BM GEOLOGICAL SERVICES

FULL PALAEONTOLOGICAL HERITAGE IMPACT ASSESSEMENT REPORT ON THE SITE OF A PROPOSED EXTENSION OF THE BUSHMANLAND GYPSUM MINE TO BE LOCATED ON THE FARM DIKPENS 182 PORTION 2 AND PORTION 4, CALVINIA DISTRICT, NORTHERN CAPE PROVINCE

31 June 2014

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Prepared for:

SitePlan Consulting CC

Prepared By:

Prof. B.D. Millsteed

EXECUTIVE SUMMARY

SitePlan Consulting CC has been appointed to produce an application for a Mining Right that will form the basis of an extension of the existing Bushmanland Gypsum Mine. The site of the proposed mine extension lies approximately 32 km south-west of Granaatboskalk and approximately 82 km north of Loeriesfontein, in the Magisterial District of Loeriesfontein in the Northern Cape Province. The area reported on is located immediately to the east of Konnes se Pan and is wholly within the farm Dikpens 182 Portion 2 and Portion 4. The study area is large, approximately 1 283 ha, but it is unlikely that any mining will occur in the north-eastern corner or the area as the Prince Albert Formation strata crop out there and do not appear to be mineralised.

The mining operations will consist of an open pit mine with a 30 year term for this Mining right Application (if granted). Mining methods will involve stripping of Cenozic regolith (particularly the red aeolian sands) to mine a gypsum deposit located at the base of the aeolian sands and on top of the overlying the bedrock.

SitePlan Consulting (Pty) Ltd has been appointed to conduct an application for a Mining Right in terms of Section 22 of the Mineral and Petroleum Resources Development Act 28 of 2002 (MPRDA). SitePlan Consulting CC has appointed BM Geological Services to provide a Full Palaeontological Heritage Impact Assessment Report in respect of the proposed project that will form part of the final Heritage Impact assessment Report.

The project area is underlain by rocks of the Prince Albert Formation, Karoo Dolerite Suite and various Cenozoic regolith sedimentary units. It is known that elsewhere in the South Africa the Prince Albert Formation and sediments coeval with the Cenozoic regolith are fossiliferous.

The potential for a negative impact on the fossil heritage of the area can be quantified in the following manner. The probability of a negative impact on the palaeontological heritage of the Prince Albert Formation and the Cenozoic regolith is assessed as low as no fossil materials were located during the detailed site investigation due and also as fossils are generally scarce elsewhere within these units. However, the vertebrate faunas contained within the correlative Cenozoic regolith elsewhere in the region are scientifically significant, amongst other reasons, for documenting the palaeoecology and palaeoclimate of the otherwise sparsely recorded last 15-16 Ma interval of South African history; any negative impact may have high significance. The fossils within the Prince Albert Formation are potentially less significant, and this unit will suffer minimal impact from the mining operation. The dolerites are igneous, intrusive rocks and are unfossiliferous and, as such there will be nil impact of any significance.

The project has been assessed as being socially beneficial, herein, as it would provide materials for the production of cement and other building products. The possibility of any negative impact on the palaeontological heritage of the project area could be

minimised by the conduct of thorough and regular examinations of the mine excavations as they are being performed. It is recognised that the mining process will be conducted by continuous mining machinery and that any fossil material unearthed would be destroyed at the same time. However, the mine high walls and floor (the former consisting of aeolian sands and the later consisting of fresh Prince Albert Formation rocks) should be inspected regularly by mine staff (e.g., the environmental officer) to see if any fossils have been exposed; this process should certainly occur before the pit is rehabilitated. Should any fossil materials be identified during the construction phase, the excavations should be halted and SAHRA informed of the discovery. A potential positive outcome of these mitigation protocols could be that fossil materials become available for scientific study that would otherwise have been hidden within or beneath the regolith. Should such new palaeontological material be located as a result of this site investigation this could prove to have a positive effect on the understanding of the fossil record of South Africa and positively affect the palaeontological heritage of the country.

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

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SitePlan Consulting CC has been appointed to produce an application for a Mining Right that will form the basis of an extension of the existing Bushmanland Gypsum Mine in terms of Section 22 of the Mineral and Petroleum Resources Development Act 28 of 2002 (MPRDA). The site of the proposed mine extension lies approximately 32 km south-west of Granaatboskalk and approximately 82 km north of Loeriesfontein, in the Magisterial District of Loeriesfontein in the Northern Cape Province (Figure 1). The area reported on, herein, occupies an area of approximately 1 283 ha, which is located immediately to the east of Konnes se Pan and wholly within the farm Dikpens 182 Portion 2 and Portion 4.

SitePlan Consulting CC has appointed BM Geological Services to provide a Full Palaeontological Heritage Impact Assessment Report in respect of the proposed project that will form part of the final Heritage Impact Assessment Report.

1. TERMS OF REFERENCE AND SCOPE OF THE STUDY

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

- Identify all palaeontological materials located in the area of the project area.
- Quantify the palaeontological heritage significance of any fossil materials identified.
- Describe the possible impact of the proposed development on the palaeontological heritage of the site, according to a standard set of conventions (Appendix A).
- 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.
- Make recommendations concerning future work programs as, and if, necessary.

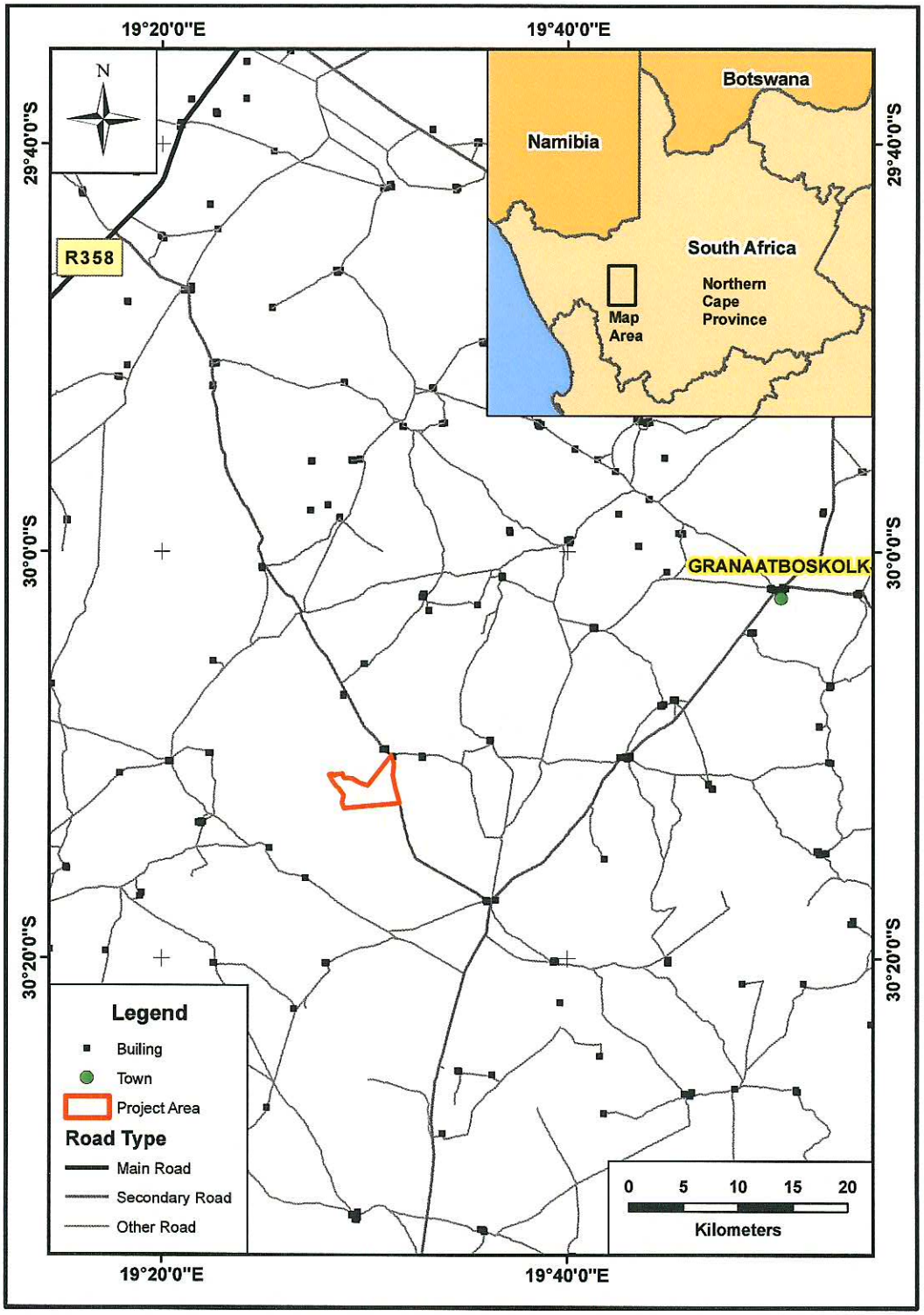

Figure 1: Location map showing the position of the proposed extension of the Bushmanland gypsum mine.

2. LEGISLATIVE REQUIREMENTS

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

2.1 The National Heritage Resources Act

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

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

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

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

2.2 Need for Impact Assessment Reports

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

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

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

2.3 Legislation Specifically Pertinent to Palaeontology*

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

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

- Destroy, damage, excavate, alter, deface or otherwise disturb any archaeological or palaeontological site or any meteorite,
- Destroy, damage, excavate, remove from its original position, collect or own any archaeological or palaeontological material or object or any meteorite,
- Trade in, sell for private gain, export or attempt to export from the Republic any category of archaeological or palaeontological material or object, or any meteorite; or

- Bring onto or use at an archaeological or palaeontological site any excavation equipment or any equipment that assists in the detection or recovery of metals or archaeological and palaeontological material or objects, or use such equipment for the recovery of meteorites,
- Alter or demolish any structure or part of a structure which is older than 60 years as protected.

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

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

2.4 The National Environmental Management Act [as amended]

This Act does not provide the detailed protections and administrative procedures for the protection and management of the nation's Palaeontological Heritage as are detailed in the National Heritage Resources Act, but is more general in 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.

3. RELEVENT EXPERIENCE

Prof. 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. Prof. Millsteed is registered with the South African Council for Natural Scientific Professions (SACNASP), and is a member of the Palaeontological Society of South African and the Geological Society of South Africa.

4. METHODOLOGY

It was considered that the most effective methodology for determining the fossiliferous potential of the project area was to traverse the area by foot. Given the extensive aerial extent of the proposed development it was impossible to visit all locations within the entire site within an acceptable time frame. It was decided that a coverage that was as aerially extensive and representative as possible should be obtained, and that areas of obvious outcrop and any dongas (which may contain outcrop of bedrock) should be specifically targeted for investigation where present. The study area was visited on the 22nd and 23rd of April 2014 by Dr B.D. Millsteed.

The path of the two foot traverses was recorded as separate trackways on a hand-held GPS and their locations are indicated in Figure 2. Photographs were taken and detailed observations made were taken at a number of locations (see data waypoint locations in Figure 2). The location of the photographs and detailed observation points was recorded using a hand-held GPS.

5. ACCESS AND INDEPENDENCE

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

The land surface is relatively flat and featureless. The area is vegetated with sparse to dense cover of low Karooid bushes and grasses generally less than 50 cm high (Figure 3). Accordingly, as the observations were conducted on foot there were no areas that could not be easily visited and studied.

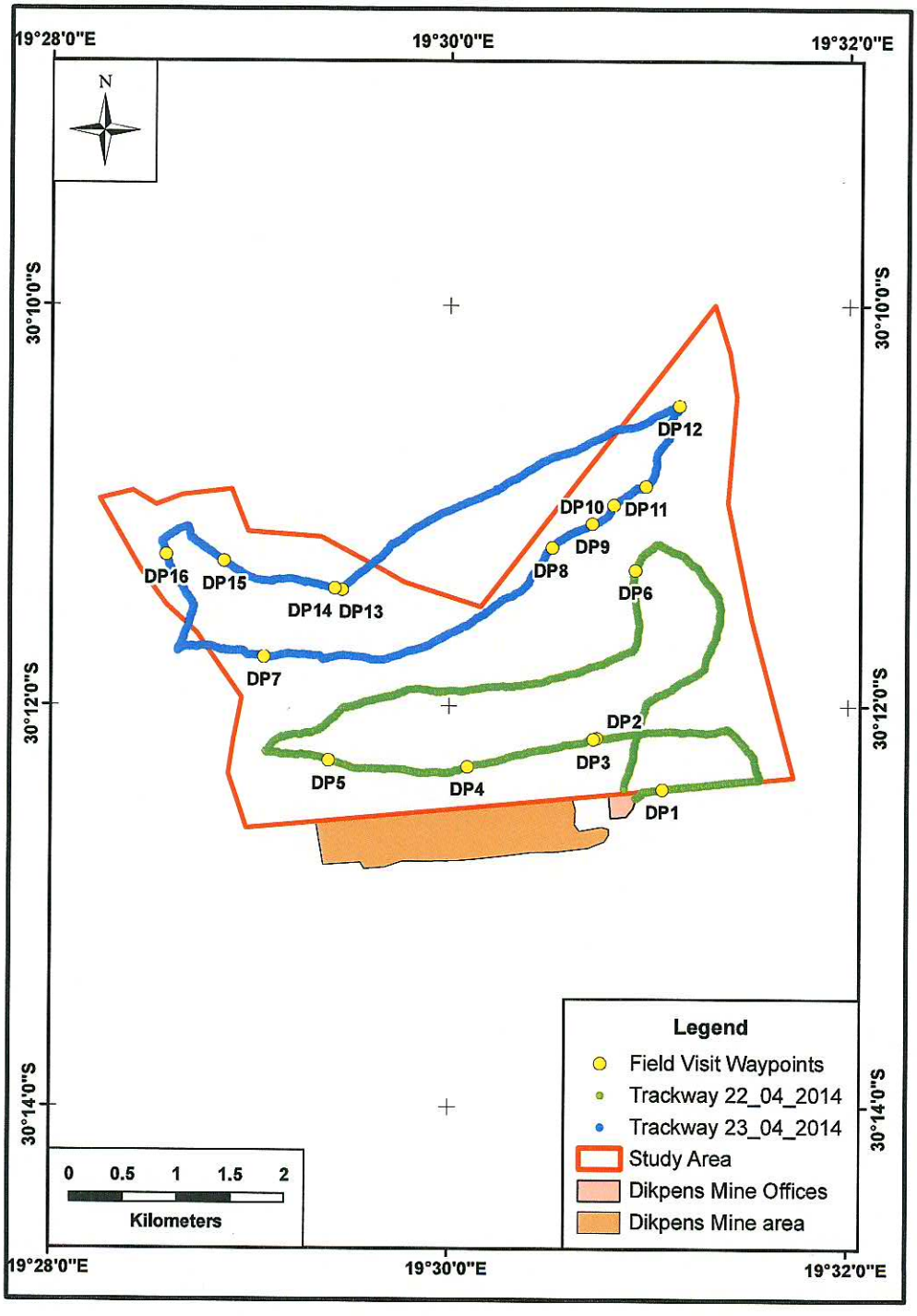

Figure 2: The location of the two field visit traverses of the project area (indicated as GPS trackways) as well as the location of the various waypoints at which data and photographs were collected.

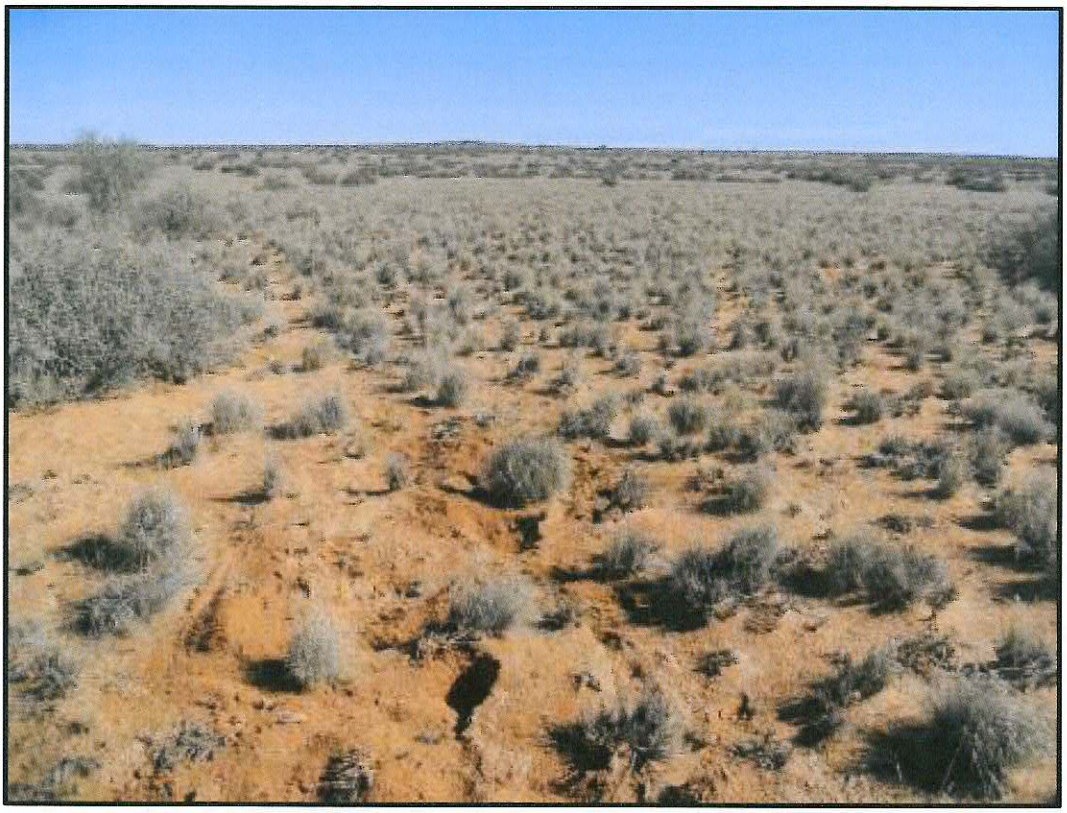

Figure 3: View of the project area looking towards the northwest from waypoint DP1 (see Figure 2). The vegetation of grasses and low karooid bushes is evident, as is the generally flat topography of the area. A small north-south elongate ridge that dominates the central portions of the project area is evident in the background.

Prof. Millsteed was contracted as an independent consultant to conduct this Palaeontological Heritage Impact Assessment study and shall receive fair remuneration for these professional services. Neither Prof. Millsteed nor BM Geological Services has any financial interest in either SitePlan Consulting CC or the proposed mining operations

6. GEOLOGY AND FOSSIL POTENTIAL

Figure 4 shows that the project area is underlain by the strata of three geological units; two bedrock units and a sequence of Cenozoic regolith. The older of the two bedrock units, and the one that appears to constitute the bed rock over the majority of the area, is the Early Permian Prince Albert Formation which crops out along the northern margin and underlies the south-eastern corner of the project area. It is also evident from Figure 4 that there are areas of the Jurassic Karoo Dolerite Suite in the north-western and north-eastern portions of the project area. The Prince Albert Formation and Karoo Dolerite Suite represent part of the basin fill of the Main Karoo Basin and is the intrusive

equivalent of the Drakensburg Group (Figure 5). The majority of the land surface of the project area consists of superficial Cenozoic regolith. A schematic stratigraphic column showing detailing the stratigraphic relationships within the local section of the Karoo Supergroup is shown in Figure 6. A summary of the characteristics of the geological units and their fossiliferous potentials follows.

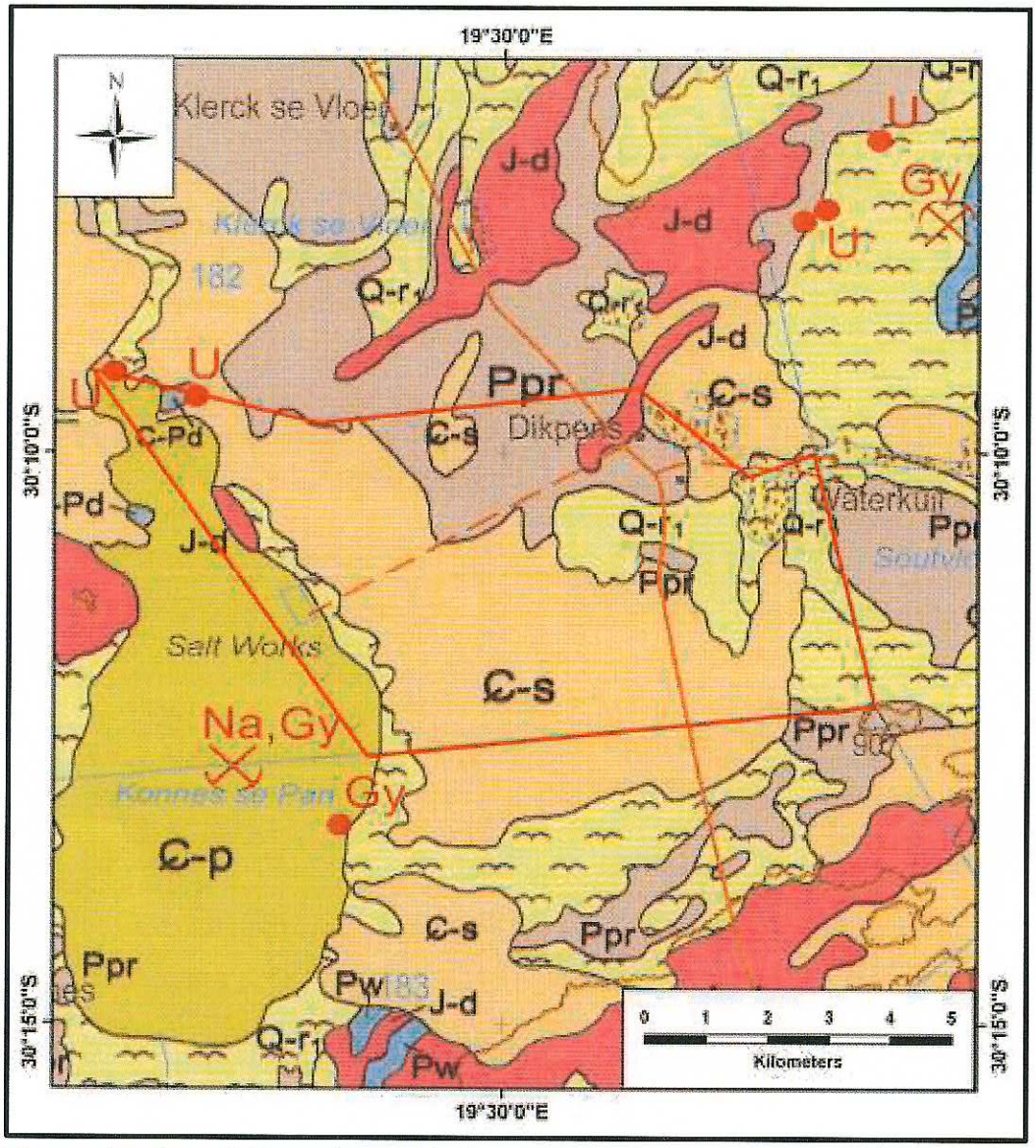

Figure 4: Map of the geology underlying the project area. The rock units depicted within the project area (red polygon) are the Prince Albert Formation (Ppr), the Karoo Dolerite Suite (J-d) and Cenozoic regolith units including include fine clay-rich pan deposits (C-p), red and grey aeolian sands (C-s), sandy soil (Q-r_1) and alluvium (≈). Also evident are that there are deposits of Gypsum (Gy), salt (Na) and uranium (U) present within the region [modified from 1: 250 000 geological map series 3018 Loeriesfontein; Geological Survey of South Africa (1983)].

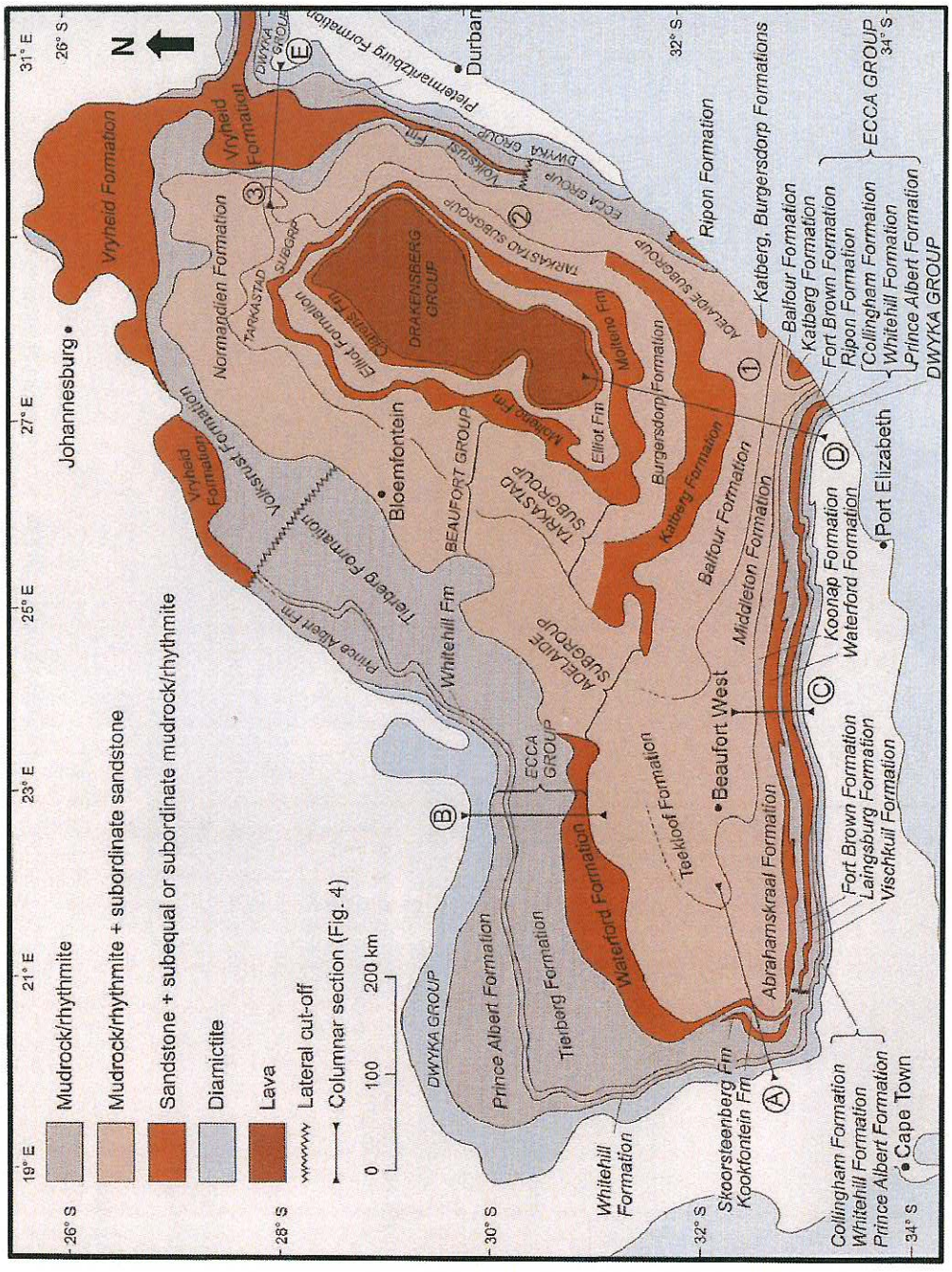

Figure 5: Map of the location of the Main Karoo Basin within South Africa; shown also are the outcrop extents of the various stratigraphic units that comprise the basin infill (Johnson *et al.*, 2006). It is evident that the outcrop of the Prince Albert Formation is widest in the north-west corner of the basin. Along the southern margin of the basin the outcrop width of the unit is so narrow that it must be combined with the Whitehill and Collingham Formations to be visible on the map.

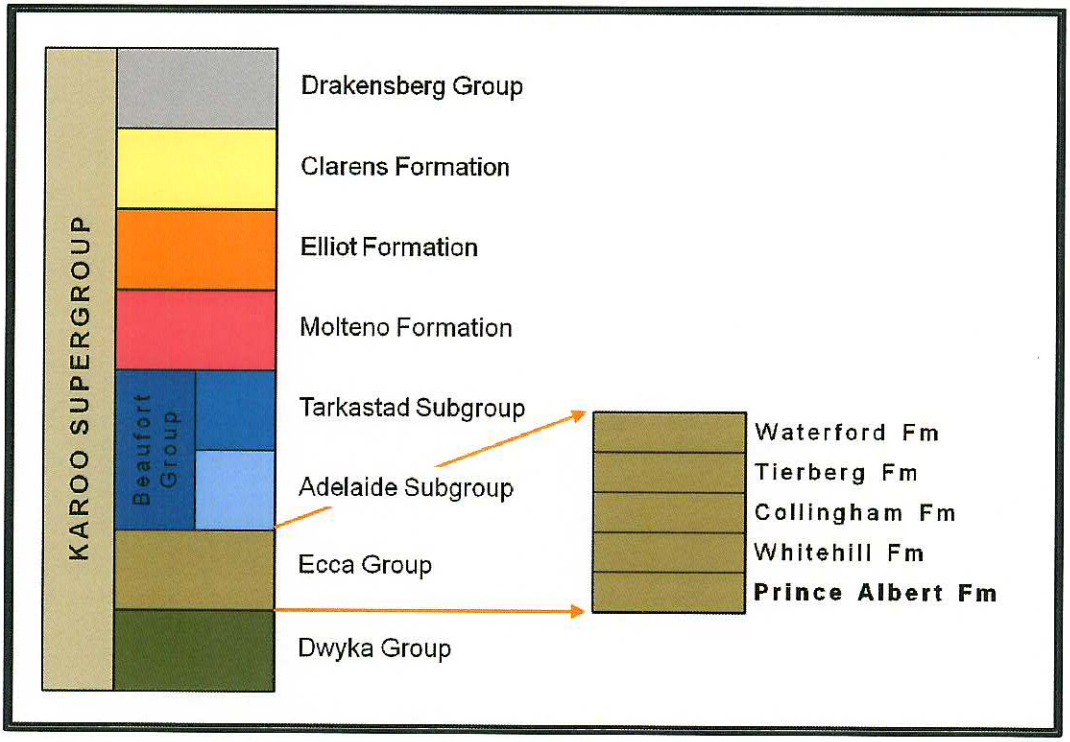

Figure 6: Generalised stratigraphic column of geological units comprising the Karoo Supergroup in the north-western corner of the Karoo Basin. The stratigraphic position of the Prince Albert Formation is highlighted with bold text.

6.1 Prince Albert Formation

6.1.1 Geology

Outcrops of the Prince Albert Formation are confined to the northern and particularly the north-eastern corner of the project area. The outcrops consist of extremely flat exposures of grey, carbonaceous, finely laminated, highly fractured and thermally metamorphosed mudrocks (Figure 7).

6.1.2 Palaeontological potential

Marine invertebrate fossils (cephalopods, bivalves and brachiopods) have been recovered from the Prince Albert Formation close to Douglas, near Kimberly. In the Tanqua Karoo the formation contains palaeoniscid fish, shark coprolites and wood. Near Laingsburg the unit contains sponge spicules, foraminifera, radiolarians and acritarchs. Near Prince Albert there is the shark *Dwykaselachus* as well as possible radiolarians (McLachlan and

Figure 7: Scattered, contact metamorphosed fragments of Prince Albert Formation (Waypoint DP9; see Figure 2).

Anderson, 1973; Veevers *et al.*, 1994; Oelofson, 1986; Visser, 1994; Cole, 2005). The fossil wood present within the unit has been identified as *Australoxylon* (Bamford, 2004).

The laminated mudrocks of the formation commonly yield sparse to dense bedding-plane ichnoassemblages dominate by arthropod trackways (especially *Umfolozia*), scratch burrows or furrows (*Isopodichnus*), arthropod resting traces (*Gluckstadtella*) and fish fin trails (*Undichnia*) (Anderson, 1974, 1976, 1981). In the Loeriesfontein area *Umfolozia* trackways have been recorded in the Ezelsfontein stream (12 km NNW of Loeriesfontein; Anderson, 1981). Large (2-5 cm) horizontal burrows forming Y-branching networks have been reported at Bloukrans (20 km south of Loerisfontein) by Almond (1996 unpubl.).

Despite the positive potential for the presence of fossils within this stratigraphic unit **no palaeontological materials were identified during the conduct of the site investigation.**

6.2 Karoo Dolerite Suite

6.2.1 Geology

The dolerites located within the project area and surrounding region are present as a series of dykes and/or sills of the Jurassic (approximately 183 million years old; Duncan and Marsh, 2006) Karoo Dolerite Suite. A small remnant of a dolerite sill caps the southern portion of the north-south oriented ridge that runs through the study area (Figure 3, and Figure 8, waypoint DP 2). It is also evident from Figure 4 that a northeast-southwest oriented dolerite dyke cross-cuts the northern portions of the study area. No outcrop of this igneous body was observed in the field, but it was noted that the metamorphism and fracturing of the shales of the Prince Albert Formation became more pronounced in this region, and thus, suggests the presence of an intruding (younger) igneous body within that area.

6.2.2 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.

6.3 Cenozoic superficial deposits

6.3.1 General Cenozoic geology of the study area

A number of Cenozoic-age superficial units (Figure 9) were identified during the field visit and the conduct of the foot traverses. These superficial deposits include aeolian sand deposits, and laminated, platy carbonate crusts mantling the land surface proximal to the margins of Konnes se Pan (Figure 4).

6.3.2 Palaeontological potential of correlative strata within the region

There are accumulations of Cenozoic sediments coeval with those in the project area elsewhere within the Northern Cape Province and south-western Namibia region. These strata contain a number of scientifically significant fossil assemblages which provide invaluable insight into the paleoenvironment and palaeoecology of South Africa during the preceding 15-16 million years (see Figure 10 for the location of the sites discussed below). A summary of the major fossil assemblages within the region follows.

A significant Early to Middle Miocene vertebrate fauna has been recorded from the alluvial deposits (gravels, grits, and lenses of clay and sand) of the Koa River palaeovalley system at Bosluis Pan (approximately 60 km northwest of the project area; Figure 5). This fauna has been date to 15-16 Ma. This fauna has been reviewed by Senut *et al.*, (1996) and contains rare bones, tusks, molars and numerous tooth

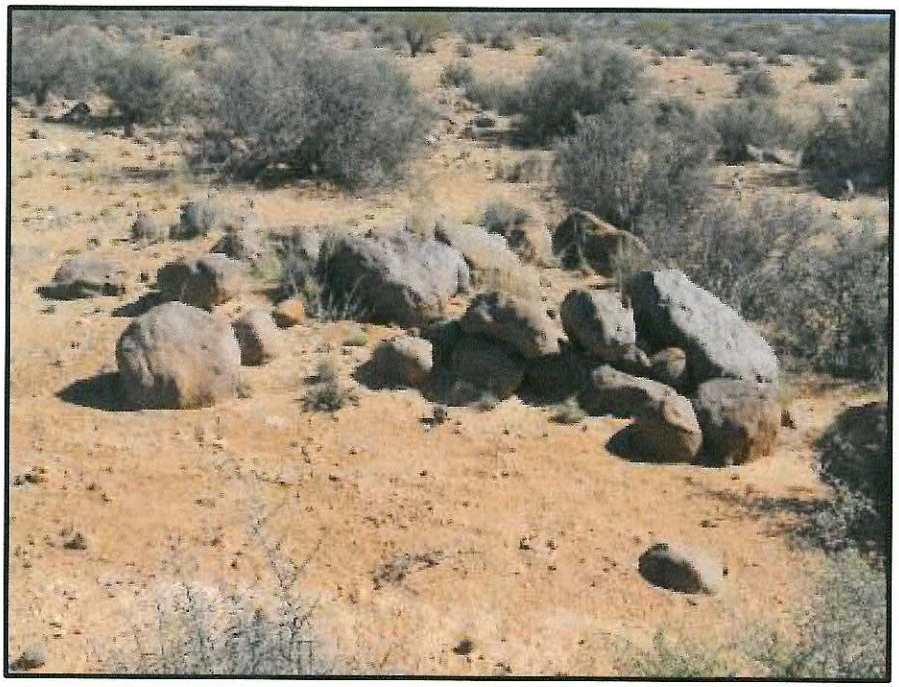

Figure 8: Rounded, manganese stained boulders of dolerite that cap this portion of the central north-south oriented ridge located in the central portion of the study area (waypoint DP2; see Figure 2).

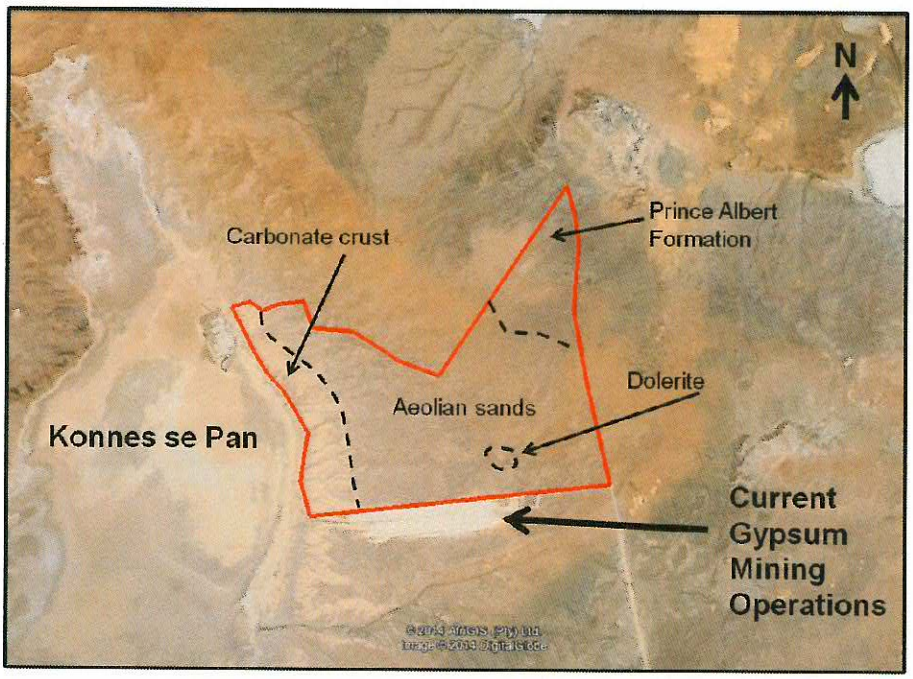

Figure 9: Google earth image showing the approximate distributions of the major geological strata that constitute the land surface within the study area (red polygon).

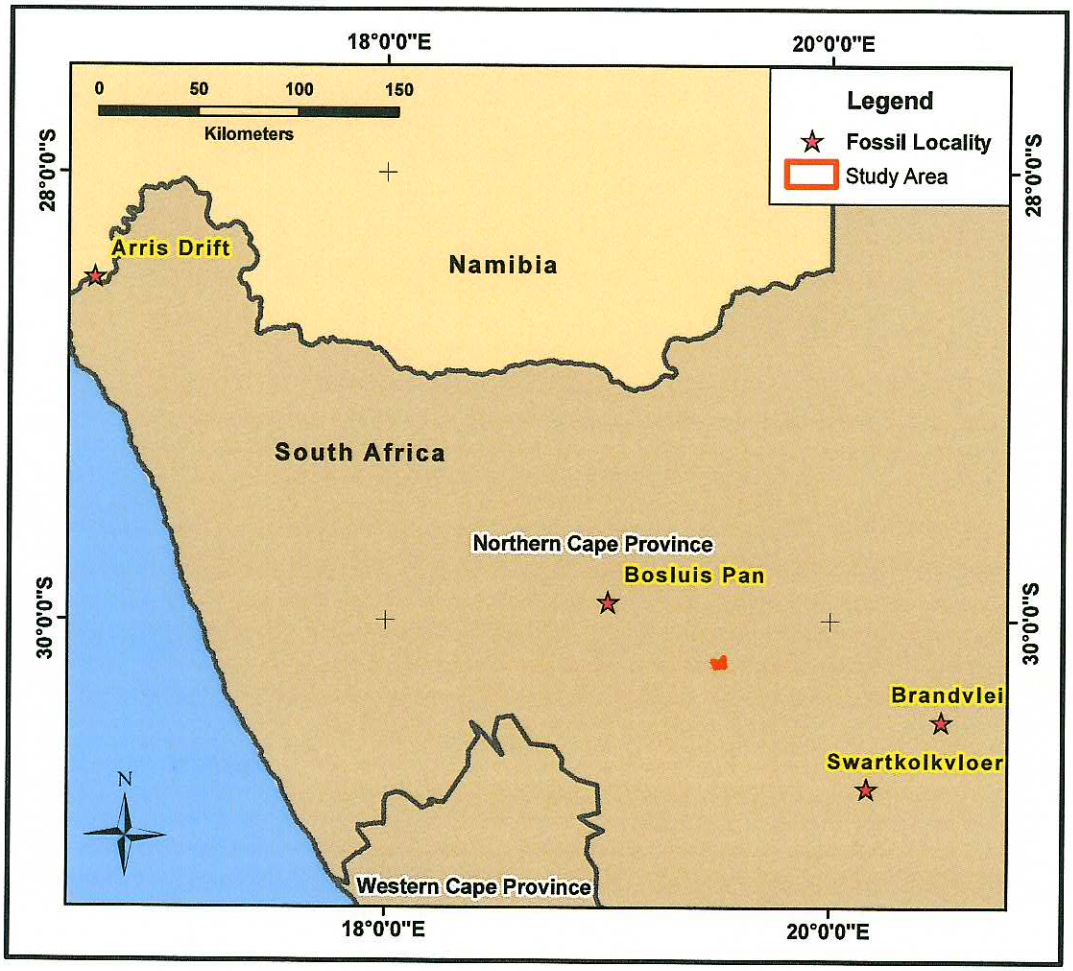

Figure 10: Map of the region surrounding the position of the proposed mine. Shown are the locations of the significant Cenozoic fossil sites discussed in Section 6.3.2.

fragments of *Gomphopherium*, crocodile teeth and tortoise shell fragments as well as elephant shrews, giraffids, bovids, a rhinocerotid and a catfish. The fauna is related to, but slightly older famous fauna from Arris Drift (Macey *et al.*, 2011). Well-indurated sands with abundant traces are situated between the Miocene fluvial succession at Bosluis Pan and the younger reddish aeolian superficial sands (Macey *et al.*, 2011) and horizontally- to vertically oriented rhizoliths occur within the massive red-sand facies in the upper part of the Bosluis Pan succession (De Wit, 1990).

Occurring commonly within reddish aeolian sands of the Quaternary superficial deposits at Bosluis Pan are spherical calcretised termitarea up to 250 cm across. These termitarea resemble nests constructed by the extant harvester termite *Hodotermes*

(Macey *et al.*, 2011). There are also smaller nests (8 cm in diameter) resembling those of *Psammatermes* present (De Wit, 1990).

Sediments of Pleistocene and younger age within the Koa River Valley palaeodrainage system at Bosluis Pan and elsewhere in the region contain fragments of egg shells of the modern ostrich as well as shells of the desert snail *Trigonepherus* (Senut and Pickford, 1995; Senut *et al.*, 1996).

In the Brandvlei Area (south-east of the project area) and within calcretised basal alluvial facies of the Geelvloer Palaeovalley are bones of anthracotherids (extinct *Hippopotomus*-like artiodactyles) (Macey *et al.*, 2011).

Abraded Plio-Pleistocene fossil woods from relict alluvial terraces from the Sak River (just to the north of Brandvlei) includes specimens from the family Polygalaceae (Bamford and De Wit, 1993).

Thick (2 m) shelly coquinas of the small freshwater gastropod *Tomichia ventricosa* occur at elevations up to 10 m above the present day floor of the Swartkolkvloer, approximately 50 km south-west of Brandvlei (Kent and Gribnitz, 1985). These shells have been radiocarbon dated to latest Pliocene (Macey *et al.*, 2011). These snails are characteristic of brackish to saline ponds.

6.3.3 Aeolian Sand Deposits

6.3.3.1 Geology

These deposits consist of fine-grained, well sorted, orange-red aeolian sands occurring as a thin veneer covering the majority of the eastern, central and north-western corner of the study area (Figure 9). The orange-red colour of these deposits is clearly evident in Figure 9; and Figures 11 and 12).

6.3.3.2 Palaeontological potential

No fossil materials were located within this sedimentary horizon during the site investigation.

6.3.4 Laminated, platy carbonate crust

These deposits are located along the lower western slopes of the low, north-south oriented ridge located in the centre of the study area and are proximal to the current

Figure 11: Orange-red coloured aeolian sands that cover the majority of the study area (waypoint DP1, see Figure 2)

Figure 12: Close-up view of the aeolian sands that blanket the majority of the study area. Shown also are fragments of non-fossilised egg fragments (waypoint DP8; see Figure 2).

eastern margin of Konnes se Pan (Figure 9). The material tends to be white to light grey in colour and is finely (but irregularly laminated) and forms a fractured (platy) layer several centimetres thick than mantles the land surface (Figures 13 and 14). The material appears to represent a deposit of pan infill sediments deposited at a time when Konnes se Pan was more aerially extensive that it is at present.

6.3.4.1 Palaeontological potential

No fossil materials were located within this sedimentary horizon during the site investigation.

7. ENVIRONMENT OF THE PROPOSED PROJECT SITE

The area investigated and reported upon, herein, is approximately 1 283 ha in extent. Examination of Google earth imagery of the wider reporting area (Figure 15) and topographic contours (Figure 16) suggests that the land surface of the project area predominantly consists of a number of topographic elements. The western margin of the project area consists of a prominent pan (Konnes se Pan). There is a small salt works located within the project area on the north-eastern margin of the pan. There also are some much smaller dry pans located along the north-eastern corner of the area. The majority of the project area consists of featureless landscape which is slightly elevated along a central northwest-southeast oriented axis. It is evident that local drainage pattern consists of a number of short, straight ephemeral channels that radiate from the pans. The study area is predominantly utilised for grazing.

Mucina and Rutherford (2006) indicate that the vegetation cover of the project area consists of two veld types (Figure 17). The central portion of the project area is dominated by the Bushmanland Arid Grassland veld type, while the southern margin and the majority of the eastern margin are vegetated with the Bushmanland Basin Shrubland veld type. The small pans and ephemeral rivers located close to, but outside of, the north-eastern corner of the project area have a vegetation cover consisting of the Bushmanland Vloere veld type. Mucina and Rutherford indicate that the conservation status of all three vegetation units is classified as least threatened.

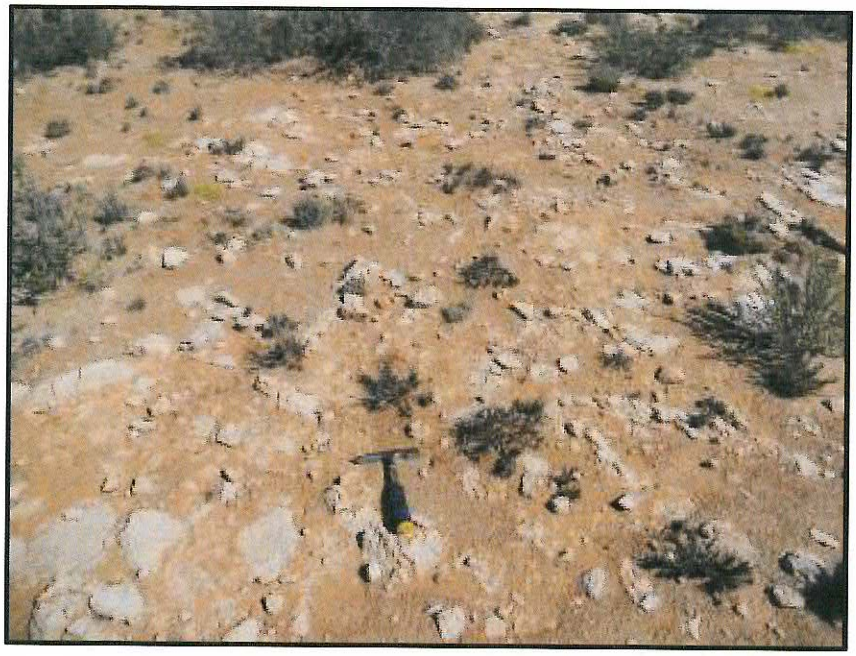

Figure 13: Outcrops of the platy, laminated cream coloured carbonate material that mantels the land surface on the western margin of the study area (waypoint DP4. see Figure 2).

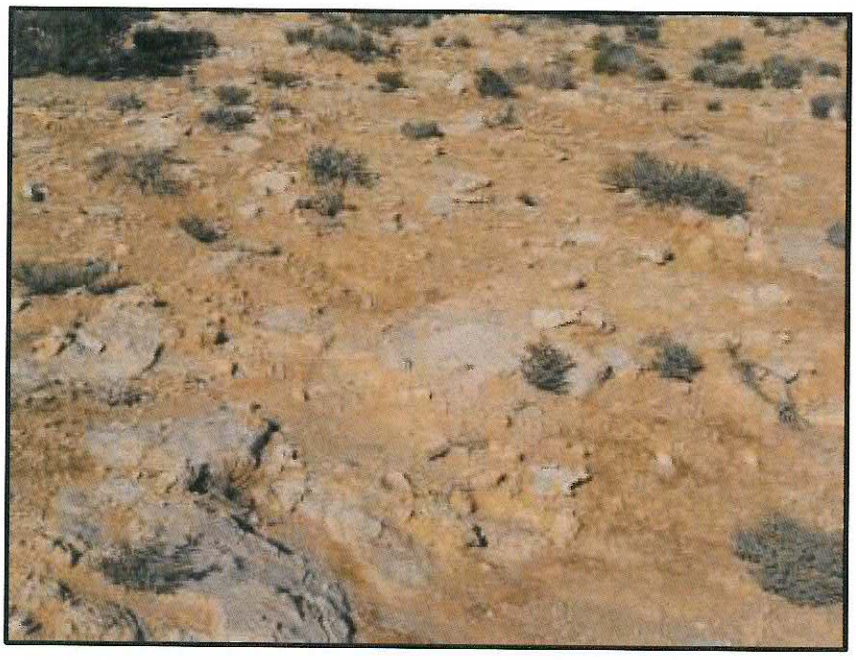

Figure 14: Outcrops of the platy, laminated cream coloured carbonate material that mantels the land surface on the western margin of the study area (waypoint DP5. see Figure 2).

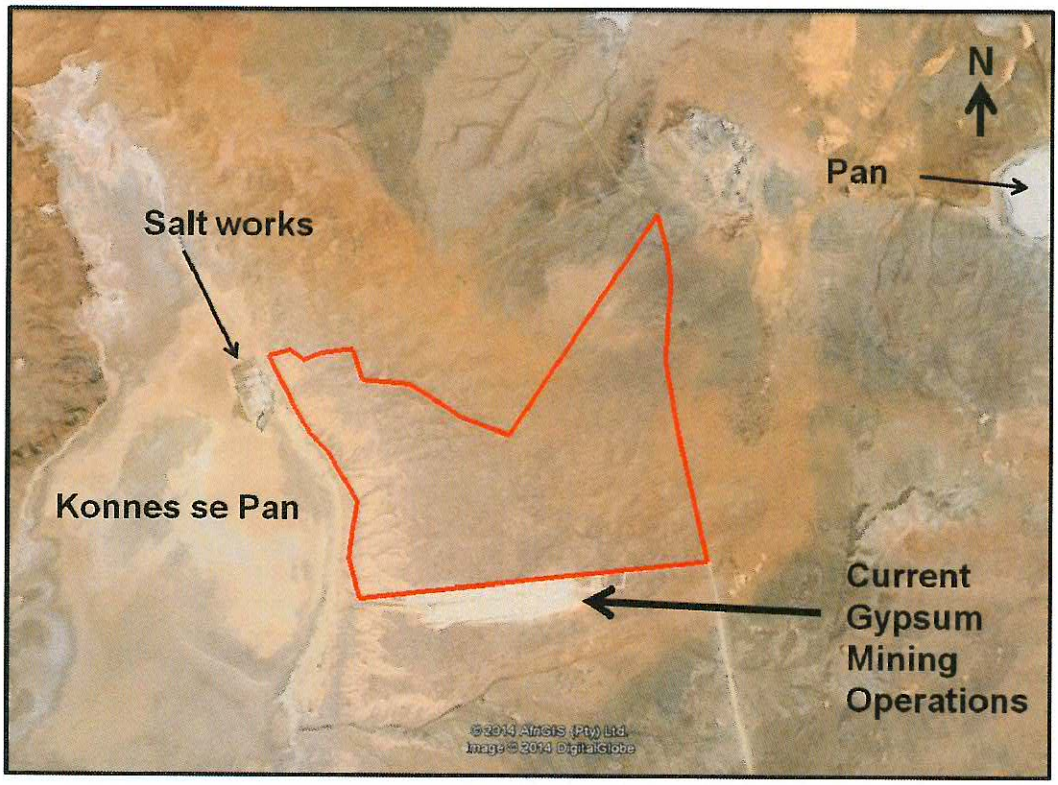

Figure 15: Google earth image of the project area (the red polygon). It is evident from the image that the western margin and north-eastern portion of the project area are dominated by pans. There are no signs of cultivation evident in the project area and the area is utilised for grazing. A salt woks is located proximal to (but exterior to) the western margin of the study are, and currently operating gypsum mining operations are located immediately south of the southern border of the study area.

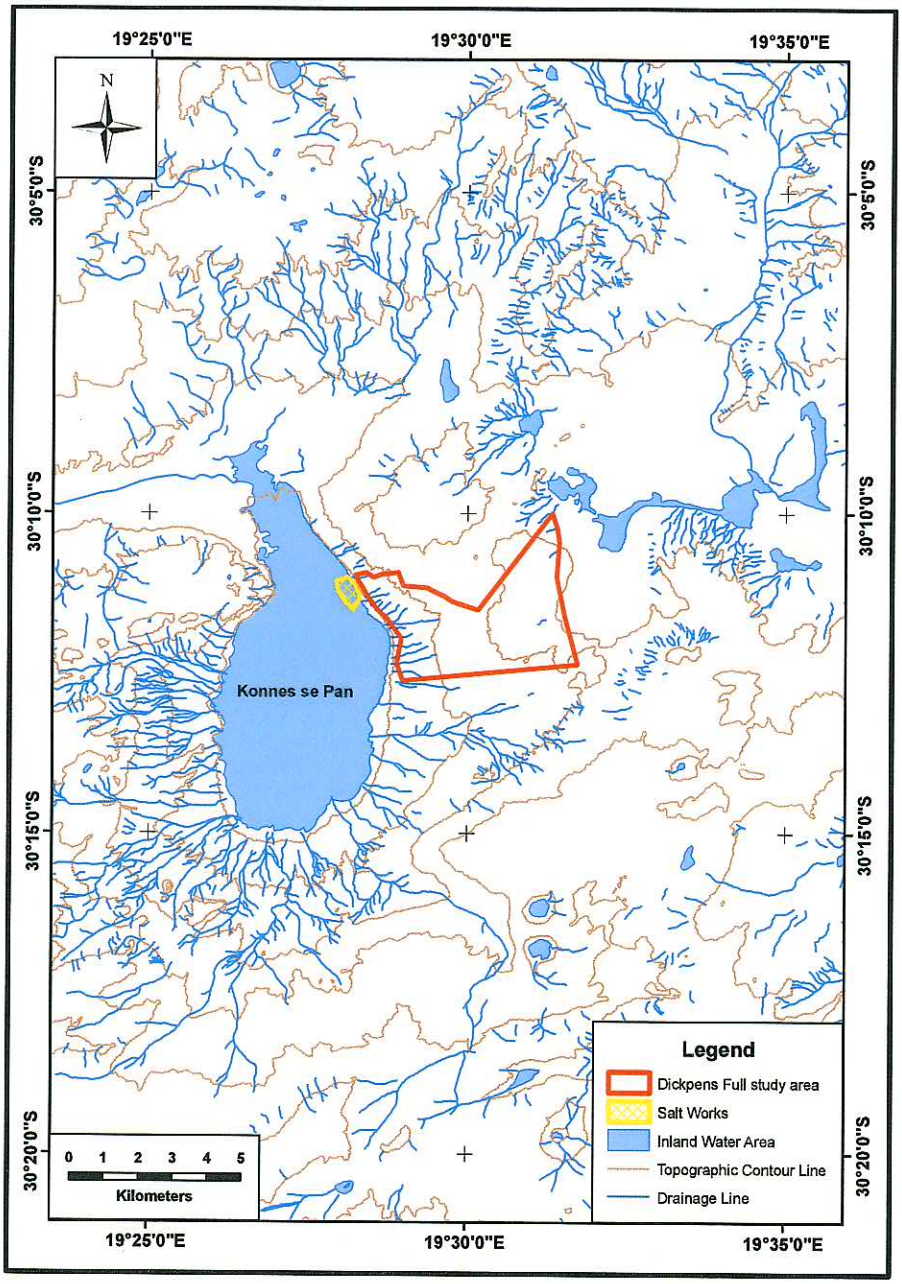

Figure 16: Map of the project area and its immediate environs. The topographic contour interval is 20 m and, as such, it is clear that the region is generally flat, but the central portions of the project area are slightly elevated along a northwest-southeast oriented axis. There is a prominent pan along the western margin of the area (Konnes se Pan) and smaller pans in the north-eastern corner of the project area. It is also evident that the surface drainage system is composed of short, straight channels radiating from the pans.

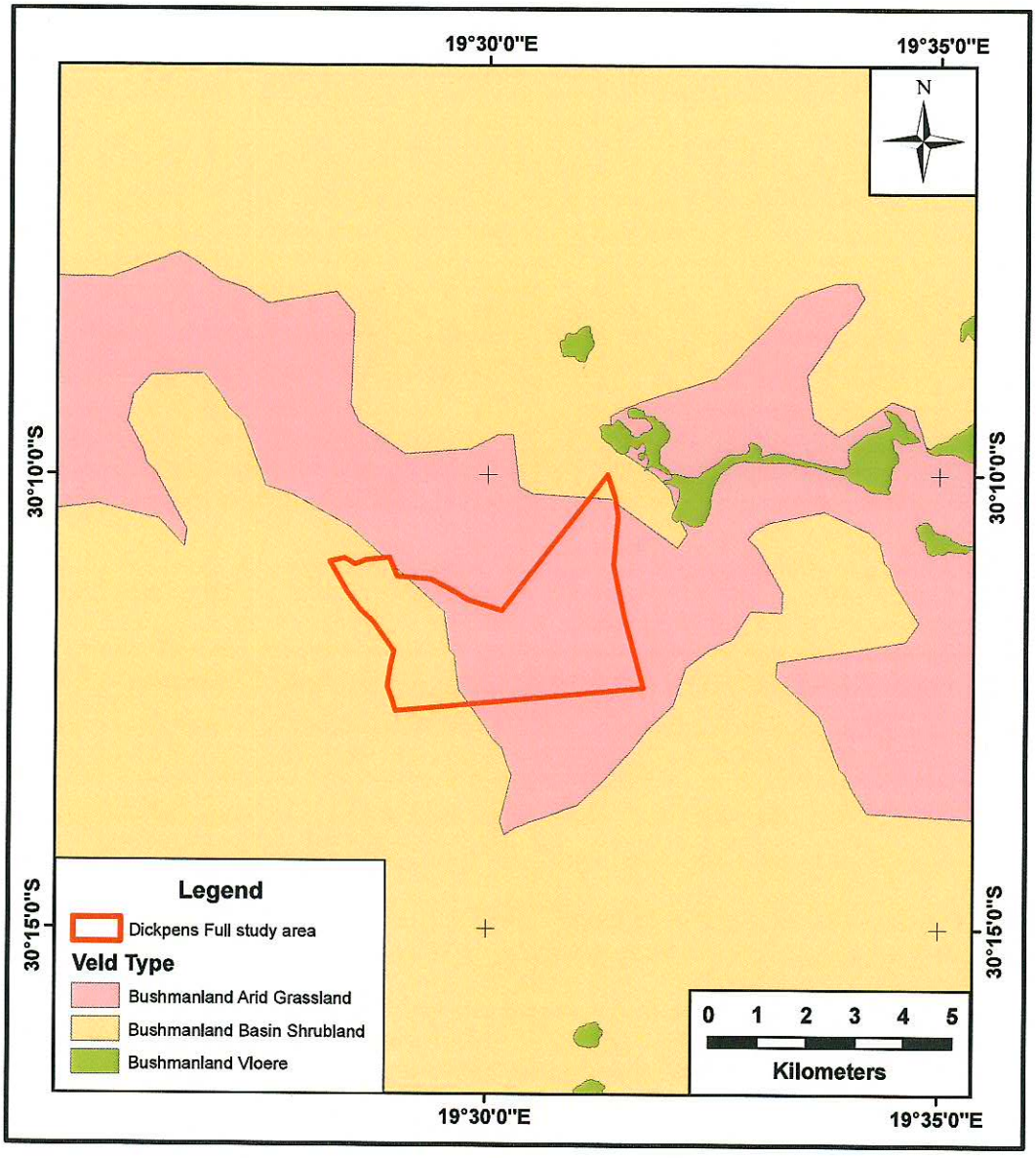

Figure 17: Map of the distribution of the vegetation veld types located within the project area and its immediate environs (after Mucina and Rutherford, 2006).

8. OVERVIEW OF SCOPE OF THE PROJECT

The proposed project will consists of an open cut mine. The application for the Mining Right will be for the maximum allowable term of 30 years.

A general overview of the infrastructure required for each facility is as follows:

8.1 Style of mineralisation

The proposed mining operation will target a gypsum deposit. The mineral deposit was formed by leaching of the underlying Prince Albert Formation to produce sulphate and of dolerites to provide calcium. In areas with restricted drainage (pans) and cyclical dry periods the calcium and sulphur generated the gypsum ($CaSO_4 \cdot 2H_2O$). The gypsum is present in the form of tiny crystals or small grains of gypsum. Thus, the mineral deposit forms a body lying at the top of the Prince Albert Formation and the base of the red, aeolian sands.

The gypsum layer is mostly covered by a layer of reddish aeolian sand with minor shale fractions present in some areas. It varies in thickness from 0 to 50 cm. The gypsite layer varies in thickness from 50 cm to 3 170 cm (data obtained from the client).

9. RESULTS OF SITE INVESTIGATION

9.1 Effect of project on the geology

The granting of a Mining Right will potentially allow the entire project area to be mined, except for a 9 m buffer around the perimeter of the Mining Right area. This buffer is not necessary between the joint boundary between the project area and the existing Bushmanland Mine (Figure 15).

It is likely that the mining activities will be primarily limited to the gypsum deposits and the overlying Cenozoic regolith. As the mining will be conducted by a continuous surface milling miner which operates by cutting to a cutting depth of 0.2 m any disruption of the rocks of the Prince Albert Formation will be minimal.

10. IMPACT ASSESSMENT

The potential impact of the proposed mining area is categorised below according to the following criteria:-

10.1 Nature of Impact

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

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

10.2 Extent of impact

The possible extent of the permanent impact of the proposed project on the palaeontological heritage of South Africa is restricted to the damage, destruction or accidental relocation of fossil material caused by the excavations and construction of the necessary infrastructure elements forming part of the project. The possible source of a less permanent negative impact on the palaeontological heritage is the loss of access for scientific research to any fossil materials that become covered by the various infrastructural elements that comprise the project. The **extent of the area of potential impact is, accordingly, categorised as local** (i.e., restricted to the project site).

10.3 Duration of impact

The anticipated duration of the identified impact is assessed as potentially **permanent to long term.** This is assessment is based on the fact that, in the absence of mitigation procedures (should fossil material be present within the area to be affected) the damage or destruction of any palaeontological materials will be permanent. Similarly, any fossil materials that exist below any infrastructural elements that will constitute the mine, but which are not subjected to mining and excavation, will be unavailable for scientific study for the life of the existence of those features.

10.4 Probability of impact

The Prince Albert Formation and the Cenozoic regolith units are fossiliferous elsewhere in the region and the area under consideration is moderately large (approximately 1 283 ha); as such there is a reasonable chance of fossil materials occurring within the Karoo rocks underlying the project area. It is pertinent to realise that fossils (particularly vertebrate fossils) are generally scarce and sporadic in their occurrence. This point is evinced by the small number of significant fossil localities that have been highlighted, herein, from the Prince Albert formation and the Cenozoic deposits despite the large aerial extent of the relevant geological units. The probability of any mining related activities affecting fossils within the Cenozoic deposits is **low** due to both the general rarity of fossil deposits within the strata elsewhere in the region in general, and as no fossil materials were located within these sediments during the field investigation. However, the existence of fossils located within the subsurface extents of the Cenozoic strata remains a possibility. Fossil deposits within the Prince Albert Formation are also uncommon (but are known to exist as close to the study area as near Loerisfontein), and it may be anticipated that any disruption to the unit by the mining activities will be superficial (i.e., probably no more than the upper few centimetres) due to the fact that the mineral being mined is not contained within the formation and the thin nature of each cut to be made by the proposed continuous mining plant. Accordingly, the probability of any negative impact on the palaeontological heritage of the Prince Albert Formation is also assessed as **low**.

The rocks of the Karoo Dolerite Suite are not fossil-bearing. As such the probability of any negative impact on the palaeontological heritage of this unit is assessed as **nil**.

10.5 Significance of the impact

The scientific and heritage importance of the fossil assemblages known to occur within the Prince Albert Formation and the Cenozoic regolith deposits can be defined as follows. It is evident from Figure 10 that significant fossil assemblages are not common place within the Cenozoic deposits of the region. However, the fossils that they contain are extremely significant at documenting the palaeoecology and palaeoclimate of this portion of the stratigraphic column; a portion of the stratigraphic column that is not well represented in South Africa's fossil heritage. Thus, the rarity of fossils within the sequence makes each fossil that is present **potentially significant**.

There are uncommon fossil occurrences and fossil assemblages present within the Prince Albert Formation elsewhere in the Karoo Basin. The trace fossil assemblages are not taxonomically diverse and vertebrate material is extremely rare and fragmentary where it has been located. When these points are taken in conjuncture with the small direct impact the mining is expected to have on the formation the significance of any negative impact on the palaeontological heritage of this formation is assessed as **low**.

The rocks of the Karoo Dolerite Suite are unfossiliferous, thus, the significance of any affect of the mining operations on the palaeontological heritage of this unit is **nil.**

The scientific and cultural significance of fossil materials is underscored by the fact that many fossil taxa (particularly vertebrate taxa) are known from only a single fossil and, thus, any fossil material is potentially highly significant. Accordingly, the loss or damage to any single fossil can be potentially significant to the understanding of the fossil heritage of South Africa and to the understanding of the evolution of life on Earth in general. Where fossil material is present and will be directly affected by the building or construction of project infrastructural elements the result will potentially be the irreversible damage or destruction of the fossil(s).

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

Thus, while **the probability of a negative impact on the palaeontological heritage contained within the sedimentary strata underlying the project area is categorised as low, the significance of any negative impact posed by the project on the palaeontological heritage is categorised as potentially high** (particularly in the Cenozoic Regolith cover) if appropriate mitigation procedures are put into place.

10.6 Severity / Benefit scale

The proposed project is categorised, herein, as being potentially **beneficial.** This classification is based on the intention that the project will provide a long term (30 year) benefit to the community in terms of the provision of materials for cement manufacture and the production of building materials such as ceiling boards.

The probability of a negative impact on the palaeontological heritage of the project area has been categorised as **low** if appropriate mitigation procedures are put into place. The low likelihood of fossils being directly affected by the planned project must be weighed in conjunction with the severity of any negative impact that may result. Many fossil taxa (particularly vertebrate forms) are known from only a single fossil and, thus, any fossil material is potentially highly significant. This potential significance is highlighted by the fact that elsewhere in the region the Cenozoic regolith sequence contains fossils that provide a rare insight into the palaeoecology and palaeoclimate of the last 15-16 Ma of South African history. Thus, it is possible that there are fossils of the highest scientific and cultural significance present within the sediments underlying the project area. Accordingly, the loss or damage to any single fossil or fossil locality can be potentially significant to the understanding of the fossil heritage of South. **Although the likely**

hood of any disturbance of palaeontological materials is low, the severity of any impact is potentially extremely high. The possibility of a negative impact on the palaeontological heritage of the area can, however, be minimised by the implementation of adequate damage mitigation procedures. **If damage mitigation is properly undertaken the benefit/severity scale for the project will lie within the beneficial category.**

A potential secondary benefit of the project would be that the excavations resulting from the progress of the project may uncover fossils materials that were hidden beneath the surface exposures and, as such, would have remained unknown to science. If the planned excavations are inspected, while they are occurring, with a view to identifying any possible palaeontological materials present the possibility would be generated of being able to study and excavate fossil materials that would otherwise be hidden to scientific study.

10.7 Status

Given the combination of factors discussed above, it is anticipated that as long as adequate mitigation processes are emplaced during the conduct of the mining operation any negative effect on the palaeontological heritage of the area will be minimised to the extent possible. As the proposed project would supply raw materials for the building industry in an isolated area of South African the project is determined as having a **positive status** herein.

11. DAMAGE MITIGATION, REVERSAL AND POTENTIAL IRREVERSABLE LOSS

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

11.1 Mitigation

It is recommended that thorough and regular examinations of all excavations be made while they are occurring. It is recognised that the mining process will be conducted by continuous mining machinery and that any fossil material unearthed by the mining activities would be destroyed at the same time. However, the mine's high walls and floor (consisting of Cenozoic regolith and fresh Prince Albert Formation rocks respectively) should be inspected regularly by mine staff (e.g., the environmental officer) to see if any fossils have been exposed; this process should certainly occur before the pit is rehabilitated. Should any fossil materials be identified, the excavations should be halted and SAHRA informed of the discovery (see Section 3.4 above). A significant potential benefit of the examination of the excavations associated with the construction of the project is that currently unobservable fossils may be uncovered. As

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

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

11.2 Reversal of damage

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

11.3 Degree of irreversible loss

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

Fossils are usually scarce and sporadic in their occurrence and the chances of negatively impacting on a fossil in any particular area are low. However, any fossil material that may be contained within the strata underlying the project area is potentially of the greatest scientific and cultural importance. Thus, the potential always exists during the conduct of mining operations within potentially fossiliferous rocks for the permanent and irreversible loss of extremely significant or irreplaceable fossil material. This said, many fossils are incomplete in their state of preservation or are examples of relatively common taxa. As such, just because a fossil is present it is not necessarily of great scientific value. Accordingly, not all fossils are necessary significant culturally of scientifically significant and the potential degree of irreversible loss will vary from case to case. The judgement on the significance of the fossil must be made by an experienced palaeontologist.

12. ASSUMPTIONS, UNCERTAINTIES AND GAPS IN KNOWLEDGE

The information provided within this report was derived from a detailed site investigation conducted on foot. No fossil materials were observed during the conduct of that survey. However, the potentially fossiliferous Prince Albert Formation strata are covered by Cenozoic regolith over the majority of the study area and, accordingly, the fossiliferous potential of the Prince Albert Formation within the study area could not be comprehensively ascertained. Similarly, despite the fact that no fossil materials were

located within the Cenozoic regolith, the presence of fossils within the subsurface levels of these strata remains a possibility.

13.ENVIRONMENTAL IMPACT STATEMENT

A detailed, foot based investigation has been conducted on the site of the proposed mine extension. This study forms part of a Heritage Impact Assessment Report that is a component of an Environmental Impact Assessment to identify and assess all potential environmental impacts associated with the proposed project for the area as identified, and propose appropriate mitigation measures in an Environmental Management Programme.

The area of the proposed Mining Right, where the mine will be located, is large (approximately 1 283 ha) in size. However, any negative impacts to the palaeontological heritage of the region will be limited to the footprint area of the mining operations and, as such, the extent of any impact is accordingly characterised as local.

In terms of the subsurface effects of the mining operations disruption to geological strata will be mostly restricted to the Cenozoic regolith, with only minor disruption of the uppermost few tens of centimetres of the Prince Albert Formation expected. Any fossil materials that remain undiscovered after the construction of the project and which are located beneath the maximum depth of the anticipated excavations will only be negatively affected in so far as they will be unavailable for scientific study for the life expectancy of the infrastructural elements that comprise the project.

This study has identified that the geological units that underlie the project area are fossiliferous elsewhere in the Main Karoo Basin and, as such, fossils are potentially present and may be negatively impacted. The fossil assemblages contained within the Cenozoic regolith units within the region are of high scientific and cultural significance because of their importance in documenting the palaeoclimate and palaeoecology of the preceding 15-16 Ma.

There is a potential for negative impact on the palaeontological heritage of the project area throughout it's the majority of its extent, but the potential risk is categorised as low due to the fact that no fossil materials were located during the site investigation and also as the fossils that occur within the various geological units are generally scarce. However, the fossils that may be anticipated to be present within these units are potentially highly significant to the cultural and scientific heritage of South Africa and the world. As such, the risk of a negative impact is low, but the significance of any negative impact on the fossil assemblages could potentially be high on exposures of the Cenozoic regolith and low on the Prince Albert Formation. Any damage that occurs to such fossil material during the excavation and construction phase of the project would be permanent and irreversible.

The potential negative impact to the palaeontological heritage of the area can be minimised by the implementation of appropriate mitigation processes. It recommended that thorough and regular examination of all excavations be made while they are occurring. It is recognised that the mining process will be conducted by continuous mining machinery and that any fossil material unearthed would be destroyed at the same time. However, the mine high walls and floor (consisting of fresh Prince Albert Formation rocks) should be inspected regularly by mine staff (e.g., the environmental officer) to see if any fossils have been exposed; this process should certainly occur before the pit is rehabilitated or modified by further mining. Should any fossil materials be identified, the mining operations should be halted in that area and SAHRA informed of the discovery.

The social benefits of the project have been classified as beneficial, herein, as the project aims to provide a source of raw materials for the building industry in an isolated area of South Africa. As such **this desktop study has not identified any palaeontological reason to prejudice the progression of this project, subject to adequate mitigation programs being put in place.**

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