PALAEONTOLOGICAL DESKTOP ASSESSMENT FOR THE PROPOSED AMENDMENT OF THE KUSIPONGO UNDERGROUND AND OPENCAST COAL MINE IN SUPPORT OF AN ENVIRONMENTAL AUTHORIZATION AND WASTE MANAGEMENT LICENCE APPLICATION

PIET RETIEF, MPUMALANGA.

Issue Date:	**11 September 2019**
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Client:	Kangra Coal (Pty) Ltd
PGS Project No:	PIA

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Declaration of Independence

I, Elize Butler, declare that –

General declaration:

- I act as the independent palaeontological specialist in this application
- I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favorable to the applicant
- I declare that there are no circumstances that may compromise my objectivity in performing such work;
- I have expertise in conducting palaeontological impact assessments, including knowledge of the Act, Regulations and any guidelines that have relevance to the proposed activity;
- I will comply with the Act, Regulations and all other applicable legislation;
- I will take into account, to the extent possible, the matters listed in section 38 of the NHRA when preparing the application and any report relating to the application;
- I have no, and will not engage in, conflicting interests in the undertaking of the activity;
- I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing - any decision to be taken with respect to the application by the competent authority; and - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
- I will ensure that information containing all relevant facts in respect of the application is distributed or made available to interested and affected parties and the public and that participation by interested and affected parties is facilitated in such a manner that all interested and affected parties will be provided with a reasonable opportunity to participate and to provide comments on documents that are produced to support the application;
- I will provide the competent authority with access to all information at my disposal regarding the application, whether such information is favorable to the applicant or not
- All the particulars furnished by me in this form are true and correct;
- I will perform all other obligations as expected a palaeontological specialist in terms of the Act and the constitutions of my affiliated professional bodies; and
- I realize that a false declaration is an offense in terms of regulation 71 of the Regulations and is punishable in terms of section 24F of the NEMA.

Disclosure of Vested Interest

I do not have and will not have any vested interest (either business, financial, personal or other) in the proposed activity proceeding other than remuneration for work performed in terms of the Regulations;

PALAEONTOLOGICAL CONSULTANT: Banzai Environmental (Pty) Ltd

CONTACT PERSON: Elize Butler

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SIGNATURE:

ACKNOWLEDGMENT OF RECEIPT

Report Title	**PALAEONTOLOGICAL DESKTOP ASSESSMENT FOR THE PROPOSED AMENDMENT OF THE KUSIPONGO UNDERGROUND AND OPENCAST COAL MINE IN SUPPORT OF AN ENVIRONMENTAL AUTHORIZATION AND WASTE MANAGEMENT LICENCE APPLICATION**		
Control	**Name**	**Signature**	**Designation**
Author	Elize Butler		Palaeontologist
Reviewed			
Client			

CLIENT:

CONTACT PERSON:

The heritage impact assessment report has been compiled taking into account the National Environmental Management Act 1998 (NEMA) and Environmental Impact Regulations 2014 as amended, requirements for specialist reports, Appendix 6, as indicated in the table below.

NEMA Regs (2014) - Appendix 6	**Relevant section in report**
1. (1) A specialist report prepared in terms of these Regulations must contain-	
a) details of-	Page ii of Report – Contact details and company, Section 2 and Appendix A
i. the specialist who prepared the report; and	
ii. the expertise of that specialist to compile a specialist report including a curriculum vitae;	
b) a declaration that the specialist is independent in a form as may be specified by the competent authority;	Page ii
c) an indication of the scope of, and the purpose for which, the report was prepared;	Section 4 – Objective
(cA) an indication of the quality and age of base data used for the specialist report;	Section 5 – Geological and Palaeontological history
(B) a description of existing impacts on the site, cumulative impacts of the proposed development and levels of acceptable change;	Section 9
d) the date, duration and season of the site investigation and the relevance of the season to the outcome of the assessment;	N/A Desktop Study
e) a description of the methodology adopted in preparing the report or carrying out the specialized process inclusive of equipment and modeling used;	Section 7 Approach and Methodology
f) details of an assessment of the specifically 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 1 and 10
g) an identification of any areas to be avoided, including buffers;	Not identified,
h) a map superimposing the activity including the associated structures and infrastructure on the environmental sensitivities of the site including areas to be avoided, including buffers;	Section 5 – Geological and Palaeontological history

NEMA Regs (2014) - Appendix 6	Relevant section in report
i) a description of any assumptions made and any uncertainties or gaps in knowledge;	Section 7.1 – Assumptions and Limitation
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 10
k) any mitigation measures for inclusion in the EMPr;	N/A
l) any conditions for inclusion in the environmental authorization;	N/A
m) any monitoring requirements for inclusion in the EMPr or environmental authorization;	N/A
n) a reasoned opinion- i. as to whether the proposed activity, activities or portions thereof should be authorized; (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 authorized, any avoidance, management and mitigation measures that should be included in the EMPr, and where applicable, the closure plan;	Desktop Assessment
o) a description of any consultation process that was undertaken during the course of preparing the specialist report;	Not applicable.
p) a summary and copies of any comments received during any consultation process and where applicable all responses thereto; and	Not applicable.
q) any other information requested by the competent authority.	Not applicable.
2) Where a government notice *gazetted* by the Minister provides for any protocol or minimum information requirement to be applied to a specialist report, the requirements as indicated in such notice will apply.	Section 3 compliance with SAHRA guidelines

EXECUTIVE SUMMARY

Banzai Environmental was appointed by PGS Heritage (Pty) Ltd to conduct the Palaeontological Desktop Assessment (DIA) to assess the proposed **amendment of the Kusipongo underground and opencast coal mine in support of an environmental authorization and waste management license application** within the Gert Sibande District Municipality. The National Heritage Resources Act (No 25 of 1999, section 38) (NHRA), states that a Palaeontological Impact Assessment (PIA) is key to detect the presence of fossil material within the planned development footprint. This DIA is thus necessary to evaluate the effect of the construction on the palaeontological resources.

The proposed Kusipongo underground and opencast coal mine development as well as all alternatives is underlain by the Vryheid Formation of the Ecca Group (Karoo Supergroup), while the central portion of Kusipongo mining right application is underlain by the Volksrust Formation (Ecca Group) and Karoo dolerite. According to the PalaeoMap of South African Heritage Resources Information System the Palaeontological Sensitivity of the Vryheid Formation is Very High and that of the Volksrust Formation is High while the Karoo Dolerite Suite consists of igneous rock and thus has a Palaeontological Sensitivity of zero (Almond and Pether 2008, SAHRIS website).

An EIA level palaeontology report will be conducted to assess the value and prominence of fossils in the development area and the effect of the proposed development on the palaeontological heritage. The purpose of the EIA Report is to elaborate on the issues and potential impacts identified during the scoping phase. A Phase 1 field-based assessment will be conducted and research in the site-specific study area as well as a comprehensive assessment of the impacts identified during the scoping phase

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TERMINOLOGY AND ABBREVIATIONS

Archaeological resources

This includes:

- material remains resulting from human activity which are in a state of disuse and are in or on land and which are older than 100 years including artifacts, human and hominid remains, and artificial features and structures;
- rock art is any form of painting, engraving or other graphic representation on a fixed rock surface or loose rock or stone, which was executed by human agency and which is older than 100 years, including any area within 10m of such representation;
- wrecks, being any vessel or aircraft, or any part thereof, which was wrecked in South Africa, whether on land, in the internal waters, the territorial waters or in the maritime culture zone of the Republic as defined in the Maritimes Zones Act, and any cargo, debris or artefacts found or associated therewith, which is older than 60 years or which SAHRA considers to be worthy of conservation;
- features, structures, and artifacts associated with a military history which are older than 75 years and the site on which they are found.

Cultural significance

This means aesthetic, architectural, historical, scientific, social, spiritual, linguistic or technological value or significance

Development

This means any physical intervention, excavation, or action, other than those caused by natural forces, which may in the opinion of the heritage authority in any way result in a change to the nature, appearance or physical nature of a place or influences its stability and future well-being, including:

- construction, alteration, demolition, removal or change in use of a place or a structure at a place;
- carrying out any works on or over or under a place;
- subdivision or consolidation of land comprising a place, including the structures or airspace of a place;
- constructing or putting up for display signs or boards;
- any change to the natural or existing condition or topography of land; and
- any removal or destruction of trees, or removal of vegetation or topsoil

Fossil

Mineralized bones of animals, shellfish, plants, and marine animals. A trace fossil is the track or footprint of a fossil animal that is preserved in stone or consolidated sediment.

Heritage

That which is inherited and forms part of the National Estate (historical places, objects, fossils as defined by the National Heritage Resources Act 25 of 1999).

Heritage resources

This means any place or object of cultural significance and can include (but not limited to) as stated under Section 3 of the NHRA,

- 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 natural features of cultural significance;
- geological sites of scientific or cultural importance;
- archaeological and palaeontological sites;
- graves and burial grounds, and
- sites of significance relating to the history of slavery in South Africa;

Holocene

The most recent geological time period which commenced 10 000 years ago.

Palaeontology

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 or trace.

Abbreviations	**Description**
ASAP	Association of South African Professional Archaeologists
BRMO	Black Rock Mining operations
CRM	Cultural Resource Management
DEA	Department of Environmental Affairs
DIA	Desktop Impact Assessment
ECO	Environmental Control Officer
EIA practitioner	Environmental Impact Assessment Practitioner
EIA	Environmental Impact Assessment
ESA	Early Stone Age
GPS	Global Positioning System
HIA	Heritage Impact Assessment
I&AP	Interested & Affected Party
LSA	Late Stone Age
LIA	Late Iron Age

Abbreviations	Description
MSA	Middle Stone Age
MIA	Middle Iron Age
NEMA	National Environmental Management Act
NHRA	National Heritage Resources Act
PIA	Palaeontological Impact Assessment
PHRA	Provincial Heritage Resources Authority
PSSA	Palaeontological Society of South Africa
SADC	Southern African Development Community
SAHRA	South African Heritage Resources Agency

1 INTRODUCTION

Kangra Coal (Pty) Ltd has been mining coal from the Maquasa operations and the existing washing plant at Maquasa East since the late 1990's. Currently the Colliery operates on the Maquasa East, Maquasa West and Maquasa West Extension properties which is approximately 51km west of Piet Retief in the Gert Sibande District Municipality, Mpumalanga. The existing operation at the Maquasa West and Maquasa West Extension Mining Rights is approaching depletion and the proposed project is important to extend the life of mine (Figure 1-7). Kangra Coal proposed the Mining of the Kusipongo resource located exactly to the west of current operations. The proposed development will maintain the current levels of production and employment at the mine. If the mining operations should close, many jobs will be lost.

1.1 DESCRIPTION OF MINING OPERATIONS

Opencast Pits

Three (3) opencast pits are proposed in order to mine the shallow coal near the surface using conventional opencast strip mining and the roll-over method. This entails that the overburden will be stripped from the initial cut and stockpiled. With each successive cut taken the overburden and soils stripped will be used to backfill and top-dress the previous cut. In this way the soil is replaced from where it was removed thereby minimising the impact of soil removal. The overburden and soils that are stripped and stockpiled for use in the final void will need to be protected from wind and water erosion as well as compaction.

The size of each of the proposed opencast pits is indicated as below:

- Twyfelhoek pit (north-east section) approximately 115 ha in size;
- Donkerhoek pit (north-west section) approximately 110 ha in size; and
- Balgarthen pit (southern section) approximately 310 ha in size.

Alternatives

There are three alternatives that are currently being investigated as part of the Scoping and EIA report for the project, which are detailed below. All three of these alternatives include amending the approved underground mine to utilise the remainder of the coal resource within the southern and western section.

The three alternatives are:

- Alternative 1 – Opencast mining and four adits;
- Alternative 2 – Four adits and minor opencast mining; and
- Alternative 3 – Four adits.

It is anticipated that the opencast pits will yield approximately 65 000 tonnes run of mine (ROM) coal per month and mining will be undertaken for 2 years, where after the opencast pits will be rehabilitated and closed except for the access point to the underground mine sections[1].

Underground Mine

Underground mining is undertaken using conventional board-and-pillar layouts with checker board stooping. Checker board stooping is the removal of every second pillar as to leave a checker board effect after stooping and still allows for the roof to be stable and not collapse. Entry to the coal reserves is achieved by adits or high walls from opencast mining pits which includes infrastructure such as a lamp room, workshop, small office, change room, luffing and slewing conveyor and coal loading area.

The main coal seams currently mined at Maquasa West and Maquasa West Extensions are the GUS and DUN (Dundas) coal seams. The GUS coal seam is located above the DUN coal seam. It is only proposed for that the GUS seam be mined due to current mine economic and coal market conditions.

The GUS seam in the Kusipongo area can be divided into two, the lower GUS (mainly bright coal) and the upper GUS (mainly dull shale coal and carbonaceous shale). The contact between the upper and lower GUS is a very prominent thin sandstone band. The GUS seam in the Kusipongo area is typically 3.5 to 4 m thick.

It is anticipated the Run of Mine (ROM) coal will be approximately 42 000 tonnes per month from the underground mining operations. The underground mining operations will operate for approximately 10 years based on the proposed mining plan[1].

Transportation

ROM coal from the proposed opencast and underground mining operations at Balgarthen will be transported by road to the existing processing plant located at Maquasa East. ROM coal from the Donkerhoek and Twyfelhoek operations will be transported by road to Maquasa West, where it will be loaded onto the existing conveyor belt and transported to the processing plant at Maquasa East. The haul roads are existing gravel roads of approximately 24 kms and 8 kms respectively. These roads will require upgrading to accommodate this traffic[1].

Water Management

The underground workings will require dewatering and there are currently a few options with regard to excess water from mine dewatering. The water will either be stored underground or piped to the pollution control dam. It is anticipated that water will also be recycled and used for dust suppression.

Following mine closure, if decant occurs, water will be treated depending on the quality of the decant. The selection of an appropriate water treatment process will be dependent on the mine decant volumes and decant water quality at the time[1].

Waste

General waste from employees will temporarily be stored on site before being disposed of at a licensed landfill site[1].

Sewage

Toilet facility requirements for the underground workings will be met with water-less toilets that will be brought to the surface when full for disposal to the portable sewage plant near Maquasa or taken to the municipal sewage works with a septic tank that will be discharged and cleaned regularly by an authorized company. Conservancy tanks will be installed for ablution facilities to be located above ground at various locations such as site offices and changing areas[1].

[1]Information provided by Kangra Coal

1.2 Kusipongo Mining Right

Kangra Coal has an existing mining right and approved Environmental Management Programme (EMPr) for the Kusipongo resource which was authorised by the Mpumalanga Department of Mineral Resources (DMR) in July 2017. The mining right authorises underground mining within the north-eastern section of the mining rights area, with access being from an adit located at the Maquasa West Extension operations (Adit 5).

The distance from the existing adit at the Maquasa West Extension operations and the Kusipongo resource is approximately 1.2 kms and should this be the only access to the underground mine, it will not sustain continuous employment nor meet market requirements for coal supply[1].

All farms within the mining right area:

Beelzebub 13 HT (Portions 1, 3, 4, 6 and Remainder)
Blinkwater 34 HT (Portions 1, 2 and Remainder)
Boschbank 11 HT (Portions 2 and Remainder)
Donkerhoek 10 HT (Portions 1, 3 and Remainder)
Donkerhoek 14 HT (Portions 2, 4, 5, 6, 7, 8, 9, 10, 12, 13, 14, 15, 21, 22, Remainder and Re of 11)
Kikvorschfontein 35 HT (Portions 1 and Remainder)
Kransbank 15 HT Re
Langverwacht 20 HT (Portions 1, 2 and 3)
Mooihoek 12 HT (Portions 1 and Remainder)
Nauuwhoek 37 HT 1
Oogiesfontein 17 HT (Portions 1 and Remainder)
Roodepoort 38 HT (Portions 0, 1, 2 and 3)
Twyfelhoek 379 IT (Portions 1, 2, 3, 4 and Remainder)
The total mining right area is 17 986 ha

[1]Information provided by Kangra Coal

2 QUALIFICATIONS AND EXPERIENCE OF THE AUTHOR

The author (Elize Butler) has an MSc in Palaeontology from the University of the Free State, Bloemfontein, South Africa. She has been working in Palaeontology for more than twenty-four years. She has extensive experience in locating, collecting and curating fossils, including exploration field trips in search of new localities in the Karoo Basin. She has been a member of the Palaeontological Society of South Africa for 13 years. She has been conducting PIAs since 2014.

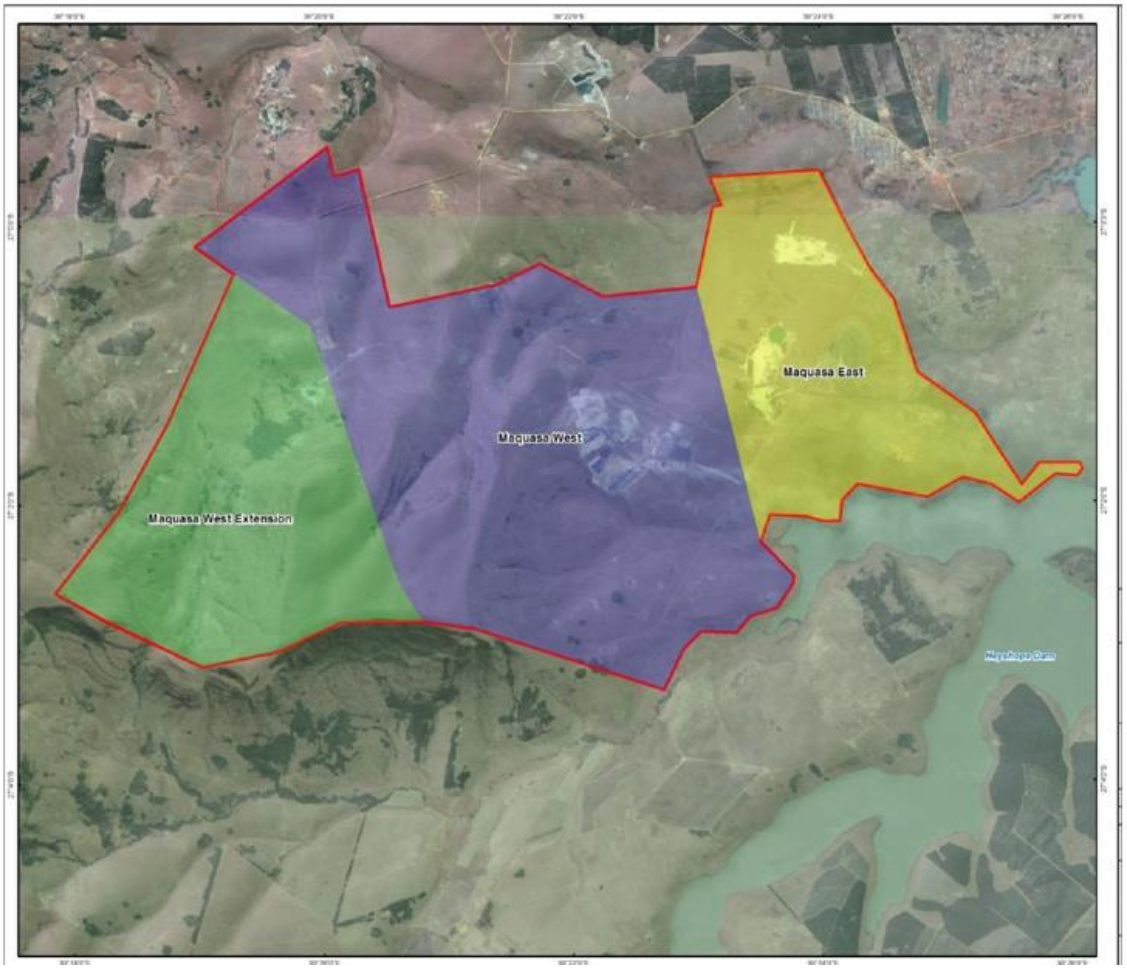

Figure 1: Overview of the Maquasa Operations. Map provided by EXM Advisory Services.

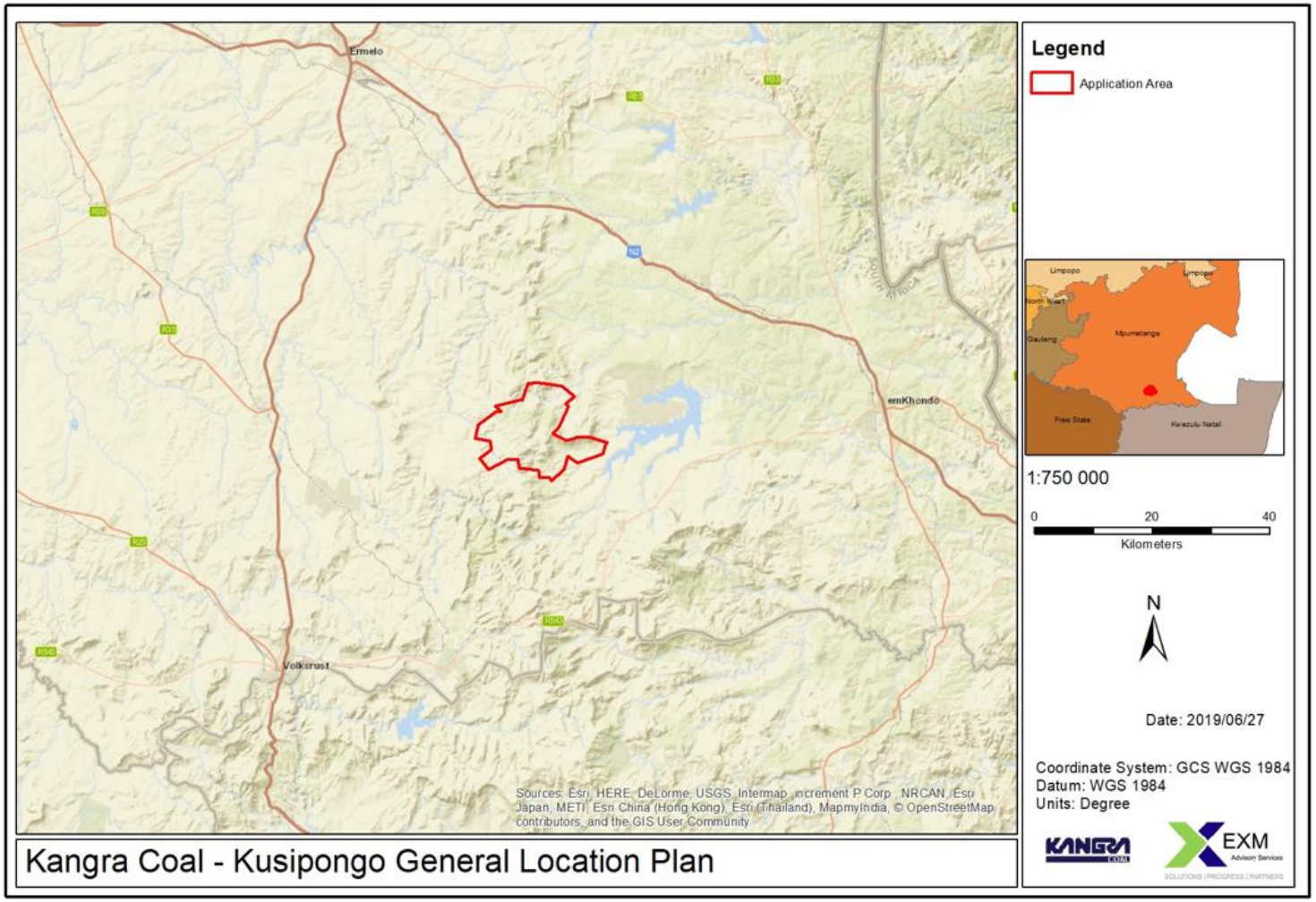

Figure 2: Locality map of the proposed Kusipongo mining operations. Map provided by EXM Advisory Services.

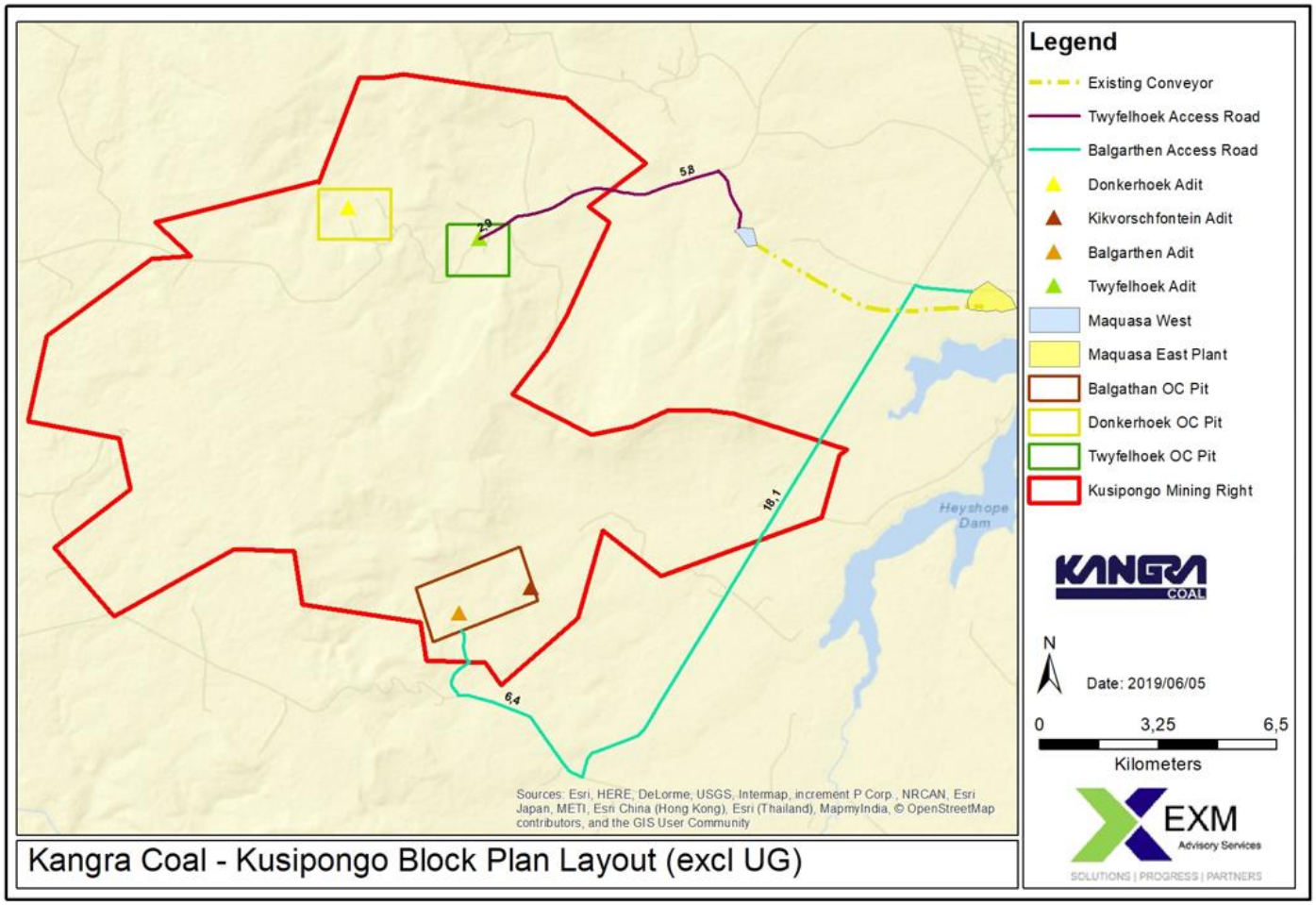

Figure 3: Proposed Kusipongo Block Plan Layout. Map provided by EXM Advisory Services.

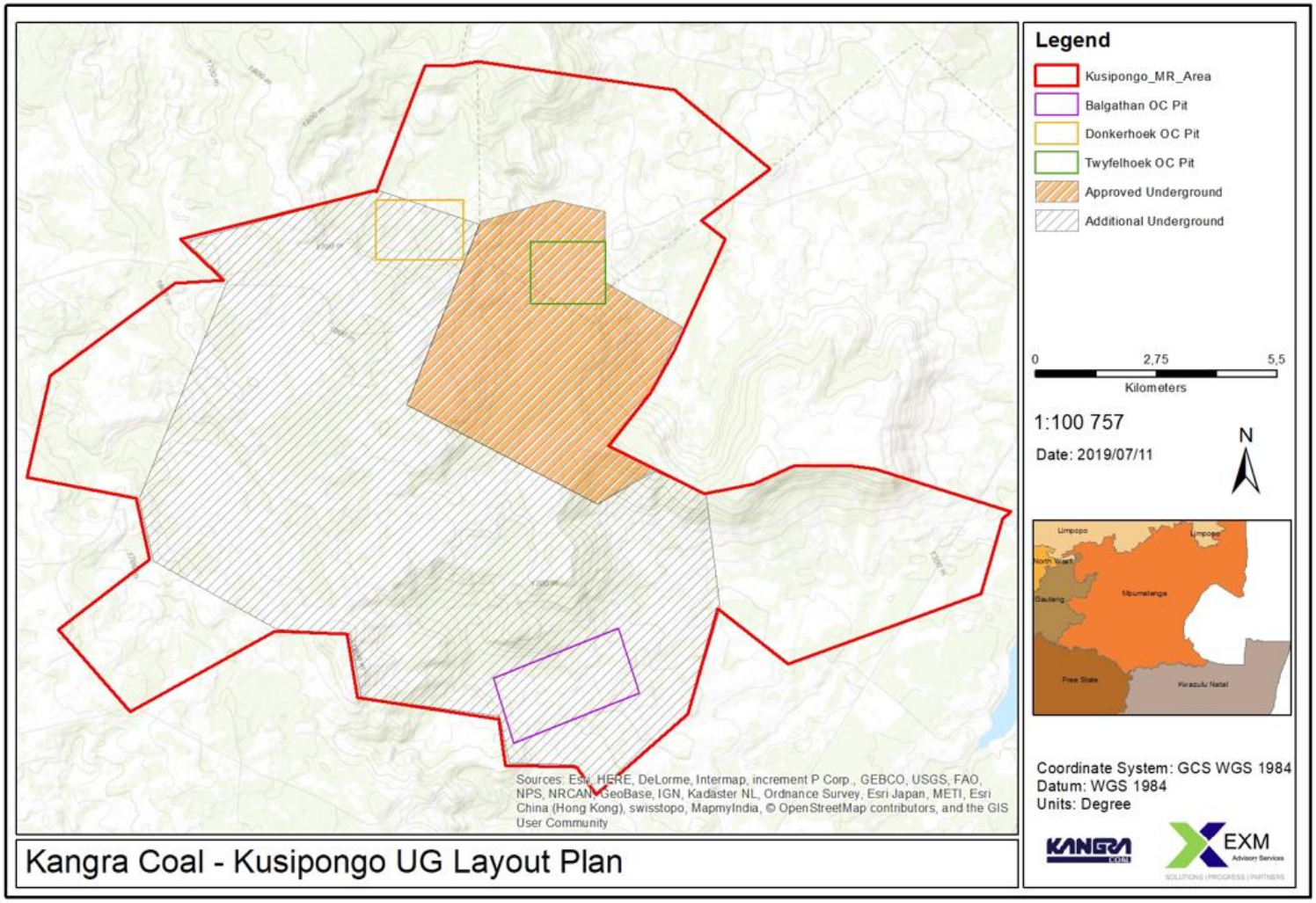

Figure 4 : Proposed Kusipongo UG Layout Plan. Map provided by EXM Advisory Services.

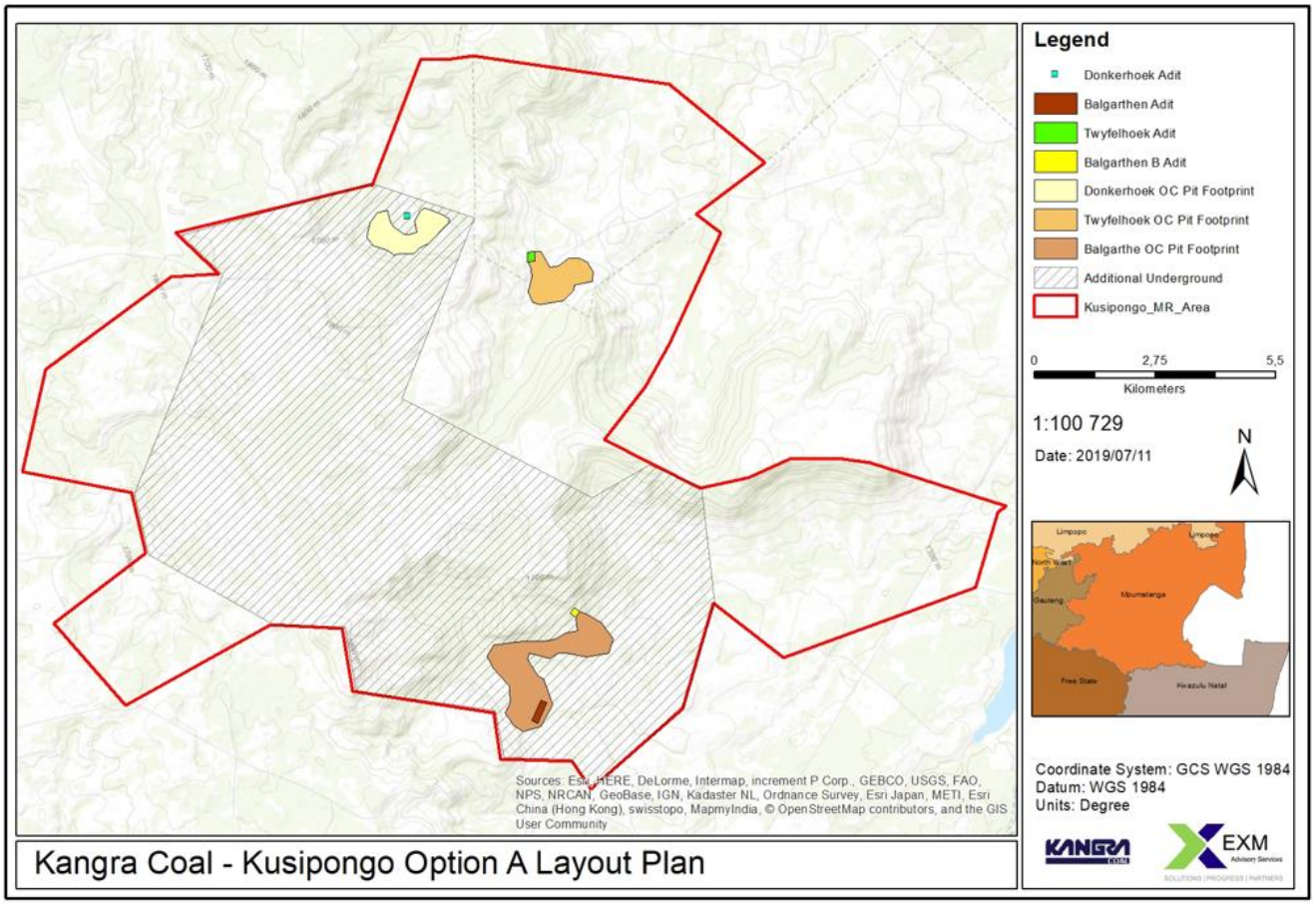

Figure 5 : Alternative Layout: Option A. Map provided by EXM Advisory Services.

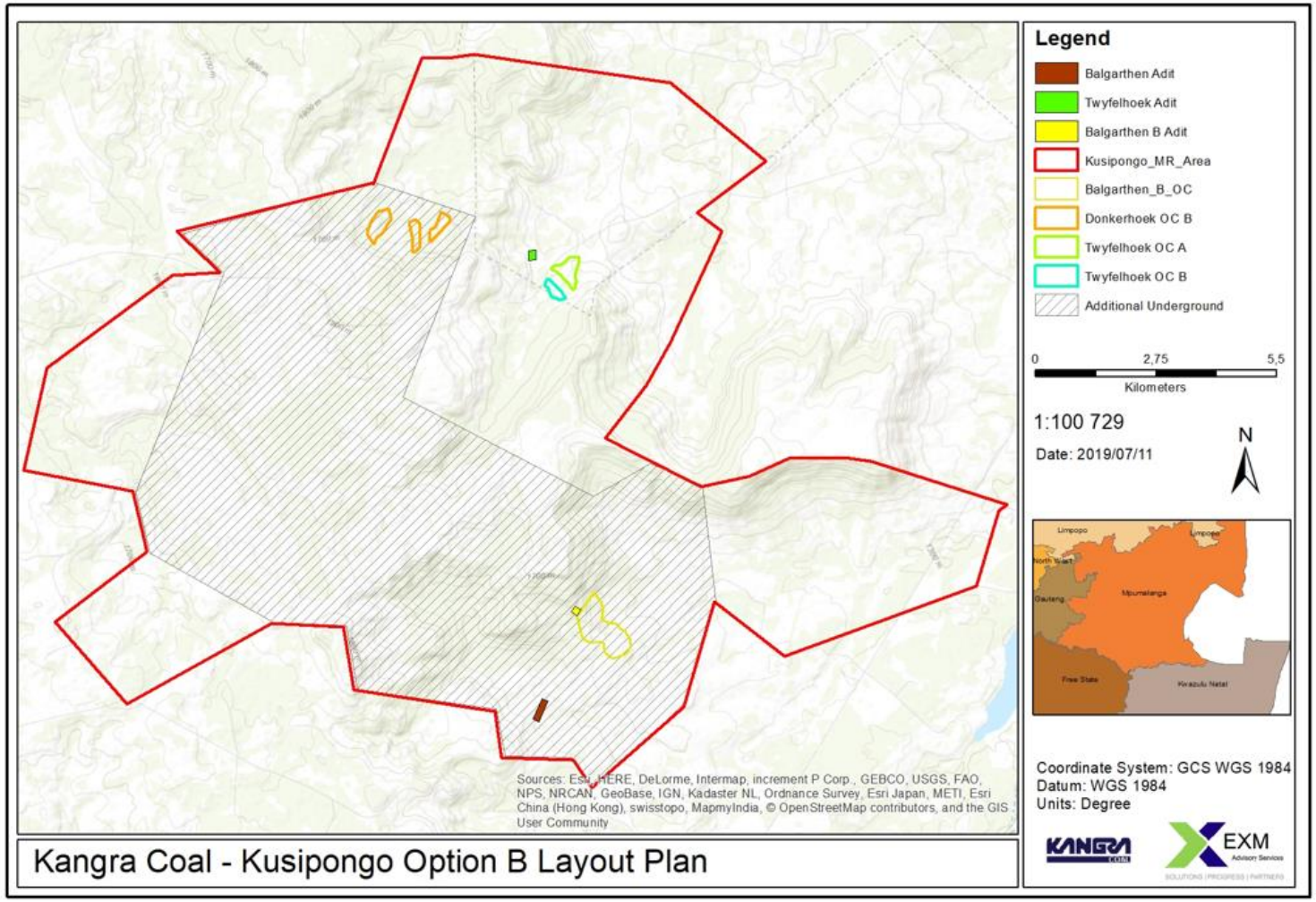

Figure 6: Alternative Layout: Option B. Map provided by EXM Advisory Services

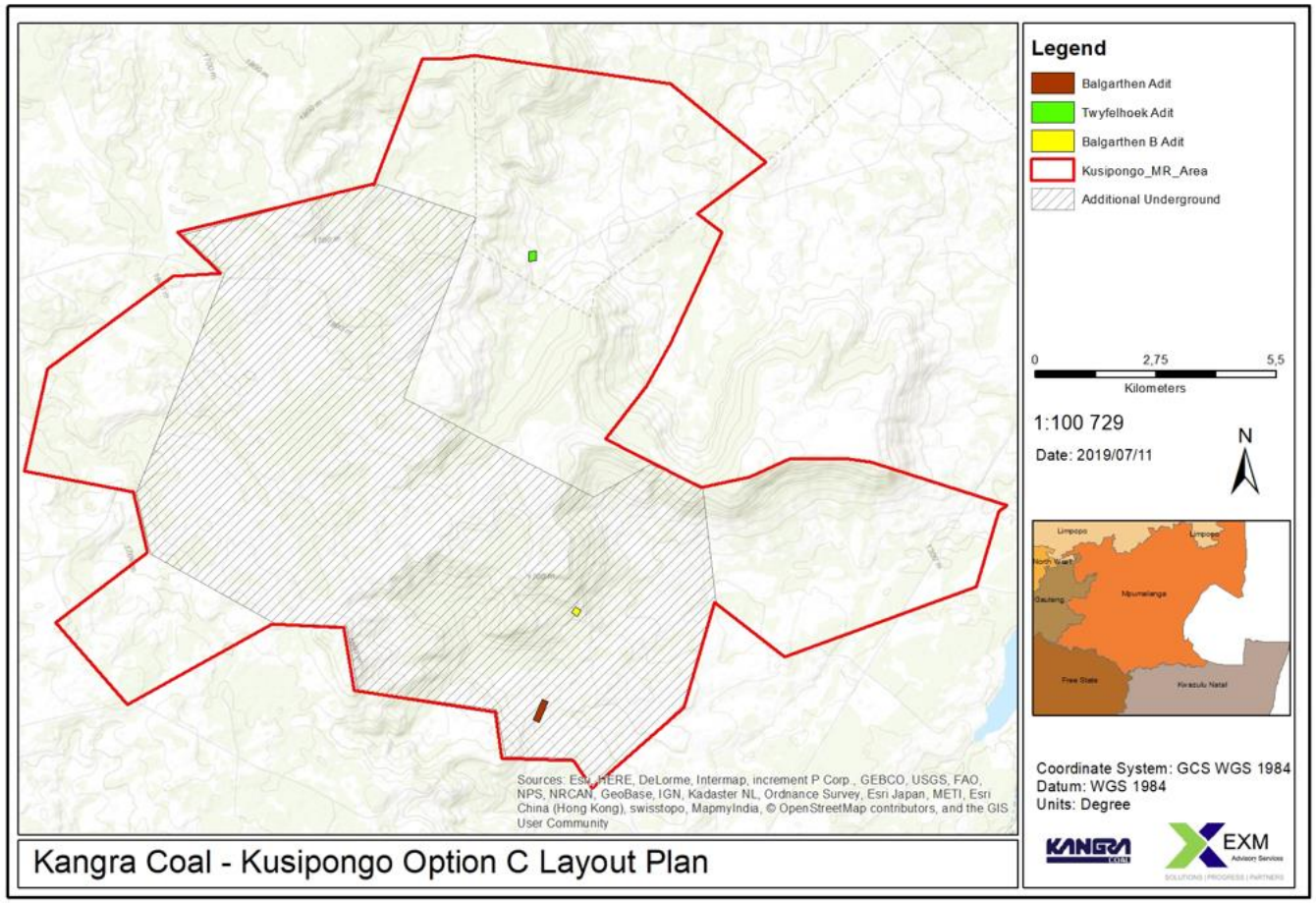

Figure 7: Alternative Layout: Option C. Map provided by EXM Advisory Services

3 LEGISLATION

3.1 National Heritage Resources Act (25 of 1999)

Cultural Heritage in South Africa, includes all heritage resources, is protected by the National Heritage Resources Act (Act 25 of 1999) (NHRA). Heritage resources as defined in Section 3 of the Act include **"all objects recovered from the soil or waters of South Africa, including archaeological and palaeontological objects and material, meteorites and rare geological specimens**".

Palaeontological heritage is unique and non-renewable and is protected by the NHRA. Palaeontological resources may not be unearthed, broken moved, or destroyed by any development without prior assessment and without a permit from the relevant heritage resources authority as per section 35 of the NHRA.

This DIA forms part of the Heritage Impact Assessment (HIA) and adhere to the conditions of the Act. According to **Section 38 (1)**, an HIA is required to assess any potential impacts to palaeontological heritage within the development footprint where:

- the construction of a road, wall, power line, pipeline, canal or other similar form of linear development or barrier exceeding 300 m in length;
- the construction of a bridge or similar structure exceeding 50 m in length;
- any development or other activity which will change the character of a site—
- (exceeding 5 000 m^2 in extent; or
- involving three or more existing erven or subdivisions thereof; or
- involving three or more erven or divisions thereof which have been consolidated within the past five years; or
- the costs of which will exceed a sum set in terms of regulations by SAHRA or a provincial heritage resources authority
- the re-zoning of a site exceeding 10 000 m^2 in extent;
- or any other category of development provided for in regulations by SAHRA or a Provincial heritage resources authority.

4 OBJECTIVE

The objective of a DPIA is to determine the impact of the development on potential palaeontological material at the site.

According to the "SAHRA APM Guidelines: Minimum Standards for the Archaeological and Palaeontological Components of Impact Assessment Reports" the aims of the PIA are: 1) to **identify** the palaeontological status of the exposed as well as rock formations just below the surface

in the development footprint 2) to estimate the **palaeontological importance** of the formations 3) to determine the **impact** on fossil heritage; and 4) to recommend how the developer ought to protect or mitigate damage to fossil heritage.

The terms of reference of a DPIA are as follows:

General Requirements:

- Adherence to the content requirements for specialist reports in accordance with Appendix 6 of the EIA Regulations 2014, as amended;
- Adherence to all applicable best practice recommendations, appropriate legislation and authority requirements;
- Submit a comprehensive overview of all appropriate legislation, guidelines;
- Description of the proposed project and provide information regarding the developer and consultant who commissioned the study,
- Description and location of the proposed development and provide geological and topographical maps
- Provide Palaeontological and geological history of the affected area.
- Identification sensitive areas to be avoided (providing shapefiles/kmls) in the proposed dvelopment;
- Evaluation of the significance of the planned development during the Pre-construction, Construction, Operation, Decommissioning Phases and Cumulative impacts. Potential impacts should be rated in terms of the direct, indirect and cumulative:
    a. **Direct impacts** are impacts that are caused directly by the activity and generally occur at the same time and at the place of the activity.
    b. **Indirect impacts** of an activity are indirect or induced changes that may occur as a result of the activity.
    c. Cumulative impacts are impacts that result from the incremental impact of the proposed activity on a common resource when added to the impacts of other past, present or reasonably foreseeable future activities.
- Fair assessment of alternatives (infrastructure alternatives have been provided):
- Recommend mitigation measures to minimise the impact of the proposed development; and
- Implications of specialist findings for the proposed development (such as permits, licenses etc).

5 GEOLOGICAL AND PALAEONTOLOGICAL HISTORY

The proposed Kusipongo underground and opencast coal mine development as well as all alternatives is underlain by the Vryheid Formation of the Ecca Group (Karoo Supergroup), while the central portion of Kusipongo mining right application is underlain by the Volksrust Formation (Ecca Group) and Karoo dolerite (Figure 8). According to the PalaeoMap of South African Heritage Resources Information System the Palaeontological Sensitivity of the Vryheid Formation is Very High and that of the Volksrust Formation is High while the Karoo Dolerite Suite consists of igneous rock and thus has a Palaeontological Sensitivity of zero (Almond and Pether 2008, SAHRIS website).

All the South African coalfields occur in the Main Karoo Basin or its associated sub-basins. The Main Karoo Basin forms part of a primary series of Gondwanan basins that was established along the southern boundary of Gondwana (Cole, 1992; De Wit and Ransome 1992; Veevers et al. 1994; Catuneanu et al. 1998;). These basins include Beacon Basin in Antarctica, Bowen Basin in Australia as well as the Paraná Basin in South America. The Basins formed between the Late Carboniferous and Middle Jurassic and their joint stratigraphies characterize the best record of non-marine sedimentation in the world.

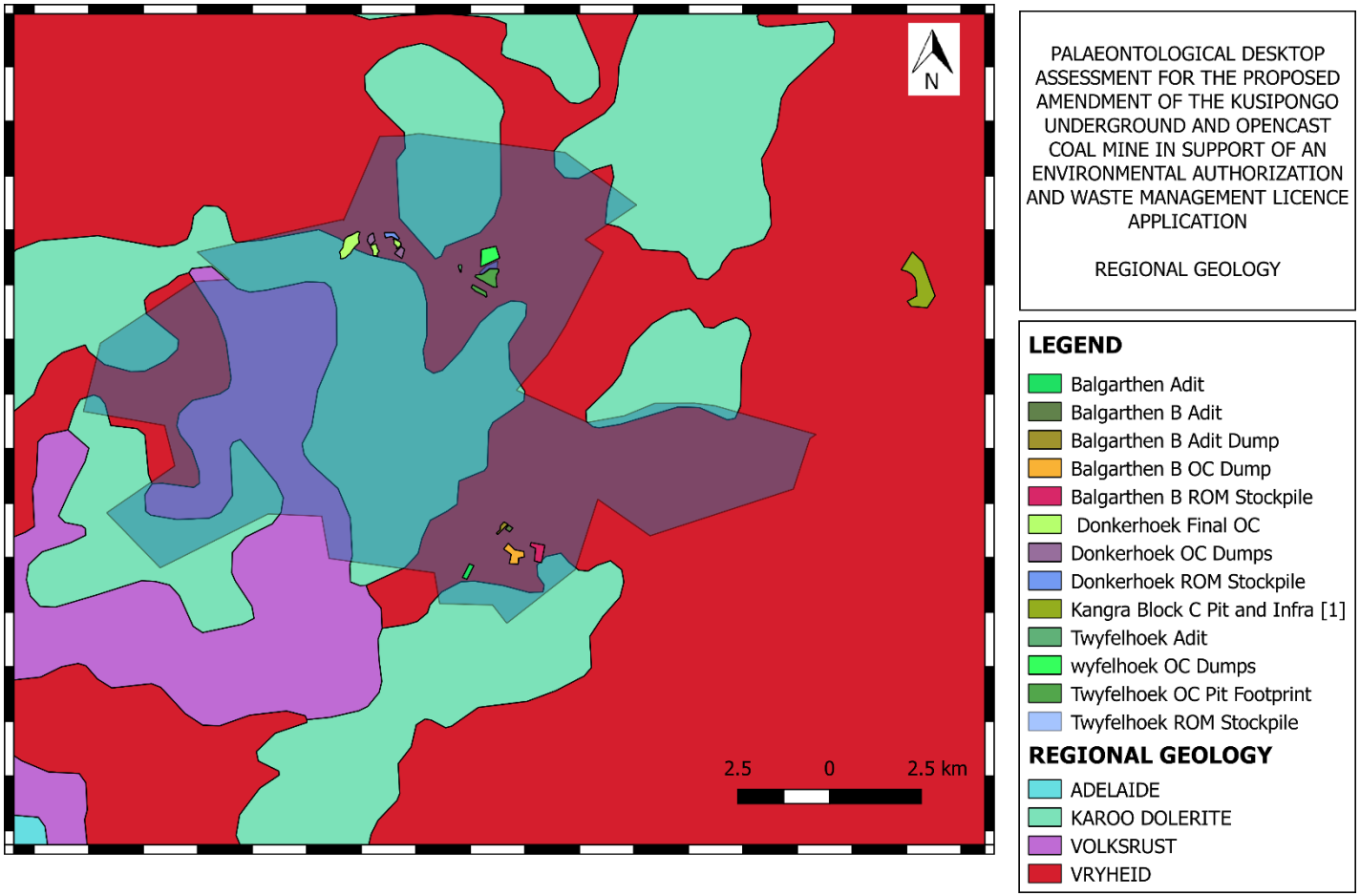

Figure 8. Surface geology of the proposed the proposed Kusipongo underground and opencast coal mine development is underlain by the Vryheid Formation of the Ecca Group (Karoo Supergroup), while the central portion of Kusipongo mining right application is underlain by the Volksrust Formation (Ecca Group) as well as Karoo Dolerite. Map was drawn by QGIS 2.18.28.

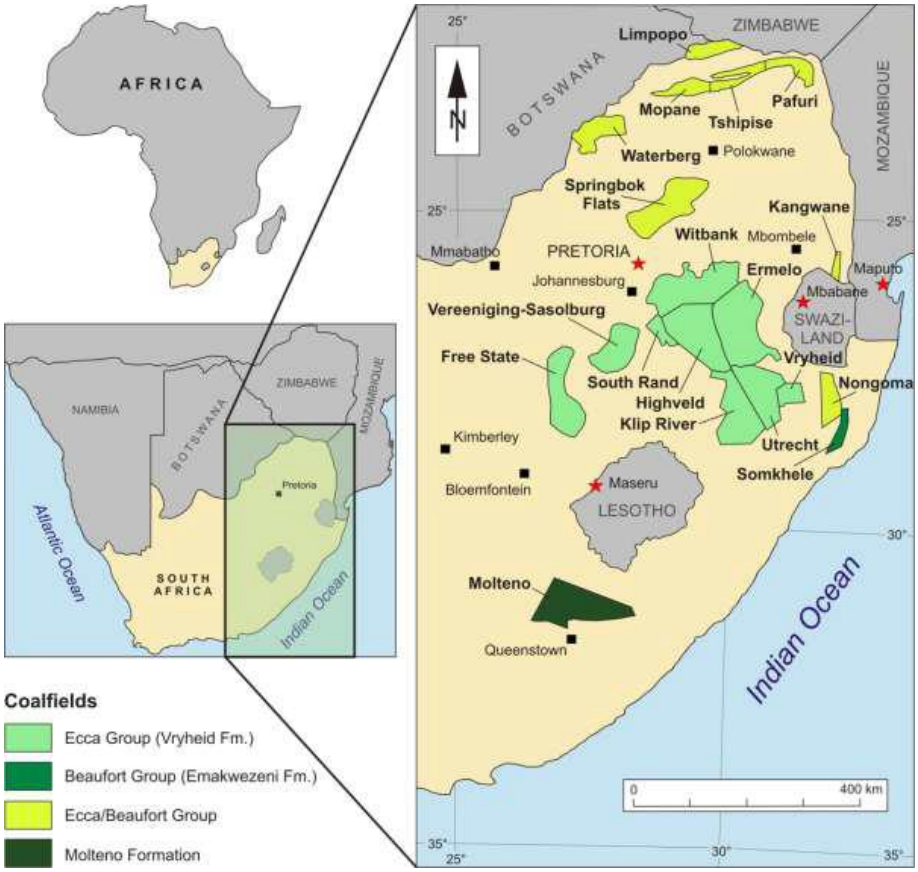

Figure 9: Coalfields of Southern Africa, taken from Hancox and Götz (2014).

Most of the coal mined in South Africa is from the Permian Vryheid Formation (Figure 9). The depth of the Vryheid Formation in the main Karoo Basin varies from 70 m to 500 m near Vryheid and New Castle in Kwazulu-Natal, where the basin was at its deepest.

Table 1: Ecca Group and Formations. (Modified from Johnson et al, 2006).

<table>
<tr><th>Period</th><th>Supergroup</th><th>Group</th><th>Formation West of 24º E</th><th>Formation East of 24º E</th><th>Formation Free State / KwaZulu Natal</th></tr>
<tr><td rowspan="8">Permian</td><td rowspan="8">Karoo Supergroup</td><td rowspan="8">Ecca Group</td><td>Waterford Formation</td><td>Waterford Formation</td><td rowspan="2"></td></tr>
<tr><td>Tierberg / Fort Brown Formation</td><td>Fort Brown Formation</td><td>Volksrust Formation</td></tr>
<tr><td>Laingsburg / Rippon Formation</td><td>Rippon Formation</td><td>Vryheid Formation</td></tr>
<tr><td>Collingham Formation</td><td>Collingham Formation</td><td rowspan="3">Pietermaritzburg Formation</td></tr>
<tr><td>Whitehill Formation</td><td>Whitehill Formation</td></tr>
<tr><td>Prince Albert Formation</td><td>Prince Albert Formation</td></tr>
<tr><td>Mbizane Formation</td></tr>
<tr><td></td></tr>
</table>

This Group consists of the following Formations (DWA, 1998):

The **Volksrust Formation** consists of grey to black, silty shale with thin, usually bioturbated, siltstone or sandstone lenses and beds, particularly towards its upper and lower boundaries. Thin phosphate and carbonate beds and concretions are relatively common. Fossils of the Volksrust Formation are mainly trace fossils that are recorded from the bedding planes of the shale beds in the formation. The fossils are rarely recorded as they are difficult to find in areas of deep weathering. If fossils are found, they will contribute considerably to our understanding of the palaeoenvironments in this part of the Karoo Basin.

The **Vryheid Formation** comprises of mudrock, rhythmite, siltstone and fine- to coarse-grained sandstone (pebbly in places). The Formation contains up to five (mineable) coal seams. The different lithofacies are mainly arranged in upward-coarsening deltaic cycles (up to 80m thick in the southeast). Fining-upward fluvial cycles, of which up to six are present in the east, are typically sheet-like in geometry, although some form valley-fill deposits. They comprise coarse-grained to pebbly, immature sandstones - with an abrupt upward transition into fine-grained sediments and coal seams.

The Vryheid Formation is known to contain a rich assemblage of Glossopteris flora which is the source vegetation for the Vryheid Formation. Gymnospermous glossopterids dominated the peat and non-peat accumulating of Permian wetlands after continental deglaciation took place (Falcon, 1986c, Greb et al., 2006).

Recent paleobotanical studies in the Vryburg Formation include that of Adenforff (2005), Bordy and Prefec (2008) and Prefec *et al.* (2008, 2009, 2010) and Prevec, (2011). Bamford (2011) described numerous plant fossils from this formation (e.g. *Azaniodendron fertile*, *Cyclodendron leslii, Sphenophyllum hammanskraalensis, Annularia sp., Raniganjia sp., Asterotheca spp., Liknopetalon enigmata, Hirsutum* sp., *Scutum* sp., *Ottokaria* sp., *Estcourtia* sp., *Arberia* sp., *Lidgetonnia* sp., *Noeggerathiopsis* sp., *Podocarpidites* sp as well as more than 20 Glossopteris species.

In the past palynological studies have focused on the coal bearing successions of the Vryheid Formation and include articles by Aitken (1993, 1994, 1998), and Millsteed (1994, 1999), while recent studies were conducted by Götz and Ruckwied (2014).

Bamford (2011) is of the opinion that only a small amount of data have been published on these potentially fossiliferous deposits and that most likely good material are present around coal mines and in other areas the exposures are poor and of little interest. When plant fossils do occur they are usually abundant. According to Bamford it is not feasible to preserve all the sites but in the interests of science these sites ought to be well documented, researched and the collected fossils must be housed in an accredited institution.

To date no fossil vertebrates have been collected from the Vryheid formation. The presence of fossil insects is rare, while palynomorphs are diverse. Non-marine bivalves and fish scales have also been reported from this formation. Trace fossils are abundantly found but the diversity is low. The mesosaurid reptile, *Mesosaurus* has been found in the southern parts of the basin but may also be present in other areas of the Vryheid formation. Regardless of the rare and irregular occurrence of fossils in this biozone a single fossil may be of scientific importance as many fossil taxa are known from a single fossil.

Karoo Dolerite Suite was formed in the Early Jurassic Period is a volcanic suite which consists of igneous rocks and is thus unfossiliferous. The Karoo Dolerite Suite is a widespread system of igneous bodies (dykes, sills) that invaded into the sediments of the Main Karoo Basin. Karoo lavas which are preserved today are erosional remnants of a more extensive lava cap that covered much of southern Africa in the past. Flood basalts do not usually form any visible volcanic structures but with various succession of eruptions form a suite of fissures of sub-horizontal lava flows. These basalts may vary in thickness from a couple of meters to hundreds and even thousands of meters.

6 GEOGRAPHICAL LOCATION OF THE SITE

The proposed Kusipongo mining right area is located approximately 54 km to the west of Piet Retief and 34 km south east of Ermelo in the Mkhondo Local Municipality within the Gert Sibande District Municipality.

7 METHODS

A desktop study was assembled to evaluate the possible risk to palaeontological heritage (this includes fossils as well as trace fossils) in the proposed development area. In compiling the desktop report aerial photos, Google Earth 2018, topographical and geological maps and other reports from the same area as well as the author's experience were used to assess the proposed development footprint.

7.1 Assumptions and Limitations

The accuracy of DIA is reduced by several factors which may include the following: the databases of institutions are not always up to date and relevant locality and geological information were not accurately documented in the past. Various remote areas of South Africa have not been assessed by palaeontologists and data is based on aerial photographs alone. Geological maps concentre on the geology of an area and the sheet explanations were never intended to focus on palaeontological heritage.

Similar Assemblage Zones, but in different areas is used to provide information on the presence of fossil heritage in an unmapped area. Desktop studies of similar geological formations and Assemblage Zones generally **assume** that exposed fossil heritage is present within the development area. The accuracy of the Palaeontological Impact Assessment is thus improved considerably by conducting a field-assessment.

8 ADDITIONAL INFORMATION CONSULTED

In compiling this report the following sources were consulted:

- The Palaeosensitivity Map from the SAHRIS website.
- 2730 AB; 2730 AA and 2630 CD Topographical maps
- Geological map 1:100 000, Geology of the Republic of South Africa (Visser 1984)
- A Google Earth map with polygons of the proposed development was obtained from PGS Consultants.

- Palaeontological Impact Assessments found on the internet in close vicinity of the proposed development include Bamford, 2011, 2017, 2018a, 2018b, Butler 2018a, 2018b. This assessment is included in the reference list.

9 IMPACT ASSESSMENT METHODOLOGY

An assessment of the impact significance of the proposed Kusipongo upgrade on local fossil heritage is presented here:

9.1 Methodology for Impact Assessment

In order to ensure uniformity, a standard impact assessment methodology has been utilised so that a wide range of impacts can be compared. The impact assessment methodology makes provision for the assessment of impacts against the following criteria:

- Significance;
- Spatial scale;
- Temporal scale;
- Probability; and
- Degree of certainty.

A combined quantitative and qualitative methodology was used to describe impacts for each of the aforementioned assessment criteria. A summary of each of the qualitative descriptors, along with the equivalent quantitative rating scale for each of the aforementioned criteria, is given in Error! Reference source not found..

Table 2: Quantitative rating and equivalent descriptors for the impact assessment criteria

RATING	SIGNIFICANCE	EXTENT SCALE	TEMPORAL SCALE
1	VERY LOW	*Isolated site/ proposed corridor*	Incidental
2	LOW	*Study area*	Short-term
3	MODERATE	*Local*	Medium-term
4	HIGH	*Regional / Provincial*	Long-term
5	VERY HIGH	*Global / National*	Permanent

A more detailed description of each of the assessment criteria is given in the following sections.

9.1.1 Significance Assessment

The Significance rating (importance) of the associated impacts embraces the notion of extent and magnitude, but does not always clearly define these, since their importance in the rating scale is very relative. For example, the magnitude (i.e. the size) of an area affected by atmospheric pollution may be extremely large (1000 km^2) but the significance of this effect is dependent on the concentration or level of pollution. If the concentration is great, the significance of the impact would be HIGH or VERY HIGH, but if it is diluted it would be VERY LOW or LOW. Similarly, if 60 ha of a grassland type are destroyed, the impact would be VERY HIGH if only 100 ha of that grassland type were known. The impact would be VERY LOW if the grassland type was common.

A more detailed description of the impact significance rating scale is given in Error! Reference source not found. below.

Table 3: Description of the significance rating scale

RATING		DESCRIPTION
5	VERY HIGH	Of the highest order possible within the bounds of impacts which could occur. In the case of adverse impacts: there is no possible mitigation and/or remedial activity which could offset the impact. In the case of beneficial impacts, there is no real alternative to achieving this benefit.
4	HIGH	Impact is of substantial order within the bounds of impacts which could occur. In the case of adverse impacts: mitigation and/or remedial activity is feasible but difficult, expensive, time-consuming or some combination of these. In the case of beneficial impacts, other means of achieving this benefit are feasible but they are more difficult, expensive, time-consuming or some combination of these.
3	MODERATE	Impact is real but not substantial in relation to other impacts, which might take effect within the bounds of those which could occur. In the case of adverse impacts: mitigation and/or remedial activity are both feasible and fairly easily possible. In the case of beneficial impacts: other means of achieving this benefit are about equal in time, cost, effort, etc.
2	LOW	Impact is of a low order and therefore likely to have little real effect. In the case of adverse impacts: mitigation and/or remedial activity is either easily achieved or little will be required, or both. In the case of beneficial impacts, alternative means for achieving this benefit are likely to be easier, cheaper, more effective, less time consuming, or some combination of these.
1	VERY LOW	Impact is negligible within the bounds of impacts which could occur. In the case of adverse impacts, almost no mitigation and/or remedial activity

		are needed, and any minor steps which might be needed are easy, cheap, and simple. In the case of beneficial impacts, alternative means are almost all likely to be better, in one or a number of ways, than this means of achieving the benefit. Three additional categories must also be used where relevant. They are in addition to the category represented on the scale, and if used, will replace the scale.
0	NO IMPACT	There is no impact at all - not even a very low impact on a party or system.

9.1.2 Spatial Scale

The spatial scale refers to the extent of the impact i.e. will the impact be felt at the local, regional, or global scale. The spatial assessment scale is described in more detail in the table below.

Table 4: Description of the Spatial significance rating scale

RATING		DESCRIPTION
5	Global/National	The maximum extent of any impact.
4	Regional/Provincial	The spatial scale is moderate within the bounds of possible impacts, and will be felt at a regional scale (District Municipality to Provincial Level). The impact will affect an area up to 50 km from the proposed site.
3	Local	The impact will affect an area up to 5 km from the proposed site.
2	Study Area	The impact will affect an area not exceeding the boundary of the study area.
1	Isolated Sites / proposed site	The impact will affect an area no bigger than the site.

9.1.3 Temporal/Duration Scale

In order to accurately describe the impact, it is necessary to understand the duration and persistence of an impact in the environment. The temporal or duration scale is rated according to criteria set out in **Table 5.**

Table 5: Description of the temporal rating scale

RATING	DESCRIPTION

1	Incidental	The impact will be limited to isolated incidences that are expected to occur very sporadically.
2	Short-term	The environmental impact identified will operate for the duration of the construction phase or a period of less than 5 years, whichever is the greater.
3	Medium-term	The environmental impact identified will operate for the duration of life of the project.
4	Long-term	The environmental impact identified will operate beyond the life of operation of the project.
5	Permanent	The environmental impact will be permanent.

9.1.4 Degree of Probability

The probability, or likelihood, of an impact occurring will be described as shown in Table 6 below.

Table 6: Description of the degree of probability of an impact occurring

RATING	DESCRIPTION
1	Practically impossible
2	Unlikely
3	Could happen
4	Very likely
5	It's going to happen / has occurred

9.1.5 Degree of Certainty

As with all studies, it is not possible to be 100% certain of all facts, and for this reason a standard "degree of certainty" scale is used, as discussed in Error! Reference source not found.. The level of detail for specialist studies is determined according to the degree of certainty required for decision-making. The impacts are discussed in terms of affected parties or environmental components.

Table 7: Description of the degree of certainty rating scale

RATING	DESCRIPTION
Definite	More than 90% sure of a particular fact.
Probable	Between 70 and 90% sure of a particular fact, or of the likelihood of that impact occurring.

Possible	Between 40 and 70% sure of a particular fact, or of the likelihood of an impact occurring.
Unsure	Less than 40% sure of a particular fact or the likelihood of an impact occurring.
Can't know	The consultant believes an assessment is not possible even with additional research.

9.1.6 Quantitative Description of Impacts

To allow for impacts to be described in a quantitative manner, in addition to the qualitative description given above, a rating scale of between 1 and 5 was used for each of the assessment criteria. Thus, the total value of the impact is described as the function of significance, spatial and temporal scale, as described below:

$$\textbf{\textit{Impact Risk}} = \frac{(\text{SIGNIFICANCE} + \textit{Spatial} + \text{Temporal})}{3} \times \frac{\text{Probability}}{5}$$

An example of how this rating scale is applied is shown below:

Table 8: Example of Rating Scale

IMPACT	SIGNIFICANCE	SPATIAL SCALE	TEMPORAL SCALE	PROBABILITY	RATING
	Very High	Study Area	Permanent	Very likely	**High**
Impact on heritage sites	5	2	5	4	3.2

Note: The significance, spatial and temporal scales are added to give a total of 12, which is divided by 3 to give a criterion rating of 4. The probability (4) is divided by 5 to give a probability rating of 0.8. The criteria rating of 4 is then multiplied by the probability rating (0,6) to give the final rating of 3.2.

The impact risk is classified according to 5 classes as described in the table below.

Table 9: Impact Risk Classes

RATING	IMPACT CLASS	DESCRIPTION
0.1 – 1.0	1	Very Low

1.1 – 2.0	2	Low
2.1 – 3.0	3	Moderate
3.1 – 4.0	4	High
4.1 – 5.0	5	Very High

Therefore, with reference to the example used for air quality above, an impact rating of 3.2 will fall in the Impact Class 4, which will be considered to be a High impact.

9.2 Summary of Impact Tables

The development footprint is completely underlain by the Vryheid and Volksrust Formations of the Ecca Group as well as Karoo Dolerite. According to the PalaeoMap of South African Heritage Resources Information System the Palaeontological Sensitivity of the Vryheid Formation is Very High and that of the Volksrust Formation is High while the Karoo Dolerite Suite consists of igneous rock and thus has a Palaeontological Sensitivity of zero. The expected duration of the impact is assessed as potentially permanent. In the absence of mitigation procedures (should fossil material be present within the affected area) the damage or destruction of any palaeontological materials will be permanent. Impacts on palaeontological heritage during the construction phase could potentially occur and are regarded as having a Very High possibility.

10 FINDINGS AND RECOMMENDATIONS

The proposed **Kusipongo underground and opencast coal mine** development as well as all alternatives is underlain by the Vryheid Formation of the Ecca Group (Karoo Supergroup), while the central portion of Kusipongo mining right application is underlain by the Volksrust Formation (Ecca Group) and Karoo dolerite. According to the PalaeoMap of South African Heritage Resources Information System the Palaeontological Sensitivity of the Vryheid Formation is Very High and that of the Volksrust Formation is High while the Karoo Dolerite Suite consists of igneous rock and thus has a Palaeontological Sensitivity of zero (Almond and Pether 2008, SAHRIS website).

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Appendix A – Elize Butler CV

CURRICULUM VITAE

ELIZE BUTLER

PROFESSION: Palaeontologist

YEARS' EXPERIENCE: 26 years in Palaeontology

EDUCATION: B.Sc Botany and Zoology, 1988
University of the Orange Free State

B.Sc (Hons) Zoology, 1991
University of the Orange Free State

Management Course, 1991
University of the Orange Free State

M. Sc. *Cum laude* (Zoology), 2009
University of the Free State

Dissertation title: The postcranial skeleton of the Early Triassic non-mammalian Cynodont *Galesaurus planiceps*: implications for biology and lifestyle

Registered as a PhD fellow at the Zoology Department of the UFS
2013 to current

Dissertation title: A new gorgonopsian from the uppermost D*aptocephalus Assemblage Zone*, in the Karoo Basin of South Africa

MEMBERSHIP

Palaeontological Society of South Africa (PSSA)	2006-currently

EMPLOYMENT HISTORY

Part-time Laboratory assistant	Department of Zoology & Entomology University of the Free State Zoology 1989-1992
Part-time laboratory assistant	Department of Virology University of the Free State Zoology 1992

Research Assistant	National Museum, Bloemfontein 1993 – 1997
Principal Research Assistant and Collection Manager	National Museum, Bloemfontein 1998–currently

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