FULL PALAEONTOLOGICAL HERITAGE IMPACT ASSESSMENT REPORT IN RESPECT OF A COAL MINE (KRANSPAN COLLIERY) PROPOSED TO BE LOCATED ON THE FARM KRANSPAN 49 IT, APPROXIMATELY 12.5 KM SOUTH-WEST OF CAROLINA, MPUMALANGA PROVINCE

26 January 2019

Prepared for:
Heritage Contracts and Archaeological Consulting CC

On behalf of:
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On Behalf of:

Ilima Coal Company (Pty) Ltd

Prepared By:

Dr B.D. Millsteed

INDEMNITY AND CONDITIONS RELATING TO THIS REPORT

The findings, results, observations, conclusions and recommendations given in this report are based on the author's best scientific and professional knowledge as well as available information. The report is based on survey and assessment techniques which are limited by time and budgetary constraints relevant to the type and level of investigation undertaken. BM Geological Services reserves the right to modify aspects of the report including the recommendations if, and when, new information becomes available from ongoing research or further work in this field or pertaining to this investigation.

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REPORT OUTLINE

Appendix 6 of the GNR 326 EIA regulations published on 7 April 2017 provides the requirements for specialist reports undertaken as part of the environmental authorisation process. In line with this, Table 1 provides an overview of Appendix 6 together with information on how these requirements have been met.

Table 1: Specialist report requirements.

Requirement from Appendix 6 of GN 326 EIA Regulation 2017	Chapter
(a) Details of - (i) the specialist who prepared the report; and (ii) the expertise of that specialist to compile a specialist report including a curriculum vitae	Section 5
(b) Declaration that the specialist is independent in a form as may be specified by the competent authority	Section 6
(c) Indication of the scope of, and the purpose for which, the report was prepared	Section1 and 2
(cA) an indication of the quality and age of base data used for the specialist report	
(cB) a description of existing impacts on the site, cumulative impacts of the proposed development and levels of acceptable change;	Section 9
(d) Duration, date and season of the site investigation and the relevance of the season to the outcome of the assessment	
(e) Description of the methodology adopted in preparing the report or carrying out the specialised process inclusive of equipment and modelling used	Sections 2 and 4
(f) details of an assessment of the specific identified sensitivity of the site related to the proposed activity or activities and its associated structures and infrastructure, inclusive of a site plan identifying site alternatives	Section 10
(g) Identification of any areas to be avoided, including buffers	
(h) Map superimposing the activity including the associated structures and infrastructure on the environmental sensitivities of the site including areas to be avoided, including buffers	
(I) Description of any assumptions made and any uncertainties or gaps in knowledge	Section 13
(j) a description of the findings and potential implications of such findings on the impact of the proposed activity including identified alternatives on the environment or activities;	Section 11
(k) Mitigation measures for inclusion in the EMPr	Section 12.1
(I) Conditions for inclusion in the environmental authorisation	
(m) Monitoring requirements for inclusion in the EMPr or environmental authorisation	Section 12.1
(n) Reasoned opinion - (i) as to whether the proposed activity, activities or portions thereof should be authorised; (iA) regarding the acceptability of the proposed activity or activities; and (ii) if the opinion is that the proposed activity, activities or portions thereof should be authorised, any avoidance, management and mitigation measures that should be included in the EMPr, and where applicable, the closure plan	Section 15

Requirement from Appendix 6 of GN 326 EIA Regulation 2017	Chapter
(o) Description of any consultation process that was undertaken during the course of preparing the specialist report	
(p) A summary and copies of any comments received during any consultation process and where applicable all responses thereto; and	
(q) Any other information requested by the competent authority	

EXECUTIVE SUMMARY

Ilima Coal Company (Pty) Ltd has applied for a Mining Right to mine for coal on Portions 1, 2, 3, 4, 5, 6, 7, 8 and the Remaining Extent of the farm Kranspan 49 IT. The site is located 13 km south-west of Carolina and 10.5 km north-east of Breyton, in the Carolina Magisterial Districts, Gert Sibande District Municipality and Albert Luthuli Local Municipality, Mpumalanga Province. The R36 Road (running between Carolina and Breyton) traverses the eastern portion of the project area. The Mining Right area can be located within the confines of 1:50 000 topographic maps 2629BB and 2630AA. The aerial extent of the Mining Right application area is 3,383.42 ha. The expected life-of-mine for the project is 14 years.

Ilima Coal Company (Pty) Ltd has appointed Heritage Contracts and Archaeological Consulting CC, as independent consultants, to conduct the Heritage Impact Assessment component of the reporting process for this coal mining project. Heritage Contracts and Archaeological Consulting CC has retained 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 aerial extent of the Mining Right application area is underlain by an assemblage of stratigraphic units consisting of coal-bearing sediments of the Vryheid Formation and intrusive dolerite of the Karoo Dolerite Suite. These bedrock units are overlain in part by a Cainozoic ferricrete layer that appears to be present upon the topographically higher areas within the project area. Lying upon the ferricrete and, in the topographically lower areas upon the Vryheid Formation strata is by a pervasive layer of unconsolidated Cainozoic regolith.

Due to the methodologies employed in the opencast mining process and also the extreme costs of mining no negative impact upon the geological sequence will be expected to occur below the base of Seam E in the opencast voids as the mining will not extend deeper than that. Within the underground mining operations, the negative impacts upon the geology will be predominantly constrained to occurring within Seam E. Coal seams occur at depths between 5–75 m. The coal seams are relatively flat lying, but the depth of burial tends to increase towards the centre of the application area due to increasing topographic height of the land surface. Any negative impacts will be constrained to the Vryheid Formation and the overlaying geological units.

The required mine infrastructure, other than opencast voids and the underground mining operations will all be located on the land surface. Excavations required for all mine infrastructure, not inclusive of the underground mining operations, the opencast pits or the ventilation shaft infrastructure will result in an impact upon the underlying geology. It is assumed that the maximum depth of the negative impact they will cause upon the underlying geology will be < 2 m.

The rocks comprising the Karoo Dolerite Suite are unfossiliferous. It is also interpreted, herein, that the interpreted Cainozoic unconsolidated regolith and the Cainozoic ferricrete are unfossiliferous. Any impacts upon the rocks comprising these units caused by the progression of the mining operations will have a negligible to nil probability of resulting in a negative impact upon their palaeontological heritage. The sediments of the Vryheid Formation are known to contain plant macrofossil assemblages of the *Glossopteris* flora as well as trace fossil assemblages. The significance of the fossil assemblages contained in the Vryheid Formation is assessed as high, but the probability of any negative impact is moderate to good.

It is evident that the proposed mining operations pose a risk of negatively impacting upon scientifically highly significant fossil assemblages and damage mitigation protocols are required. Accordingly, it is recommended that:

During the construction phase of the mine:

- When the surface infrastructure elements of the mine are being constructed these locations must be regularly inspected to observe if the excavations have encountered bedrock of the Vryheid Formation.
- These regular inspections should be made by a suitable mine employee (such as the environmental officer) who has been trained to identify the types of fossils that may reasonably be expected to occur within the Vryheid Formation.
- Should fossil materials be identified, the excavations must be halted in that area and SAHRA informed of the discovery (as required in Section 3.3 above).
- An experienced Karoo palaeontologist should be contacted by the mine to assess the significance of the fossils.
- If fossil materials prove to be scientifically significant the palaeontologist should make recommendations that they should be either be protected completely *in situ* or could have damage mitigation procedures emplaced (i.e., excavation by a suitability by a suitably experienced palaeontologist) to minimise negative impacts.

Once excavation of the opencast pit voids begins:

- On-site checks for the occurrence of any fossils of the excavated pits and stockpiled material should be conducted biannually (i.e., every six months).
- The frequency of these checks should be reassessed after twelve (12) months based on the findings.
- The Karoo palaeobotanist should submit a monitoring report to SAHRA on this work.

In addition,

- Should any fossil materials be identified, the palaeontologist should ascertain their scientific and cultural importance.

- Should the fossil prove scientifically or culturally significant the particular excavations involved should be halted and SAHRA informed of the discovery (as required in Section 3.3 above).
- Should scientifically or culturally significant fossil material exist within the project areas 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.

When the underground mining component of the mining program commences no damage mitigation protocols are recommended. The coals comprising Seam E are the product of a complex series of jellification and other coalification processes that transformed the original vegetation (peat) into coal. Recognisable plant macrofossil materials are not expected to be present within the coals. Such plant macrofossil materials may be present within any siliciclastic partings within the seam. However, the automatic mining machinery will destroy any such fossils before they can be recognised as being present. Similarly, modern industrial health and safety rules would make it extremely difficult for a palaeontologist to be able to access and work at a working mine face.

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.

The considered opinion resulting from this Full Heritage Impact Assessment Study is that this study has not identified any palaeontological reason to prejudice the progression of this project subject to the recommended mitigation protocols outlined above being instituted.

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1 INTRODUCTION

Ilima Coal Company (Pty) Ltd has applied for a Mining Right to mine for coal on Portions 1, 2, 3, 4, 5, 6, 7, 8 and the Remaining Extent of the farm Kranspan 49 IT. The site is located 13 km south-west of Carolina and 10.5 km north-east of Breyton, in the Carolina Magisterial Districts, Gert Sibande District Municipality and Albert Luthuli Local Municipality, Mpumalanga Province (Figure 1). The R36 Road (running between Carolina and Breyton) traverses the eastern portion of the project area. The location of the various farm portions as well as the GPS co-ordinates of the projects corner points are provided in Figure 2. The Mining Right area can be located within the confines of 1:50 000 topographic maps 2629BB and 2630AA. The aerial extent of the Mining Right application area is 3,383.42 ha. The expected life-of-mine for the project is 14 years.

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2 TERMS OF REFERENCE AND SCOPE OF THE STUDY

The terms of reference for this study are 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.

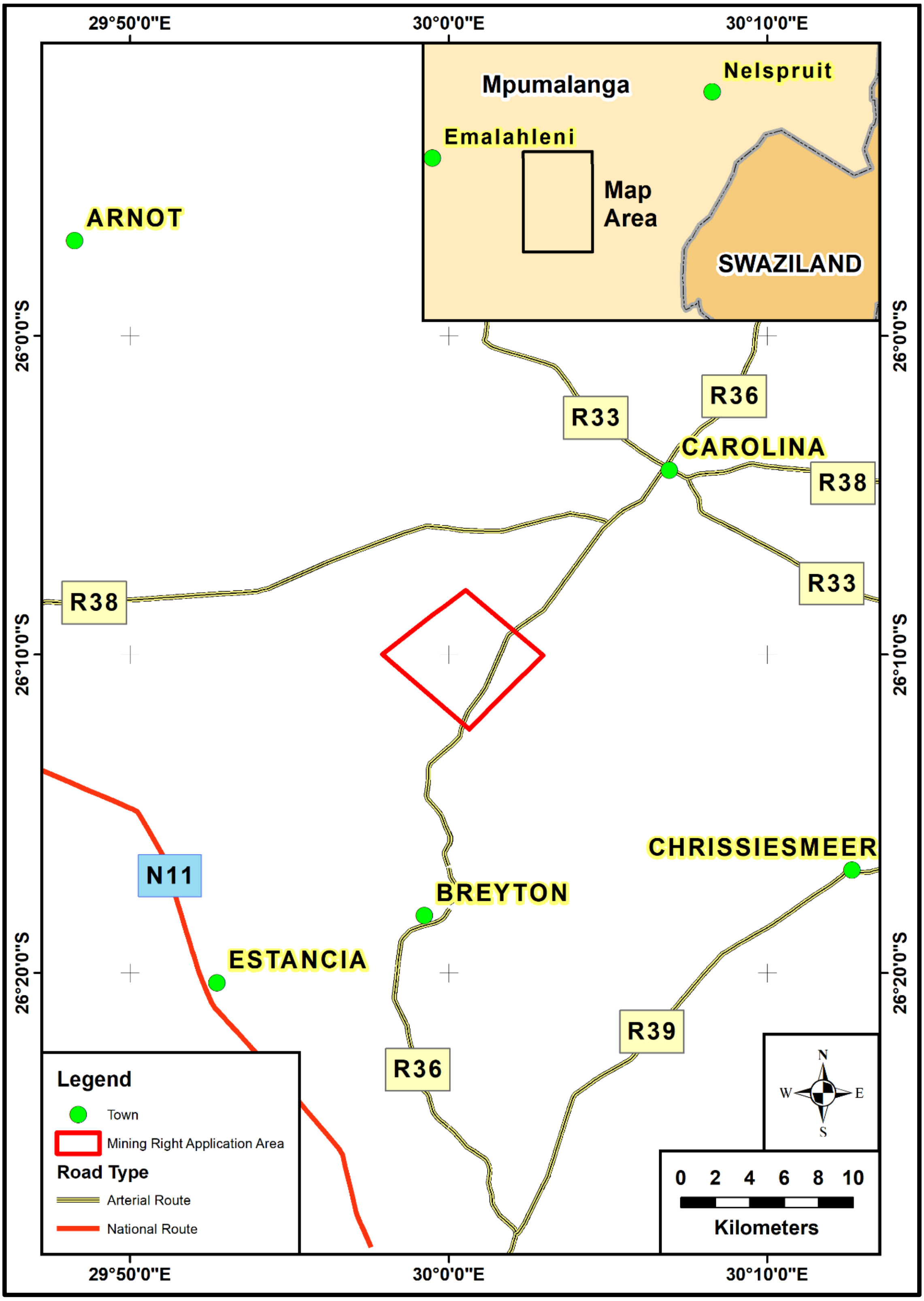
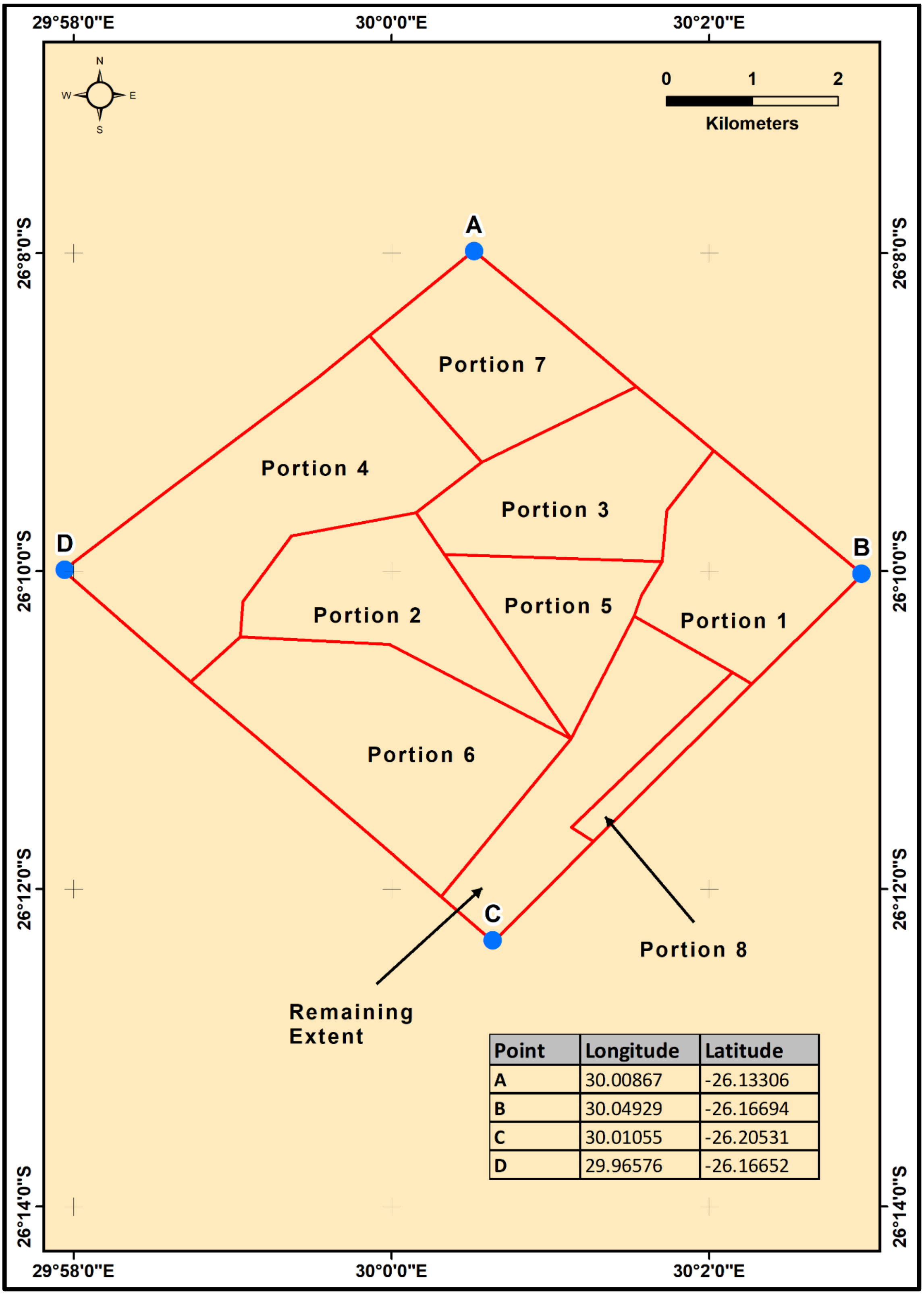


Figure 1: The location of the Mining Right application area.



Point	Longitude	Latitude
A	30.00867	-26.13306
B	30.04929	-26.16694
C	30.01055	-26.20531
D	29.96576	-26.16652

Figure 2: Map showing the location of the various portions of the farm Kranspan 49 IT that collectively form the Mining Right application area. The co-ordinates of the corner points are provided in decimal degrees and geographic projection.

3 LEGISLATIVE REQUIREMENTS

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

3.1 The National Heritage Resources Act

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

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

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

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

3.2 Need for Impact Assessment Reports

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

- The construction of a linear development (road, wall, power line, canal etc.) exceeding 300 m in length.

- The construction of a bridge or similar structure exceeding 50 m in length.
- Any development or other activity that will change the character of a site and exceed 5 000 m^2 or involve three or more existing erven or subdivisions thereof.
- Re-zoning of a site exceeding 10 000 m^2.
- Any other category provided for in the regulations of SAHRA or a provincial heritage authority.

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

3.3 Legislation Specifically Pertinent to Palaeontology*

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

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

- Destroy, damage, excavate, alter, deface or otherwise disturb any archaeological or palaeontological site or any meteorite.
- Destroy, damage, excavate, remove from its original position, collect or own any archaeological or palaeontological material or object or any meteorite.
- Trade in, sell for private gain, export or attempt to export from the Republic any category of archaeological or palaeontological material or object, or any meteorite; or
- Bring onto or use at an archaeological or palaeontological site any excavation equipment or any equipment that assists in the detection or recovery of metals or archaeological and palaeontological material or objects, or use such equipment for the recovery of meteorites.
- Alter or demolish any structure or part of a structure which is older than 60 years as protected.

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

Further to the above point, Section 35(3) of this Act indicates that "any person who discovers archaeological or palaeontological objects or material or a meteorite in the course of development or agricultural activity must immediately report the find to the responsible heritage resources authority, or to the nearest local authority offices or museum, which must immediately notify such heritage resources authority". Thus, regardless of the granting of any official clearance to proceed with any development based on an earlier assessment of its impact on the Palaeontological Heritage of an area, the development should be halted and the relevant authorities informed should fossil objects be uncovered during the progress of the development.

3.4 The National Environmental Management Act [as amended]

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

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

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

4 METHODOLOGY

A site visit was conducted by Dr Millsteed between 17-18/01/2019. Photographs were taken and observations made at a number of locations (see data waypoint locations in Figures 3-6). The location of the photographs and observation points was recorded using a hand-held GPS. The majority of the survey field work [two separate traverses labelled 17 Jan 2019 and 18 Jan 2019 (A) in Figures 3-6] were conducted by foot traverse, and one traverse [labelled 18 Jan 2019 (B)] was conducted at very slow speed by car, following the eastern margins of the R36 road. The paths of the traverses were recorded as trackways on a hand-held GPS and are indicated in Figures 3-6. Given budgetary constraints as well as the considerable aerial extent of the proposed development it was impossible to visit every bedrock exposure within the project site within an acceptable timeframe. It is pertinent to accept that the field of view of the land surface available to Dr Millsteed was much larger than is indicated by the narrow trackway depicted in Figures 3-6. Figure 7 shows the trackways of the various traverses performed overlain against the planned location of mine infrastructure and the location of areas of the Mine Right application area that either are, or have recently been, under cultivation (interpreted from Google earth imagery). It is considered evident that the area covered by the various traverses provides an adequate coverage of the area to be impacted by the proposed mining activities as well as those areas where surface observation is appropriate (i.e., those areas not under cultivation) to support the validity of the observations made and the considered opinion resulting from this study.

During the conduct of the traverses, outlined above, particular emphasis was placed on looking for bedrock outcrops or other geological units that may be potentially fossiliferous. Considerable extents of the Mining Right area are currently under cultivation for crops, or have been in the recent past (Figures 8-10). It was considered appropriate not to investigate these cultivated areas or include them in the paths of the traverses. This decision was based on the realisation that these areas have been extensively ploughed. Thus, any fossil materials that may have been present at surface will have been destroyed, damaged or moved and their original context lost resulting in the loss of any scientific value. Similarly, should any bedrock outcrops that may have been present within the fields would have been extremely difficult to locate within the dense vegetation and searching for them would not have been a productive use of time. This position is further supported by the reality that the crops are being cultivated where they are due to the pervasive presence of thick regolith cover. The presence of this regolith cover makes it further unlikely that there would be significant quantities of bedrock outcrop present.

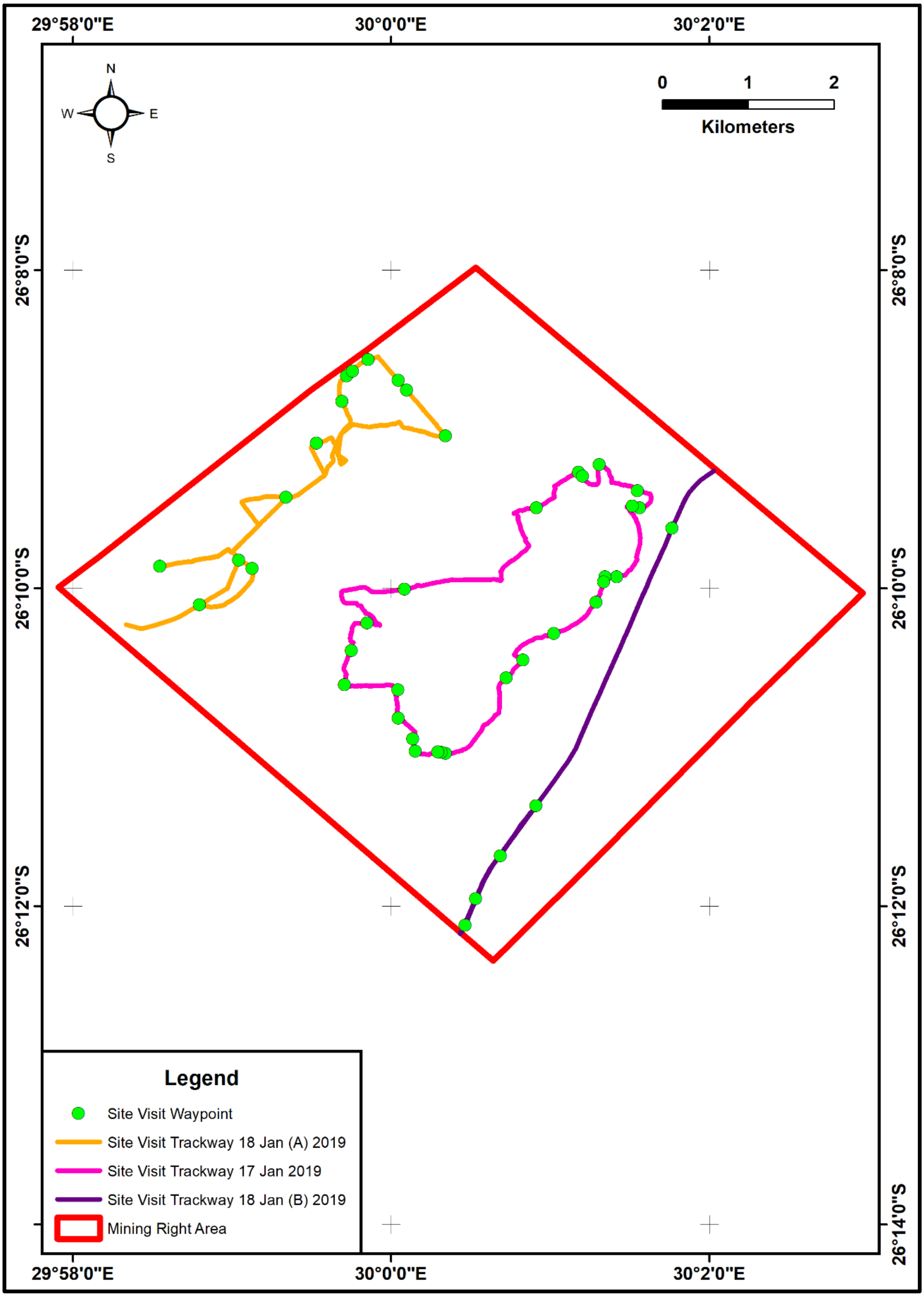


Figure 3: Map showing the location of the three GPS trackways collected during the site visit as well as the waypoints at which detailed observations and/or photographs were taken.

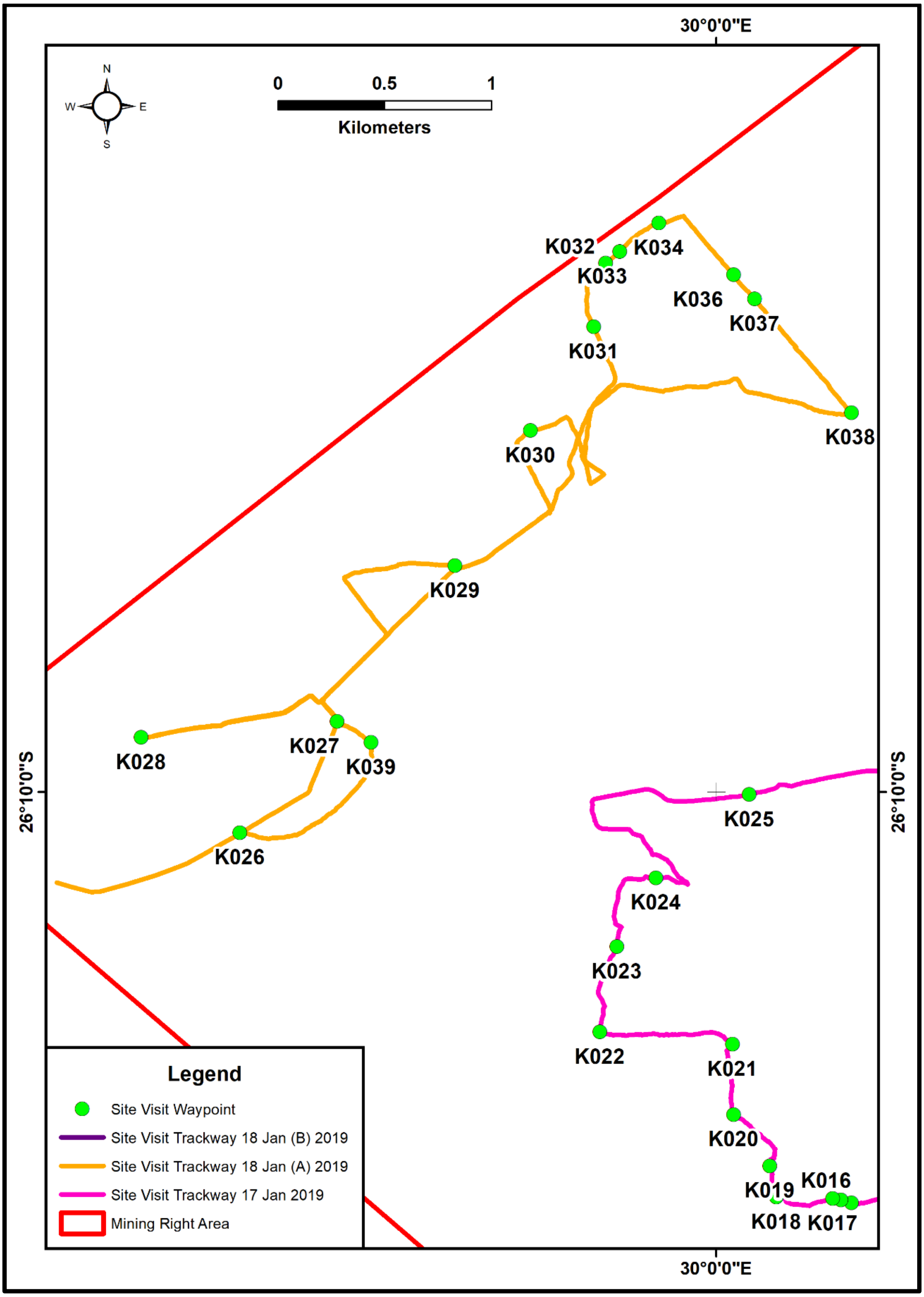


Figure 4: Close up view of the portion of the Mining Right application area showing the location of the trackway 18 Jan (A) 2019 with labelled waypoints.

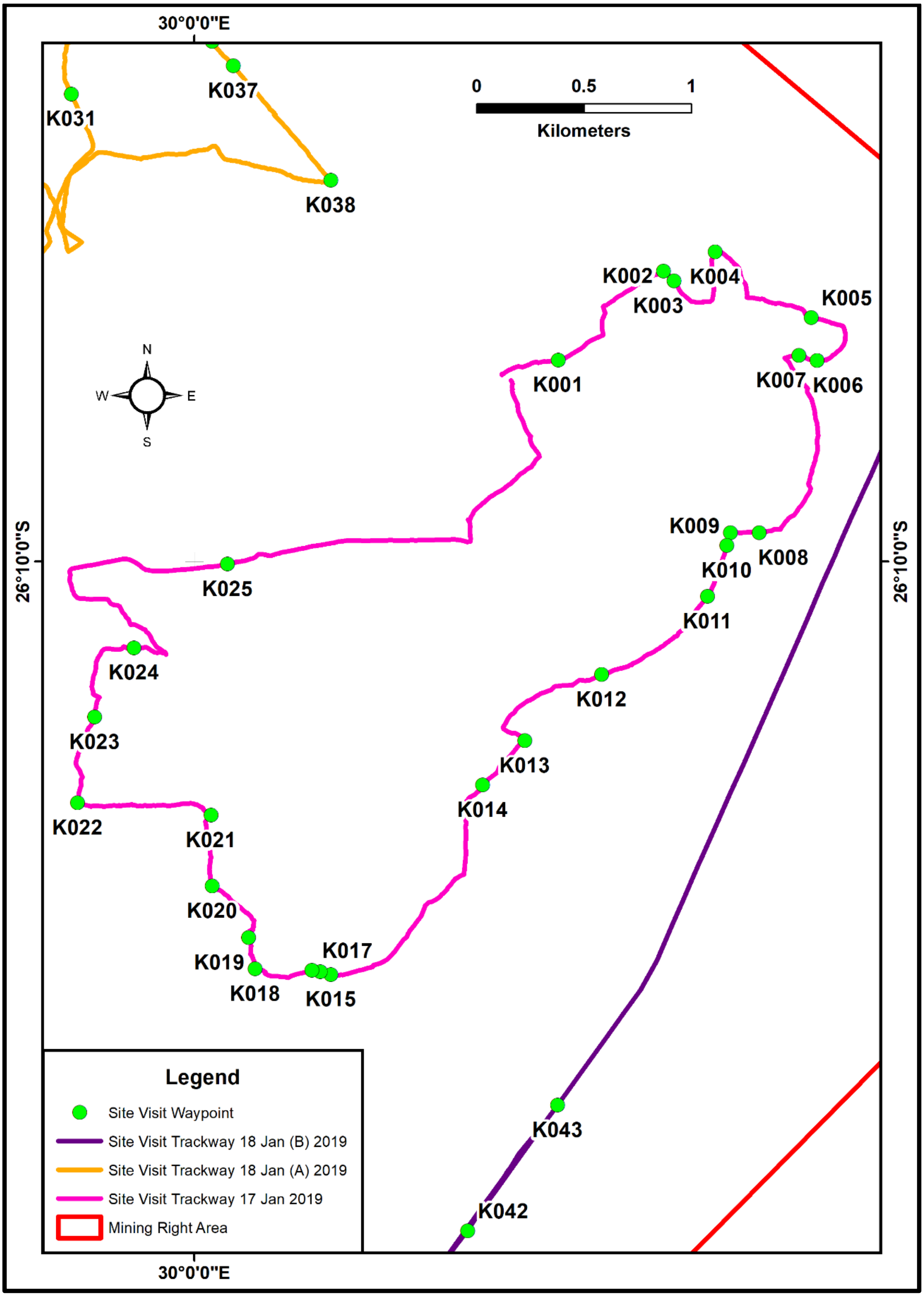


Figure 5: Close up view of the portion of the Mining Right application area showing the location of the trackway 17 Jan 2019 with labelled waypoints.

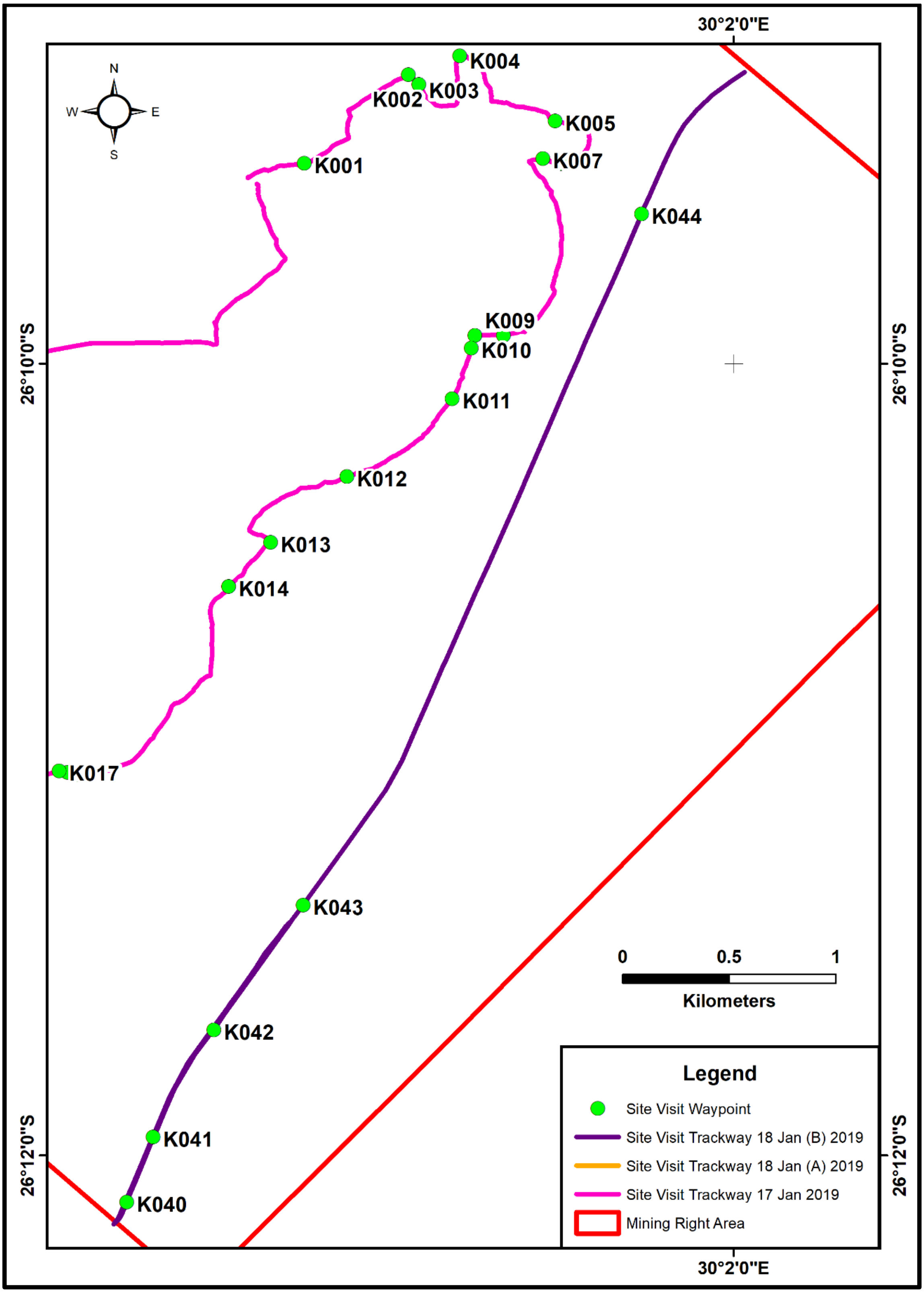


Figure 6: Close up view of the portion of the Mining Right application area showing the location of the trackway 18 Jan (B) 2019 with labelled waypoints.

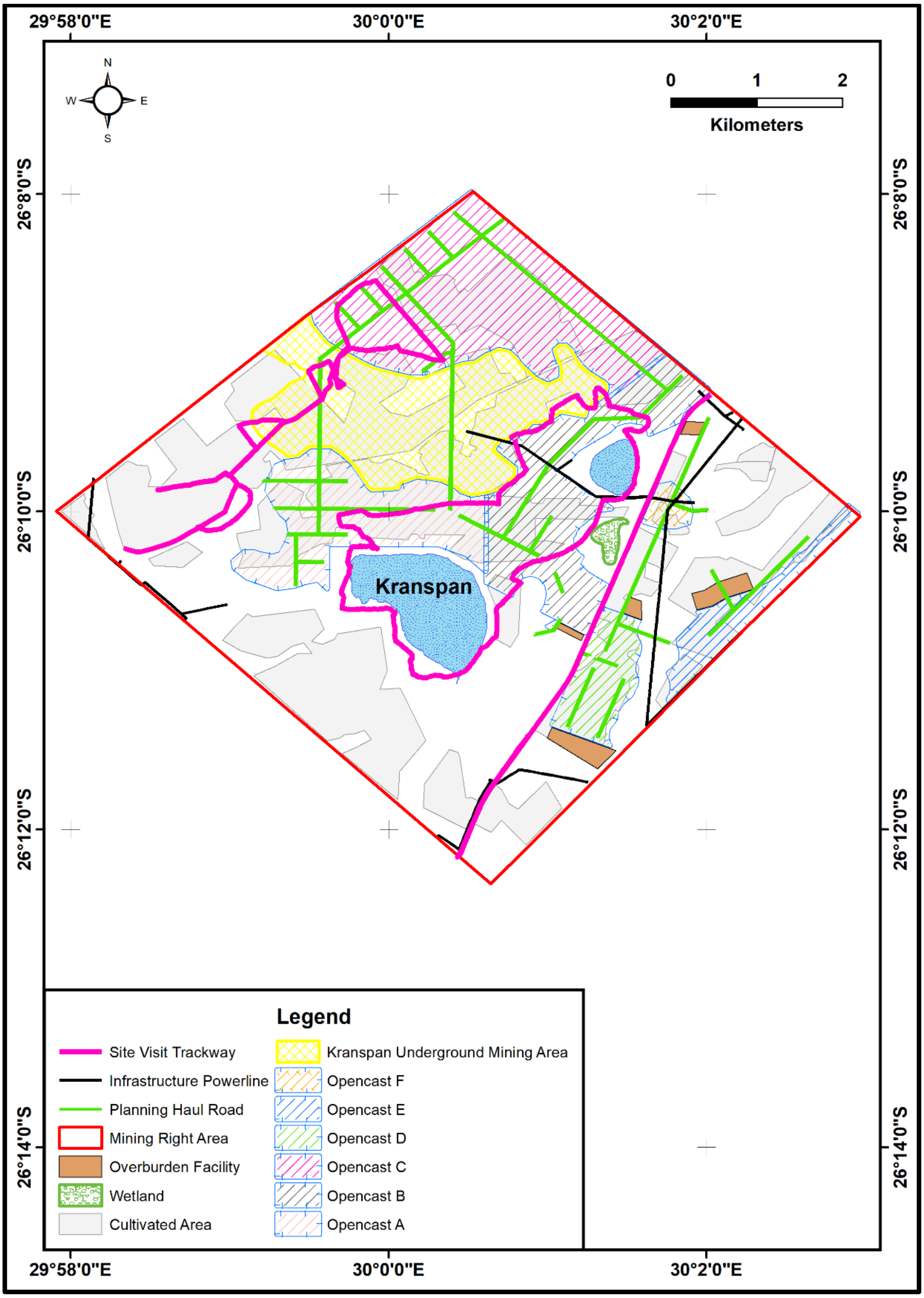


Figure 7: Map showing the three trackways representing the path along which observations were made during the site visit. The trackways are overlain against the location of proposed mine infrastructure elements as well as areas that have or are being cultivated (as interpreted from Google earth). It is evident that all proposed infrastructure located to the east of eastern-most trackway will be located upon cultivated areas.

Figure 8: View of maize field towards 310^{o} (waypoint K026, see Figure 4).

Figure 9: View of previously cultivated maize field view towards 280^{o} (waypoint K014, see Figure 5). Remnant small maize plants are in the foreground and Kranspan is in the background.

Figure 10: View of cultivated field of a leguminous-type crop, view towards 060^o (waypoint K027, see Figure 4).

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; Reg. No. 400332/07), is a member of the Palaeontological Society of South African and the Association of Australasian Palaeontologists and is also a Fellow of the Geological Society of South Africa.

6 INDEPENDENCE

Dr Millsteed was contracted as an independent consultant to conduct this full 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 Ilima Coal Company (Pty) Ltd, the proposed mining operations, nor any companies or individuals associated with the coal mining project.

7 ACCESS

Access was made freely available to all portions of the study area by Ilima Coal Company (Pty) Ltd and the field visit was potentially able to be conducted wherever it was deemed necessary for the satisfactory completion of the study. The land surface is gently undulating and accessible, accordingly there were no areas that could not be easily visited and studied.

Dr Millsteed was unable to gain access to Portion 7 of the farm Kranspan 49 IT at the time of the site visit. However, the inability to access Portion 7 is not considered to negatively impact upon the findings of this report as Portion 7 forms a reasonably small proportion of the total aerial extent of the Mining Right application area and a large proportion of the farm portion is under cultivation for crops (see discussion in Section 4 above). The southern half of Portion 7 was able to be observed from the shared border with Portion 4 and it was evident that those areas of Portion 7 that were not under cultivation bear a grassland vegetation cover and associated landforms identical to those observed elsewhere within the study area and it could reasonably be expected that the fossiliferous potential of the grasslands of Portion 7 are the same as that of the grasslands located elsewhere in the Mining Right application area.

8 GEOLOGY AND FOSSIL POTENTIAL

The Mining Right application area is almost completely underlain by Early Permian siliciclastic sedimentary rocks of the Vryheid Formation and these rocks in part crop out forming the land surface (Figure 11). A narrow dolerite dyke is located close to the southwestern margin of the project area [as indicated from data provided by Ilima Coal Company (Pty) Ltd]. The remainder of the land surface is alternatively composed of Cainozoic ferricrete or unconsolidated Cainozoic regolith. A brief description of the geology of the Mining Right application area and the palaeontological potential of those geological units is provided below.

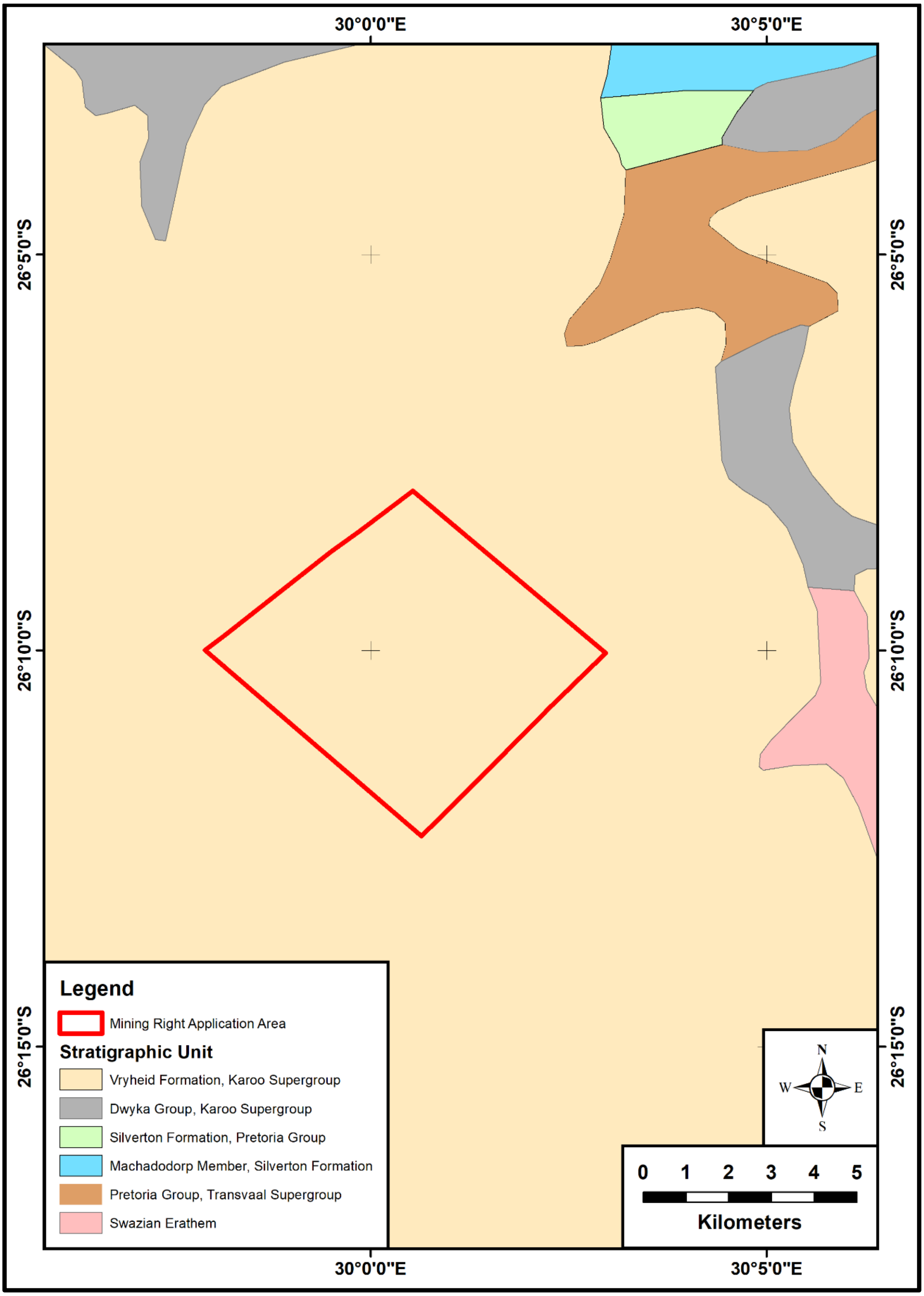


Figure 11: Map of the bed rock geology of the Mining Right application area and its surrounding environs.

8.1 Vryheid Formation

8.1.1 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 Volksrust and underlying Pietermaritzburg Formations; both of which are both are predominantly argillaceous (Figure 12). 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 12).

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.

In the project area almost the only unit of the Vryheid Formation that crops out is what appears to be a single, buff to white, sandstone unit at least 2 m thick. Scattered outcrops of this unit occur throughout the project area (e.g., waypoints K002, K006, K007, K009, K015, K021, K024, K033, K039, see Figures 4-6). The primary outcrops of the sandstone are located around the margins of the pans occurring within the project area where they form thin, elongate krans's (Figure 13). The unit consists of stacked sequences of thick bedded (up to 70 cm thick) sandstone that vary between planar thin bedded, tabular cross bedded or massive beds (Figures 14 and 15). At several locations (waypoints K010, K017 and K021) the sandstone contains numerous hollow, spherical concretions lined with thick (up to several centimetre thick) iron-stained zones. The concretions vary from being golf ball to softball in size (Figures 16 and 17).

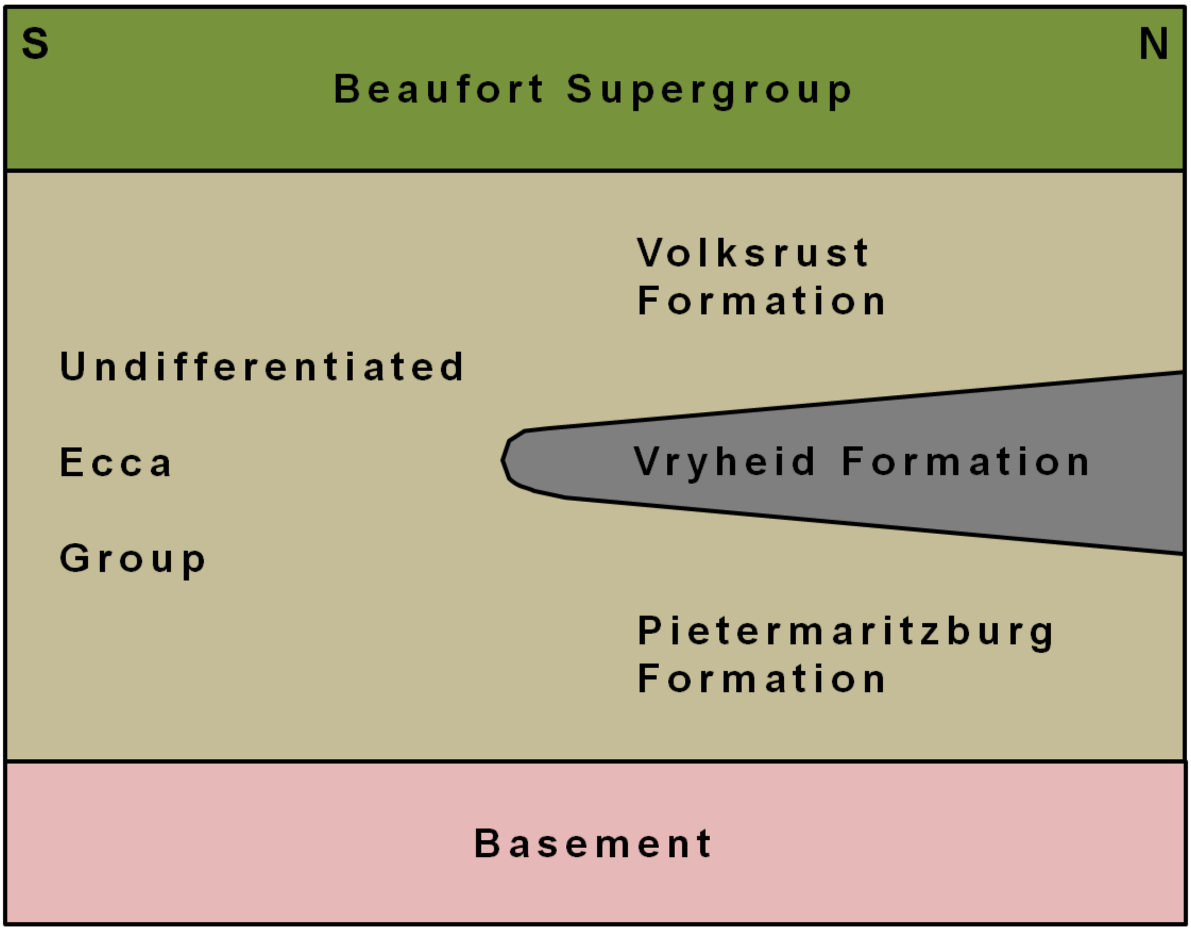


Figure 12: Schematic north-south oriented stratigraphic section of the Ecca Group in the north-east corner of the Karoo Basin. The Volksrust and Pietermaritzburg Formations can only be recognised when the Vryheid Formation forms part of the vertical sequence. In the north and north-western portions of the basin the Pietermaritzburg Formation was not deposited and the coal-bearing strata of the Vryheid Formation rest directly upon the basement.

The author has observed identical concretions in the Molteno Formation in KwaZulu-Natal. Where they were observed in the Molteno Formation, they were rarely infilled with sulphide mineralisation. The hollow examples result from the removal of the sulphides via weathering.

At one locality stratigraphically above the thick krans-forming sandstone in the region, and located upon the flanks of the highest hill in the region is an area of maroon, fine- to medium-grained, indurated sandstones. The rocks are extensively jointed, and the margins of the joints are more heavily indurated than the remainder of the rock (Figure 18).

Figure 13: View of prominent sandstone krans located along the northern margin of Kranspan, view towards 035° (waypoint K023, see Figure 5).

Figure 14: Close-up view of thick bedded sandstones that comprise the sandstone krans along the northern margin of a pan at waypoint K007 (see Figure 5). The krans is ± 2 m high.

Figure 15: Tabular cross-bedded Vryheid Formation sandstone (waypoint K022, see Figure 5).

Figure 16: Hollow concretions with iron-enriched mantles within the Vryheid Formation sandstone (waypoint K010, see Figure 5).

Figure 17: Golf ball sized hollow concretions with iron-enriched mantles within the Vryheid Formation sandstone (waypoint K016, see Figure 5).

Figure 18: Fine- to medium-grained, maroon coloured sandstones lying stratigraphically higher in the sequence than the main, buff coloured sandstone that forms the prominent krans's in the region. The unit is extensively jointed and the margins of the joints are more heavily indurated than the remainder of the rock

8.1.2 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 Drs 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.

No fossil materials were identified within the Vryheid Formation sandstone outcrops located within the study area. However, the possibility that the formation contains fossils remains (particularly in the subsurface non-outcropping units). The possibility exists, therefore, that fossils, particularly those of the *Glossopteris* flora may be present within the project area.

8.2 Karoo Dolerite Suite

8.2.1 Geology

No outcrops of the Karoo Dolerite Suite were located during the conduct of the site visit and there are none indicated in Figure 11. However, data supplied by Ilima Coal Company (Pty) Ltd indicate the presence of a narrow dolerite dyke within the project area and which is oriented subparallel to the southwestern boundary of the Mining Right application area. The dyke lies close to, and slightly south of, the southern margin of the Kranspan depression. Ilima Coal Company (Pty) Ltd's data indicates that the intrusion of the dyke has resulted in a wide zone of devolatilization of the coal lying proximal to, and north of, the dyke.

The dolerites of the Karoo Dolerite Suite are known to occur throughout South Africa as a series of dykes and sills of Jurassic age (approximately 183 million years old; Duncan and Marsh, 2006).

8.2.2 Palaeontological Potential

Dolerite is an intrusive igneous rock, as such there is no potential for any fossil material to be located within this rock type and the unit is considered unfossiliferous

8.3 Cainozoic Ferricrete

8.3.1 Geology

A layer of brown, extremely porous ferricrete with a measurable thickness >1 m is intermittently observable throughout the project area but appears to be restricted in occurrence to the topographically higher areas within the project area (e.g., waypoints K002, K003, K017, K018, K019, K020, K032; see Figures 4 and 5). The ferricrete is always located immediately upon the upper surface of the Vryheid Formation sandstone bed (Figure 19). Texturally the ferricrete resembles the interior of a termite mound, but the maze-work of interconnected channels are up to 1 cm in diameter (Figure 20).

8.3.2 Palaeontological potential

No fossil materials were observed as being present within the units and none should be expected due to the combination of pedogenic processes that formed the ferricrete. The unit is accordingly considered to be unfossiliferous herein.

Figure 19: Contact between the white to buff coloured krans-forming Vryheid Formation sandstone (the light -coloured unit forming most of the krans) and the more prominent, dark-brown coloured ferricrete forming the upper-most ca. 1 m of the krans (waypoint K017, see Figure 5).

Figure 20: Clos-up view of the texture of the ferricrete present within the area (waypoint K002, see Figure 5).

8.4 Unconsolidated Cainozoic Regolith

8.4.1 Geology

The land surface throughout the majority of the project area is formed by a layer of unconsolidated regolith. The regolith is variable in composition varying between medium brown, medium-grained, clay-rich and dark brown, loamy coarse-grained materials. The maximum depth of the regolith horizon is undetermined, but obviously is deep enough to sustain cultivation (ploughing over most of the project area) and is also deep enough to allow the digging of large mammal burrows (at least large enough to have been formed by jackals).

The regolith is stratigraphically younger and lies directly upon the ferricrete described above. The genesis of the regolith is not certain, however, there are no large, proximal fluvial systems that may suggest an alluvial origin, nor are there any proximal prominent topographic features that would indicate a colluvial origin for the regolith. On balance, it is most probable that the regolith is the result of *in situ* decomposition of the underlying bedrock (i.e., it is a soil).

8.4.2 Palaeontological potential

No palaeontological materials were observed within this unit during the site investigation. If the regolith is a soil (see section 8.3.1 above) then it is unlikely that any fossil materials should be expected to be present due to the combination of pedogenic and weathering processes that formed the unit. The regolith unit is considered herein to be unfossiliferous.

9 ENVIRONMENT OF THE PROPOSED PROJECT SITE

The environment of the Mining Right application area and the surrounding environs is shown in Figures 21 and 22. It is evident in Figure 21 that the Mining Right application area is topographically composed of low, rounded hills and wide, shallow valleys with the area lying between 1670 and 1700 metres above sea level. It is further evident from Figure 21 that the topographically highest point in the project area lies just to the northwest of the centre point of the project area. Indeed, this point is the highest topographic point in the environs surrounding the project area. This results in the local fluvial drainage pattern radiating from this point. Very few fluvial drainage channels traverse the project area and these are restricted to a short northwest-oriented channel located in the northern corner of the project area which drains to the northeast and becomes a tributary of the Boesmanspruit. A longer northeast oriented channel is located close to the eastern corner of the project area. Numerous seeps and swampy areas were located around the margins of the pans and a small lake surrounded by wetlands is located in the east of the project area and just south of the northern-most of the two pans present in the project area (Figures 21 and 22).

The eastern portion of the Mining Right application area is traversed by the R36 road. The R38 runs approximately east-west and is located approximately 3.5 km north of the project (Figure 21). An ESKOM power line traverses the project area and is located east of the R36 and runs subparallel to the road.

Almost the entire extent of the Mining Right application area is underlain by vegetation of the Eastern Highveld Grassland biome. Two small areas intimately associated with the two pans present within the project area bear a vegetation of the Eastern Temperate Freshwater biome (Figure 23). Mucina and Rutherford (2006) describe the conservation status of the Eastern Highveld Grassland as endangered, while that of the Eastern Temperate Freshwater is described as least threatened. It is apparent from Figures 7 and 21 that much of the original Eastern Highveld Grassland has been removed within the Mining Right application area; the area has been extensively utilised for cultivation (predominantly maize) and those areas have been cleared and almost completely ploughed. The remaining grass lands are utilised for grazing of cattle and sheep. The pans appear to be more-or-less in their original natural state.

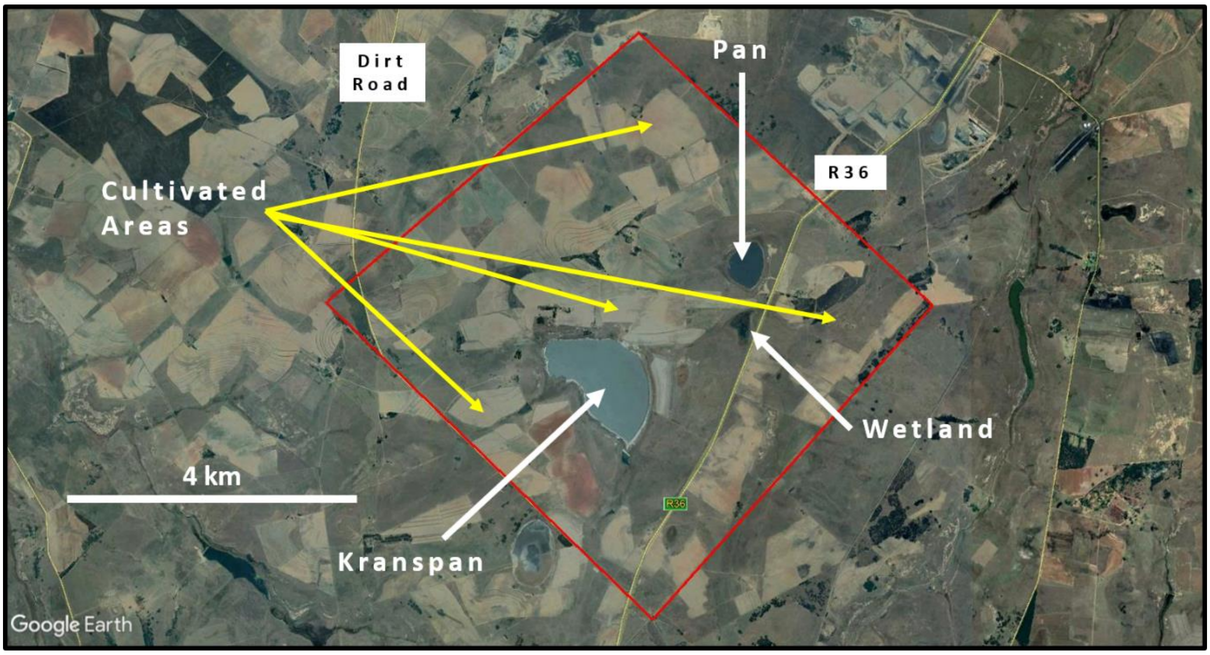


Figure 21: Google earth image of the extent of the Mining Right application area (white polygon). Shown is the location of the pans, a wetland, the R36 road and a dirt road that partially forms the south-western boundary of the area as well as several examples of what the cultivated areas look like on the image.

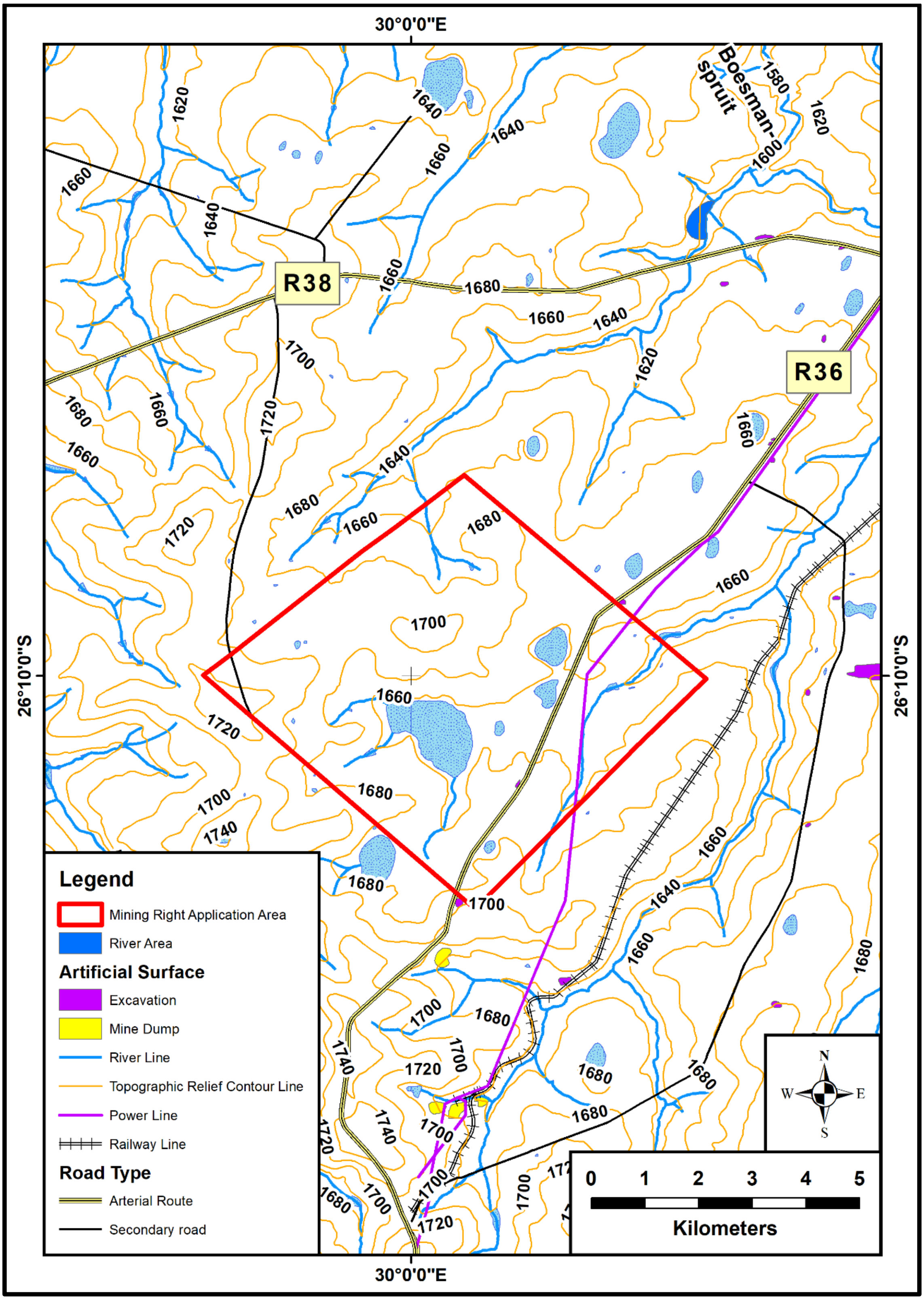


Figure 22: The environment of the area underlying the Mining Right application area (red polygon) and the surrounding environs. The topographic relief contour interval for the map is 20 m.

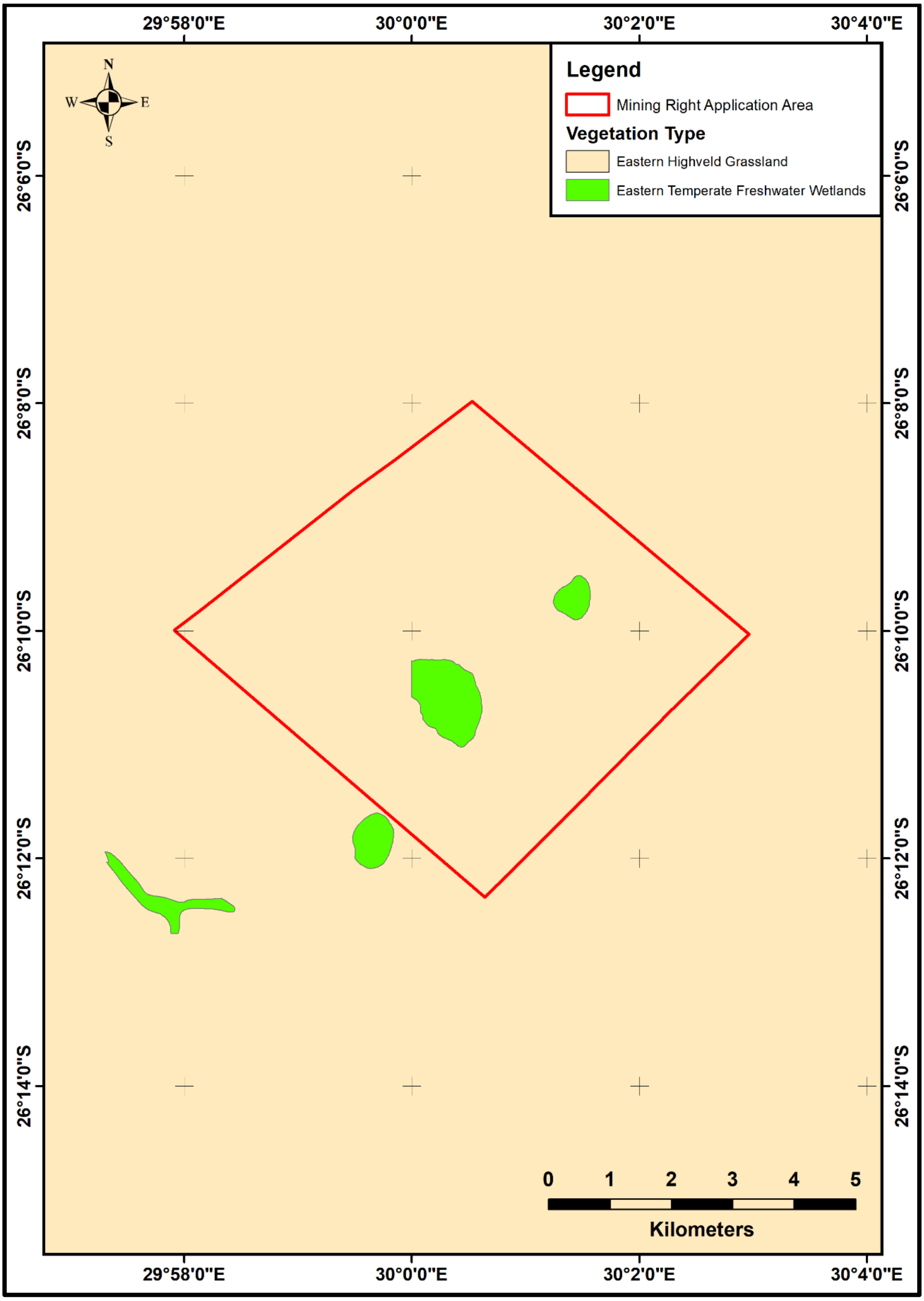


Figure 23: Vegetation types underlying the Mining Right application area and the surrounding environs (modified from Mucina and Rutherford, 2006).

10 OVERVIEW OF SCOPE OF THE PROJECT

The proposed colliery project will consist of both underground and opencast mining operations. Opencast mining will be conducted using conventional strip mining [roll-over] methods in six pits to be named Opencast A-F. Underground mining will be conducted using conventional bord and pillar methodologies utilising a single mining area that underlies and the highest topographic feature within the project area (Figure 24). However, the target area for the mining operations is smaller than the application area. A dolerite sill lies within the project area, and runs parallel to the southwestern boundary of the application area. It appears from data provided by Ilima Coal Company (Pty) Ltd that no coal is located to the southwest of the sill and a band of devolatilised (and, thus, uncommercial grade) coal is located parallel northeast of, and parallel to, the sill. Accordingly, the area lying southwest of Kranspan and parallel to the southwest boundary of the area will not be utilisable for mining. The total aerial extent of the Mining Right application area is 3,383.42 ha. The proposed life-of-mine for the project is 14 years.

The target coal seams and their bounding Vryheid Formation sediments form part of the Ermelo Coalfield. Coal seams occur at depths between 5–75 m; the coal seams are relatively flat lying, but the depth of burial tends to increase towards the centre of the application area due to increasing topographic height of the land surface. The stratigraphic succession of the Ermelo Coalfield comprises of five (5) coal seams named sequentially Seams A-E (A being the stratigraphically youngest and Seam E being the stratigraphically oldest unit) and these are located within an 80-90 m thick stratigraphic interval. All five of these coal seams underly the project area, but only Seam E is considered to be of economic quality and this is the seam that will be economically targeted via the underground mining methods. The average thickness of Seam E is 1.80 m over most of the project area. The six opencast pits will all target Seam E, but Opencast A also contains Seam C which will also be mined, but the removal of this seam will be an integral part of the process of removal of the non-coal-bearing overburden to Seam E.

10.1 infrastructure

The proposed infrastructure required on site includes the following:

- Opencast mining areas with contractor’s camp.
- Haul roads to access the mining areas.
- Adits from opencast high walls to provide access to the underground mining.
- ROM stockpile areas.
- Upcast ventilation shaft with the main fan situated on this shaft.
- Offices, stores, workshop, change house and lamp room. All will be prefabricated structures that allow for easy removal and rehabilitation of the site.
- Parking area.

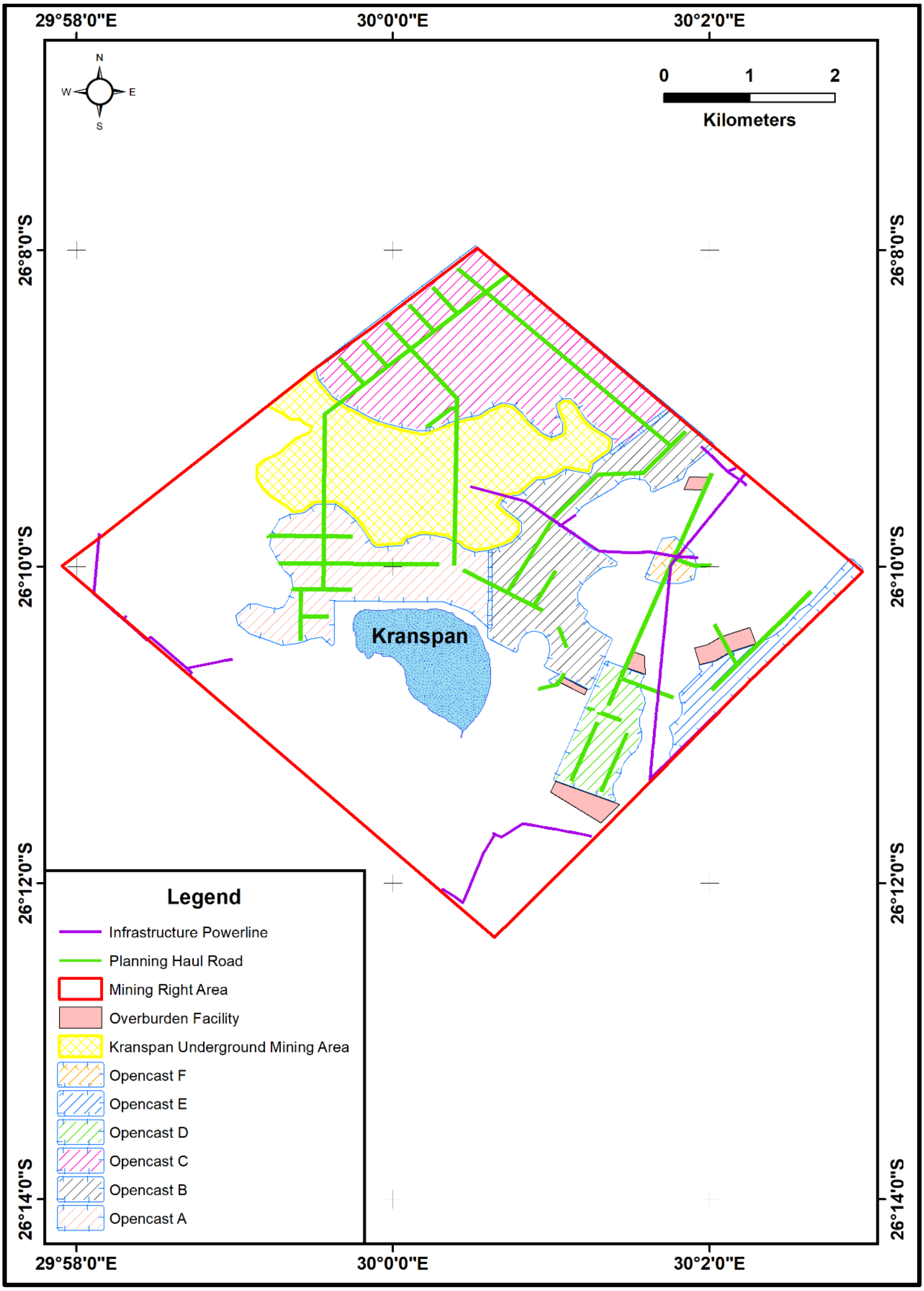


Figure 24: Map showing the location of the various infrastructure elements needed for the proposed coal mining operations within the Mining Right application area (red polygon).

- Diesel tanks.
- Crushing and screening plant (Raw).
- Dense medium beneficiation plant.
- Product stockpiles and loading area.
- Onsite laboratory.
- Weighbridges.
- An access road to the site that will be constructed along the overland conveyer route and in the same servitude.

10.2 Impact upon the geology

The proposed mining operations will be conducted by a mix of mining operations. Opencast mining will be conducted widely across the area with six opencast pits expected to be developed and they will target the exploitation of Seam E. Accordingly, the mining operations will result in the total extraction and transport of all geological materials occurring between the land surface and the base of Seam E. For the purposes of palaeontology any fossil materials contained in the mined rocks can be treated as being destroyed. Due to the methodologies employed in the mining process and also the extreme costs of mining no negative impact upon the geological sequence will be expected to occur below the base of Seam E. The maximum depth of this impact varies across the project area between approximately 10-44 m in the opencast pits.

The underground portion of the operations will also target Seam E and these have a maximum depth of 75 m below land surface. The mining methods to be employed will ensure that the negative impacts of the underground mining operations will be constrained to Seam E with little to no negative impact expected upon the overlying strata.

The required mine infrastructure, other than the six opencast pits, and the ventilation shaft will all be located upon the land surface. The excavation of the ventilation shaft will directly and negatively affect all the geological strata overlying the base of Seam E, but the volume of rock involved in the excavation of this feature is relatively minor. Of the remaining non-opencast pit infrastructure, the construction of roads as well as the excavations required for and the foundations for offices and other buildings, a weighbridge, and trenches to provide power and water access will result in the deepest impact upon the underlying geology. It is assumed that the maximum depth of the negative impact they will cause upon the underlying geology will be < 2 m. It is expected that all of these excavations will impact directly upon the unconsolidated regolith cover as well as the Cainozoic ferricrete (where present). Some negative impact upon the upper-most portions of the Vryheid Formation sediments may also be expected.

The following impact assessment (Section 11) is made in the light of these assumptions.

11 IMPACT ASSESSMENT

The potential impact of Ilima Coal Company (Pty) Ltd's Kranspan coal mining project is categorised below according to the following criteria:-

11.1 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.

11.2 Extent of impact

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

11.3 Duration of impact

The anticipated duration of the identified impact is assessed as potentially **long term to permanent**. This is assessment is based on the fact that, in the absence of mitigation procedures (should fossil material be present within the area to be affected) the damage or destruction of any palaeontological materials will be permanent. Similarly, any fossil materials that may exist below the structures and infrastructural elements that will constitute the coal mining operation will be unavailable for scientific study for the duration of the existence of those features (i.e., a minimum of 14 years).

11.4 Probability of impact

It is pertinent to realise that fossils are generally scarce and sporadic in their occurrence and, as such, the probability of any development affecting a fossil at any particular point on the land surface is relatively low. However, the sediments of the Vryheid Formation are noted for containing an important palaeontological heritage particularly in respect of plant macrofossils of the *Glossopteris* flora as well as trace fossil assemblages. However, the occurrence of fossils within the geological record is erratic in general and the chance of impacting upon most macrofossil types at any particular point within the Vryheid Formation is low. It must be noted however, that where plant macrofossils or trace fossils are present within a sequence (as they are elsewhere in the Vryheid Formation) they are often in dense accumulations. The probability of a negative impact upon the palaeontological heritage of the unit (including both plant macrofossils and trace fossil assemblages) arising from the mining operations is accordingly assessed as being **moderate to good**.

The presence of a Cainozoic regolith cover underlying the project area is recorded herein (see Sections 8.2 and 8.3 above). It is anticipated that the unconsolidated Cainozoic regolith is derived from *in situ* decomposition of the underlying bedrock (i.e., it is a soil). The probability of any fossil materials having been originally present within this regolith is assessed as negligible as the unit is considered, herein, to be unfossiliferous within the project area. However, it is also evident in Figures 7 and 21 that many areas of the Mining Right application area have been cultivated (ploughed) and the land surface has been overturned (multiple times) to the depth of a plough blade. Should any fossil materials have originally existed in the regolith at surface prior to cultivation, they will now have been destroyed. The Cainozoic ferricrete horizon was formed due to the *in situ* pedogenic processes. No fossil materials were identified in this unit during the site visit and none should be expected due to the mode of formation of the unit and it is considered to be unfossiliferous. The probability of any fossil materials having been originally present within the unconsolidated regolith or the ferricrete unit is assessed as **negligible** as the units are considered, herein, to be unfossiliferous within the project area.

11.5 Significance of impact

Should the project progress without due care to the possibility of fossils being present within either the bedrock or regolith the resultant damage, destruction or inadvertent relocation of any affected fossils will be permanent and irreversible. The rocks of the Vryheid Formation are well known to contain highly scientifically significant plant macrofossil assemblages of the *Glossopteris* flora as well as trace fossil assemblages.

Thus, the sediments of the Vryheid Formation provide an important window into the evolution of plant life that constitutes the famous *Glossopteris* flora during this poorly understood interval in the Early Permian within the Main Karoo Basin. Their significance is 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 areas are potentially extremely scientifically and culturally significant and any negative impact on them would be of **high significance**. The trace fossil assemblages contained within the unit are not as significant as the plant macrofossils as, while they may be present in large numbers, they tend to be taxonomically depauperate; they, do provide important palaeoenvironmental data.

The rocks of the Karoo Dolerite Suite and the regolith cover are unfossiliferous. The significance of any negative impact resulting upon the palaeontological heritage of these units is assessed as being **nil**.

12 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.

12.1 Mitigation

The following mitigation protocols are recommended to minimise negative impacts resulting from the mining operations.

During the construction phase of the mine:

- When the surface infrastructure elements of the mine are being constructed these locations must be regularly inspected to observe if the excavations have encountered bedrock of the Vryheid Formation.
- These regular inspections should be made by a suitable mine employee (such as the environmental officer) who has been trained to identify the types of fossils that may reasonably be expected to occur within the Vryheid Formation.
- Should fossil materials be identified, the excavations must be halted in that area and SAHRA informed of the discovery (as required in Section 3.3 above).
- An experienced Karoo palaeontologist should be contacted by the mine to assess the significance of the fossils.
- If fossil materials prove to be scientifically significant the palaeontologist should make recommendations that they should be either be protected completely *in situ* or could have damage mitigation procedures emplaced (i.e., excavation by a suitability by a suitably experienced palaeontologist) to minimise negative impacts.

Once excavation of the opencast pit voids begins:

- On-site checks for the occurrence of any fossils of the excavated pits and stockpiled material should be conducted biannually (i.e., every six months).
- The frequency of these checks should be reassessed after twelve (12) months based on the findings.
- The Karoo palaeobotanist should submit a monitoring report to SAHRA on this work.

In addition,

- Should any fossil materials be identified, the palaeontologist should ascertain their scientific and cultural importance.
- Should the fossil prove scientifically or culturally significant the particular excavations involved should be halted and SAHRA informed of the discovery (as required in Section 3.3 above).
- Should scientifically or culturally significant fossil material exist within the project areas 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.

When the underground mining component of the mining program commences no damage mitigation protocols are recommended. The coals comprising Seam E are the product of a complex series of jellification and other coalification processes that transformed the original vegetation (peat) into coal. Recognisable plant macrofossil materials are not expected to be present within the coals. Such plant macrofossil materials may be present within any siliciclastic partings within the seam. However, the automatic mining machinery will destroy any such fossils before they can be recognised as being present. Similarly, modern industrial health and safety rules would make it extremely difficult for a palaeontologist to be able to access and work at a working mine face.

12.2 Reversal of damage

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

12.3 Degree of irreversible loss

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

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

13 ASSUMPTIONS, UNCERTAINTIES AND GAPS IN KNOWLEDGE

The information provided within this report was derived in part from a desktop study of available maps and scientific literature as well as direct observation of the strata cropping out in the area. However, much of the project area is covered by Cainozoic regolith and direct observation of the bedrock is not often possible.

The presence and mode of formation of the Cainozoic unconsolidated regolith interpreted to be underlying the project area has been hypothesised from available evidence, but this does not represent either a comprehensive nor an authoritative interpretation of the genesis of the unit.

14 IMPACT STATEMENT

A Full Palaeontological Heritage Impact Assessment study has been conducted on the site of a Mining Right application to mine for coal on Portions 1, 2, 3, 4, 5, 6, 7, 8 and the Remaining Extent of the farm Kranspan 49 IT. The site is located 13 km south-west of Carolina and 10.5 km north-east of Breyton, in the Carolina Magisterial Districts, Gert Sibande District Municipality and Albert Luthuli Local Municipality, Mpumalanga Province. The R36 Road (running between Carolina and Breyton) traverses the eastern portion of the project area. The Mining Right application area can be located within the confines of 1:50 000 topographic maps 2629BB and 2630AA. The aerial extent of the Mining Right application area is 3,383.42 ha. The expected life-of-mine for the project is 14 years.

The aerial extent of the Mining Right application area is underlain by an assemblage of stratigraphic units consisting of coal-bearing sediments of the Vryheid Formation and intrusive dolorite of the Karoo Dolorite Suite. These bedrock units are overlain in part by a Cainozoic ferricrete layer that appears to be present upon the topographically higher areas within the project area. Lying upon the ferricrete and, in the topographically lower areas, upon the Vryheid Formation strata is a pervasive layer of unconsolidated Cainozoic regolith.

Due to the methodologies employed in the opencast mining process and also the extreme costs of mining no negative impact upon the geological sequence will be expected to occur below the base of Seam E in the opencast voids as the mining will not extend deeper than that. Within the underground mining operations, the negative impacts upon the geology will be predominantly constrained to occurring within Seam E. Coal seams occur at depths between 5–75 m. The coal seams are relatively flat lying, but the depth of burial tends to increase towards the centre of the application area due to increasing topographic height of the land surface. Any negative impacts will be constrained to the Vryheid Formation and the overlaying geological units.

The required mine infrastructure, other than opencast voids and the underground mining operations will all be located on the land surface. Excavations required for all mine infrastructure, not inclusive of the underground mining operations, the opencast pits or the ventilation shaft infrastructure will result in an impact upon the underlying geology. It is assumed that the maximum depth of the negative impact they will cause upon the underlying geology will be < 2 m.

The rocks comprising the Karoo Dolerite Suite are unfossiliferous. It is also interpreted, herein, that the interpreted Cainozoic unconsolidated regolith and the Cainozoic ferricrete are unfossiliferous. Any impacts upon the rocks comprising these units caused by the progression of the mining operations will have a **negligible to nil** probability of resulting in a negative impact upon their palaeontological heritage. The sediments of the Vryheid Formation are known to contain plant macrofossil assemblages of the *Glossopteris* flora as well as trace fossil assemblages. The significance of the fossil assemblages contained in the Vryheid Formation is assessed as **high**, but the probability of any negative impact is **moderate to good**.

It is evident that the proposed mining operations pose a risk of negatively impacting upon scientifically highly significant fossil assemblages and mitigation protocols are required to reduce any potential negative impacts to a minimum. Accordingly, it is recommended that:

During the construction phase of the mine:

- When the surface infrastructure elements of the mine are being constructed these locations must be regularly inspected to observe if the excavations have encountered bedrock of the Vryheid Formation.
- These regular inspections should be made by a suitable mine employee (such as the environmental officer) who has been trained to identify the types of fossils that may reasonably be expected to occur within the Vryheid Formation.
- Should fossil materials be identified, the excavations must be halted in that area and SAHRA informed of the discovery (as required in Section 3.3 above).
- An experienced Karoo palaeontologist should be contacted by the mine to assess the significance of the fossils.

- If fossil materials prove to be scientifically significant the palaeontologist should make recommendations that they should be either be protected completely, *in situ,* or could have damage mitigation procedures emplaced (i.e., excavation by a suitability by a suitably experienced palaeontologist) to minimise negative impacts.

Once excavation of the opencast pit voids begins:

- On-site checks for the occurrence of any fossils of the excavated pits and stockpiled material should be conducted biannually (i.e., every six months).
- The frequency of these checks should be assessed after twelve (12) months based on the findings.
- The Karoo palaeobotanist should submit a monitoring report to SAHRA on this work.

In addition,

- Should any fossil materials be identified, the palaeontologist should ascertain their scientific and cultural importance.
- Should the fossil prove scientifically or culturally significant the particular excavations involved should be halted and SAHRA informed of the discovery (as required in Section 3.3 above).
- Should scientifically or culturally significant fossil material exist within the project areas 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.

When the underground mining component of the mining program commences no damage mitigation protocols are recommended. The coals comprising Seam E are the product of a complex series of jellification and other coalification processes that transformed the original vegetation (peat) into coal. Recognisable plant macrofossil materials are not expected to be present within the coals. Such plant macrofossil materials may be present within any siliciclastic partings within the seam. However, the automatic mining machinery will destroy any such fossils before they can be recognised as being present. Similarly, modern industrial health and safety rules would make it extremely difficult for a palaeontologist to be able to access and work at a working mine face.

15 CONSIDERED OPINION

This study has not identified any palaeontological reason to prejudice the progression of this project subject to the recommended damage mitigation protocols outlined above being instituted.

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