Nebo Granite (Walraven and Hattingh, 1993) and it is accordingly Palaeoproterozoic in age.

7.2.2 Palaeontological potential

The fact that the Lebowa Granite Suite consists entirely of medium- to coarse-grained, intrusive igneous rocks indicates nil potential for the presence of any palaeontological materials within the stratigraphic unit.

7.3 Vryheid Formation

7.3.1 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 3). 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 3).

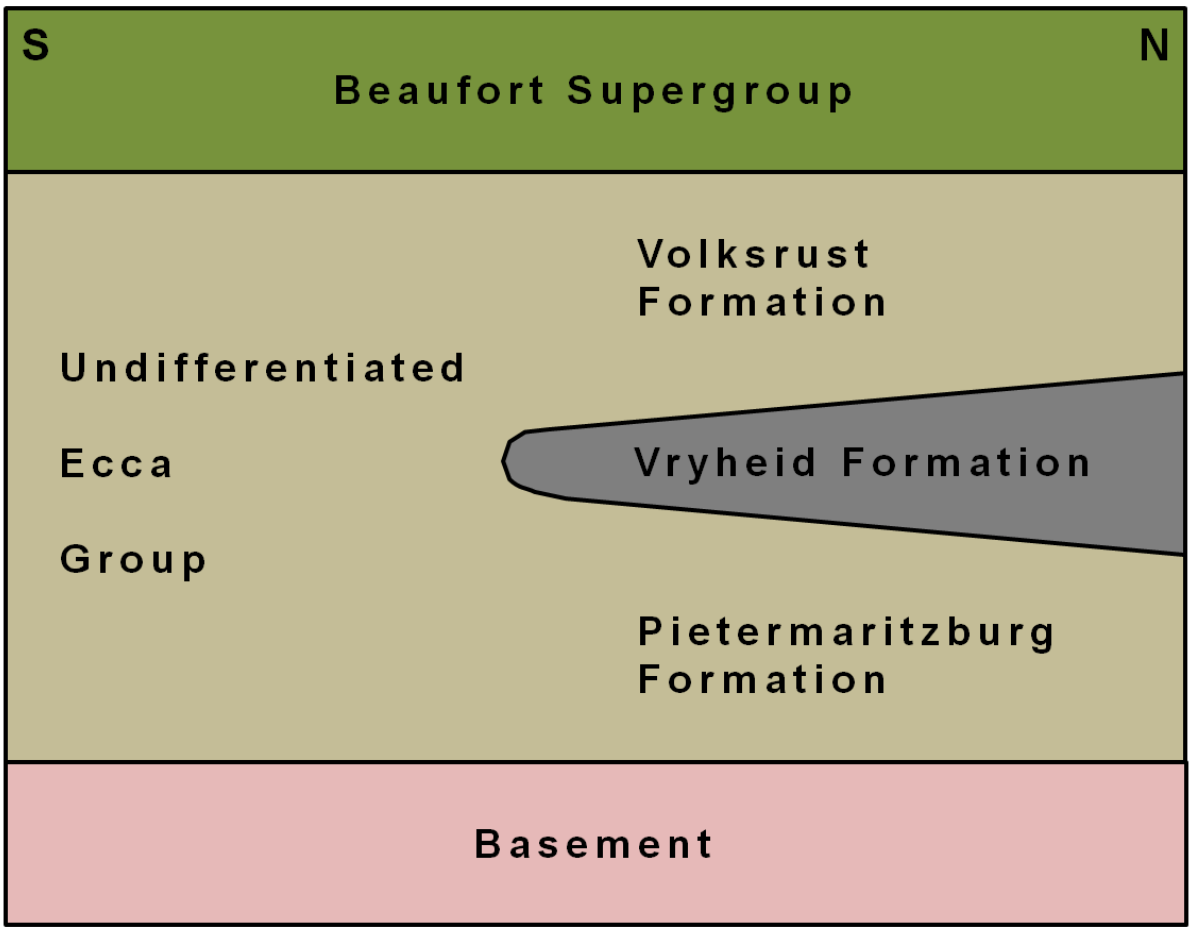

Figure 3: Schematic north-south oriented stratigraphic section of the Ecca Group in the north-east corner of the Karoo Basin. The Volksrust and Pietermaritzburg Formations can only be recognised when the Vryheid Formation forms part of the vertical sequence. In the north and north-western portions of 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.

7.3.2 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.

8 ENVIRONMENT OF THE PROPOSED PROJECT SITE

The project area is approximately 945 ha in extent. Topographically the area predominantly consists of a mildly undulating land surface dominated by the presence of a northwest-southeast oriented ephemeral drainage line traversing the central portion and southern-most portions of the study area as well as some minor drainage feature in the southern and north-western portions of the area (Figures 4 and 5). The drainage lines drain to the northwest and eventually join with the Steenkool Spruit.

Mucina and Rutherford (2006) indicate that the original vegetation cover of the project area consists of the Eastern Highveld Grassland veld type (Figure 6). The conservation status of all this veld type is listed as endangered by Mucina and Rutherford (2006).

The project area is almost completely utilised for agricultural cultivation (i.e., ploughed, Figure 4). The extensive utilisation of the land surface for agriculture suggests that little (if any) of the original Eastern Highveld Grassland veld type remains within the study area.

Figure 4: Google earth image of the project area (the red polygons). Evident from the image is that that the majority of the project area is flat to gently undulating. The entire area appears to be utilised for agriculture and the land surface disturbed by ploughing.

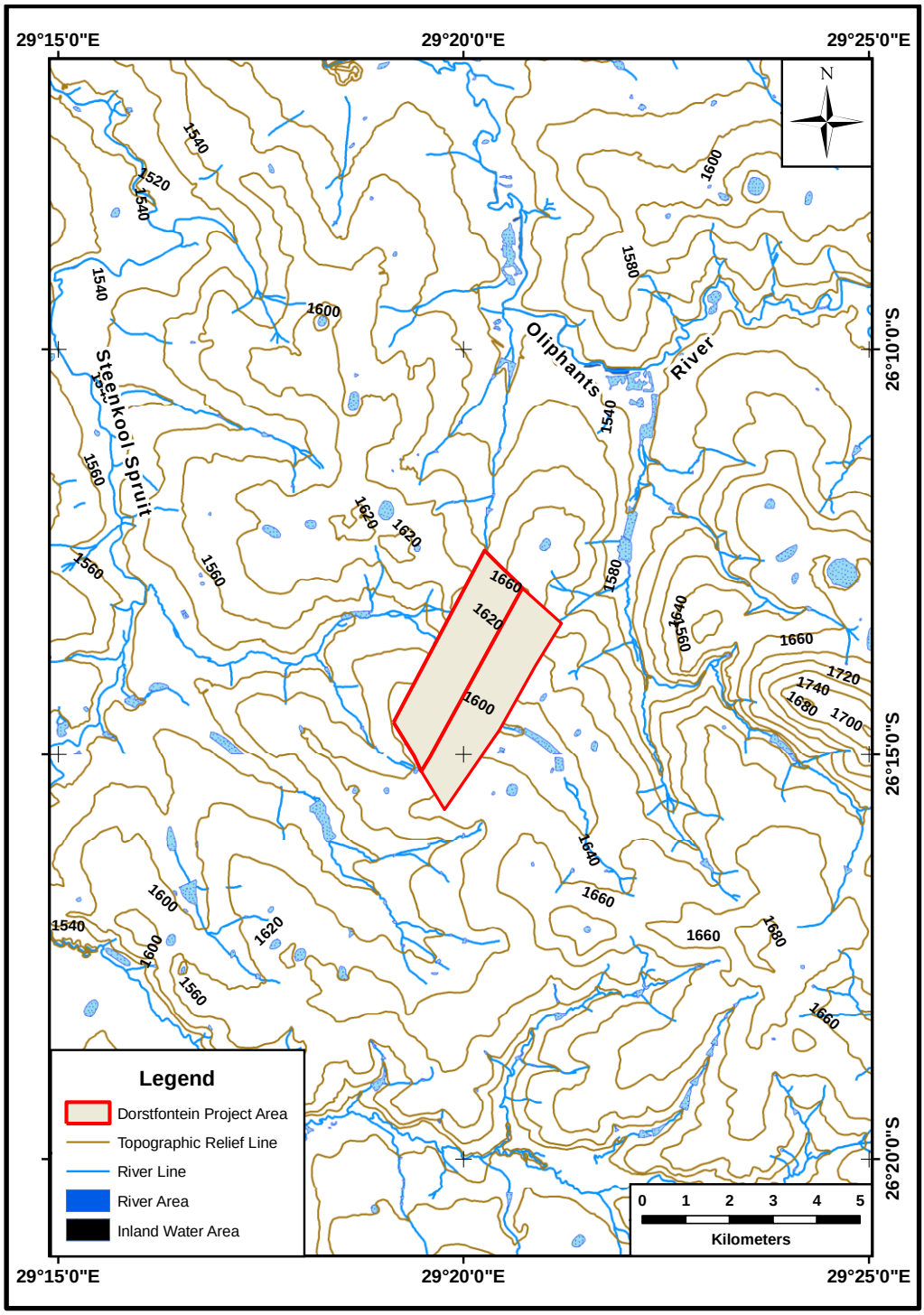

Figure 5: Map of the project area with topographic contours superimposed. It is evident that the project area consists predominantly of a gently undulating landscape. Located within the central, southern and north-western portions of the area are ephemeral drainage lines that collectively drain the area to the north-west where they eventually join with the Steenkool Spruit. The contour interval of the topographic contours is 20 m.

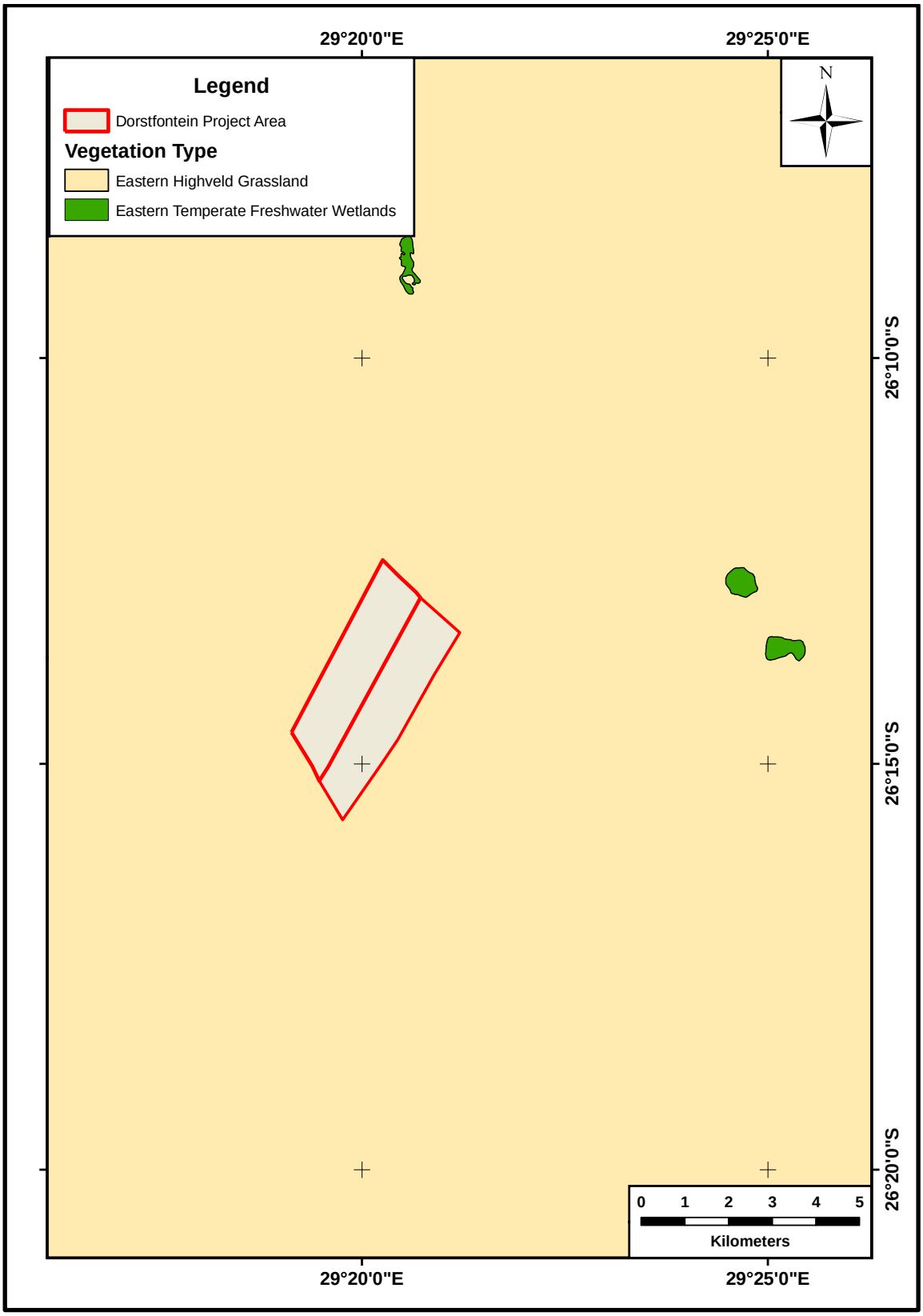

Figure 6: Map of the distribution of the vegetation veld types located within the project area and surrounding environs (after Mucina and Rutherford, 2006).

9 OVERVIEW OF SCOPE OF THE PROJECT

The proposed facility would have a generating capacity of approximately 500 MW. The main infrastructure includes:

Access roads (access from existing mine or R544 to be considered).

- Conveyor belts and coal handling areas.
- Power plant production unit/s (boilers / furnaces, turbines, generator and associated equipment, control room).
- Ash dumps.
- Water infrastructure such as Raw-Water Storage Dam, purification works and reservoirs.
- A substation.
- Pipeline for supply of water to the facility.
- Office and maintenance area/s.

It is expected that the generated power can be evacuated into the electricity grid via a new 400 kV transmission line to either Kriel or Matla power stations or the existing 400 kV power line traversing the site.

9.1 Technologies to be implimented

- The proposed power station will make use of Circulating Fluidised Bed (CFB) technology. It is anticipated that the use of this technology will facilitate the combustion of various grades of coal (including low-grade coal and coal discards) and biomass, thus, allowing for the utilisation of coal discard dumps at the nearby Dorstfontein East Mine and other mine sites. The CFB technology is ideally suited to the combustion of biomass as an auxiliary fuel, sourced from forest wastes in Mpumalanga.
- Cooling technology – Two options being considered in this regard include direct dry cooling using an air cooled condenser or indirect dry cooling utilising a traditional cooling tower.

The CFB process provides an ideal burning environment for a wide variety of fuels. The advantages of CFB technology can be summarized as follows:

- Fuel flexibility and multi-fuel firing,
- Low SO^2 emissions due to efficient sulphur capture with limestone in the furnace,
- Low NOx emission due to low combustion temperature and air-staging,
- Low CO and CxHy due to turbulent conditions and good mixing, – Secondary flue gas clean-up systems are typically not needed,
- Stable operating conditions and good turn-down ratio,
- Support firing is not needed except during start-up periods,

- Increased capacity possible within the same footprint as old boilers,
- No need for fuel preparation (e.g. pulverizing).
- Ability to fire biomass with no additional modifications

10 IMPACT ASSESSMENT

The potential impact of ISS Global Mining (Pty) Ltd's coal-fired power generation facility is categorised below according to the following criteria:-

10.1 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.

10.2 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 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 is, accordingly, categorised as **local** (i.e., restricted to the project site).

10.3 Duration of impact

The anticipated duration of the identified impact is assessed as potentially **permanent to long term**. 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 (i.e., long term).

10.4 Probability of impact

The sediments of the Vryheid Formation are noted for containing an important palaeontological heritage particularly in respect of plant macrofossils. However, the occurrence of fossils within the geological record is in general erratic and the chances of impacting a fossil at any particular point within the Vryheid Formation is **moderate**. It is evident from Figure 4 that the entire extent of the Vryheid Formation strata has been utilised for agricultural production (i.e., it has been extensively ploughed). Accordingly any fossil materials that may have been occurring at surface or within the shallow near-surface will have historically been either destroyed, damaged or moved (and their providence lost) as a result of the ploughing. Thus, the probability of negatively impacting upon scientifically useful fossils that may have located at the land surface or within the upper few tens of centimetres of the subsurface is now **negligible**.

The infrastructure elements required to construct this project (see Section 8 above) will generally only affect the upper few meters (1-2 m) of the land surface, although the construction of the raw-water dam and power plant may impact on the subsurface geology to a deeper levels, but no information is available to the author concerning the planned depth of excavation that will be required for these two features. Thus, over the majority of the project area the probability of negatively affecting any fossil materials will be restricted to the upper 1-2 m of the land surface. Given that only the upper-most 1-2 m of the geological unit that will be impacted over most of the projects extent, as well as the historical disruption of the land surface by ploughing the total probability of any negative impacts is assessed as **low**.

The Rooiberg Group and the Lebowa Granite Suite are composed of extrusive and intrusive igneous rocks respectively. The igneous origin of these lithological units precludes the possible presence of fossil materials. Similarly, sedimentary strata may be present within the Rooiberg Group, but their Palaeoproterozoic age precludes any fossiliferous potential. As such the probability of the proposed project causing any negative impact on the palaeontological heritage within these two units is **negligible**.

10.5 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 is accentuated by the fact that often plant macrofossils and trace fossils 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**.

No fossil materials are expected to occur within the strata of the Rooiberg Group or the Lebowa Granite Suite. The severity of any negative effects on the palaeontological heritage of these lithological units is accordingly categorised as being **nil**.

The scientific and cultural significance of fossil materials is underscored by the fact that 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 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.

The probability of a negative impact on the palaeontological heritage contained within the Vryheid Formation is categorised as moderate in general (due to the generally erratic and sparse occurrence of fossils within the geological record), but the fact that the fossils present within the formation are often present in dense accumulations. The significance of any negative impact posed by the project on the palaeontological heritage, due to any excavations required for construction of project infrastructure, is categorised as potentially high if appropriate mitigation procedures are not put into place. Despite this general situation the probability of a negative impact is reduced to being negligible in the

upper-most portions of the Vryheid Formation due to the impacts of the extensively ploughed nature of the land surface).

10.6 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 a long term benefit to the community in terms of the provision of electricity to an increasingly stressed national power grid. This positive benefit will continue throughout the life of the project. The probability of a negative impact on the palaeontological heritage of the project area has been categorised as ranging between moderate to negligible for the Vryheid Formation and negligible for the Rooiberg Group and the Lebowa Granite Suite.

The low likelihood of fossils 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 (particularly vertebrate forms) are known from only a single fossil and, thus, any fossil material is potentially highly significant. This potential significance is highlighted by the fact that the sediments of the Vryheid Formation may contain important or unique 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. As such, **although the likely hood 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 procedures. 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 uncover fossils materials that were hidden beneath the surface exposures and, as such, would have remained unknown to science. If the planned excavations are inspected, while they are occurring, with a view to identifying any possible palaeontological materials present the possibility would be generated of being able to study and excavate fossil materials that would otherwise be hidden to scientific study.

10.7 Status

Given the combination of factors discussed above, it is anticipated that as long as adequate mitigation processes are emplaced prior to commencement of the construction phase little to no negative effect on the palaeontological heritage of the area is

anticipated. As the proposed project would supply electricity to the stressed South African national power grid the project is determined as having a **positive status** herein.

11 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.

11.1 Mitigation

Given the nil possibility of any negative impact on the palaeontological heritage of the project area resulting from disruption of the non-fossiliferous rocks of the Rooiberg Group and the Lebowa Granite Suite the most significant impact mitigation process possible would be to restrict as much of the proposed construction as possible to the portions of the project area that are underlain by these two stratigraphic units (Figure 7).

The possibility exists of significant negative impact occurring to the fossil heritage of the Vryheid Formation resulting from excavations associated with the construction of several of the planned infrastructure elements. However inspection of Google earth imagery of the project area that the entire land surface underlain by the Vryheid Formation has been severely impacted by ploughing activities; with the result that any fossils that may have been present (and visible) will have been either destroyed, damaged or moved and their prominence lost. As such, little would be gained by a thorough field investigation of the final project area which is underlain by the Vryheid Formation by a palaeontologist prior to the commencement of construction. Accordingly, it is recommended that a close examination of all excavations be made while they are occurring. Should any fossil materials be identified, the excavations should be halted and SAHRA informed of the discovery (as per legislation outlined in Section 3.3 of this report).

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. Cleary, for this recommendation to be adequately complied with either a palaeontologist should be retained by the management of the project to periodically inspect all excavations as they are being performed or a responsible officer (e.g., the Environmental Officer) of the project management team should be trained to identify fossil types that may be expected to be encountered and be tasked with ensuring compliance with the relevant legislation.

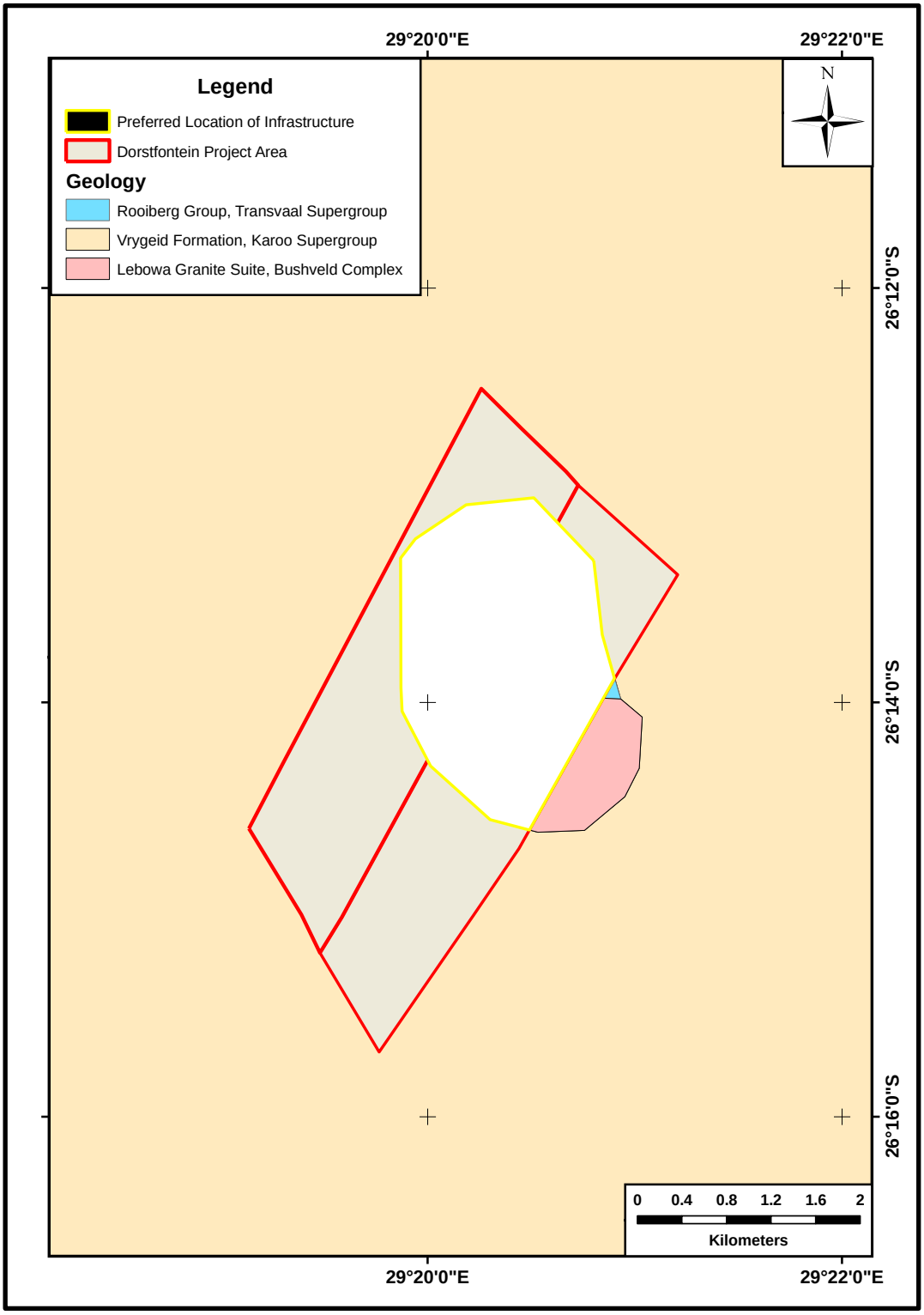

Figure 7: Map showing the aerial distribution of the geological units underlying the project area. Shown (yellow stippling) is the area completely underlain by unfossiliferous strata that constitutes the preferred location of as much project infrastructure as possible if the potential for negative impact on the palaeontological heritage of the area is to be minimised.

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.

11.2 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**.

11.3 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**.

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. However, any fossil material that may be contained within the strata underlying the project area is potentially of the high 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.

12 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 result of a site visit. In particular, the discussion of the geological units present 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 map 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.

13 ENVIRONMENTAL IMPACT STATEMENT

A desktop study has been conducted on the site of the proposed construction of a 500 MW coal-fired power station. This desktop study forms part of a Heritage Impact Assessment Report that is a component of a larger Scoping and Environmental Impact Assessment to identify and assess all potential environmental impacts associated with the proposed project for the area as identified, and propose appropriate mitigation measures in an Environmental Management Programme.

The project area, where the power generation infrastructure will be located, is relatively large (approximately 945 ha) in size. It is probable that the area that will be affected by the proposed project will be smaller than the total extent of the area reported upon herein; although the final extent of the project area is yet to be finalised. Additionally, any negative impacts to the palaeontological heritage of the region will be limited to the footprint area of the construction of the projects infrastructural elements that are constructed within the project area; the extent of any impact is accordingly characterised as local. It is anticipated, herein, that most infrastructural elements will only directly affect the surface of the site to a relatively shallow depth (1-2 m), although the maximum depth of the constructions is unknown at the time of compilation of this report.

The rocks of three geological units underlie the project area; these being the Lebowa Granite Suite, Rooiberg Group and the Vryheid Formation. The strata of the Rooiberg Group and the Lebowa Granite Suite are expected to be unfossiliferous due to a combination of their igneous rock types and early Precambrian age. Only the Vryheid Formation is potentially fossiliferous, but no fossil materials are known to occur within the unit within the environs of the project area.

It is fortuitous that the outcrops of the Lebowa Granite Suite and Rooiberg Group occur as a single, large coherent area within the northern half of the project area. Any construction associated with the proposed power station that occurs upon the outcrop extent of these units cannot have any impact upon the palaeontological heritage of the area. Accordingly, the most significant impact mitigation procedure available to the project would be to site as much of the project infrastructure as possible, if not all, upon these two geological units (Figure 7).

Of the geological units that underlie the project area only the Vryheid Formation is potentially fossiliferous. In general the potential for any negative impact on fossil materials contained within the unit is classified as moderate, but in the upper-most few tens of centimetres of the land surface the effects of ploughing have reduced this to being negligible.

Despite the moderate to negligible chances of any negative impact being caused by the project the fossils that may be anticipated to be present within these units are potentially highly significant to the cultural and scientific heritage of South Africa and the world. Any damage or loss of provenance (due to accidental relocation) that occurs to such fossil material during the excavation and construction phase of the project would be permanent and irreversible. Any fossil materials that remain undiscovered after the construction of the project and which are located beneath the maximum depth of the anticipated excavations will only be negatively affected in so far as they will be unavailable for scientific study for the life expectancy of the infrastructural elements that comprise the project.

The potential negative impact to the palaeontological heritage of the area can be minimised by the implementation of appropriate mitigation processes (see Section 13 below). A secondary advantage of the implementation of these mitigation measures would be that any fossil materials located 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 project have been classified as beneficial, herein, as the project aims to provide a renewable source of energy to the South Africa power grid. The power generation capacity of South Africa is presently under significant pressure. As such **this desktop study has not identified any palaeontological reason to prejudice the progression of this project, subject to the mitigation recommendations listed below being put in place**.

14 RECOMMENDATIONS

The following recommendations are made to ensure that any potential negative impacts resulting from the proposed project upon the palaeontological heritage of the area are minimised.

- That as much of the project infrastructure as possible is located within the area indicated in Figure 7. This area is completely underlain by unfossiliferous strata and, as such, no negative impact on the palaeontological heritage of the region is anticipated.
- Should it be necessary to locate infrastructure elements upon the outcrop of the Vryheid Formation it would be preferable if only those elements that would only directly impact upon the portion of the land surface that has been affected by ploughing are constructed there.
- Should any excavations be undertaken on parts of the project area that are underlain by strata of the Vryheid Formation that regular inspections be made of those excavations to ensure that no fossil materials are being impacted.

- That the anticipated regular inspections of any excavations anticipated in the previous point should be undertaken either by a palaeontologist or an individual (e.g., the project environmental officer) who has been trained to recognise the types of fossils that may be expected to be present.
- Should any fossil materials be identified in the afore mentioned excavations the excavations must be halted (see Section 3.3 herein) until such time as their significance has been assessed by a palaeontologist. SAHRA must be notified of the fossil finds.
- Should scientifically or culturally significant fossil material exist within the project area and be identified in any excavations any negative impact upon it would be mitigated by its excavation (under permit from SAHRA) by a palaeontologist and the resultant material being lodged with an appropriately permitted institution.

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