Annex G.4

Faunal Specialist Report

Draft Faunal Biodiversity Report

Gamsberg Project:

Terrestrial Fauna and Aquatic Biodiversity Report for proposed Zinc Mine on Gamsberg, Northern Cape

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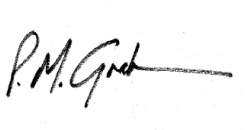

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EXECUTIVE SUMMARY

Black Mountain Mining (Pty) Ltd intends to establish a zinc mine and associated infrastructure at Gamsberg, approximately 40 km west of the town of Poffadder, South Africa. GroundTruth Water, Wetlands and Environmental Consultants were appointed by Environmental Resources Management Southern Africa (Pty) Ltd to undertake a faunal biodiversity study as part of the overall Gamsberg zinc mine Environmental and Social Impact Assessment. The primary aim of the study was to define the faunal biodiversity of the study area in order to assess the potential impacts associated with the proposed Gamsberg mine.

An initial desktop study was undertaken to establish species previously recordered within the study area as well as to identify the species expected to occur in the region. Databases considered during the desktop investigations included the International Union for Conservation of Nature (IUCN) Red List and the Convention on International Trade in Endangered Species (CITES). For each component - terrestrial invertebrates, vertebrate fauna and aquatic biodiversity - specific focus was given to the various aspects identified by a gap analysis, as being aspects not adequately covered in previous studies undertaken in this area. A reconnaissance visit was undertaken during May 2009 (with a focused invertebrate survey in September 2009). One of the objectives of the 2009 invertebrate survey was to determine whether Heelwalkers (Mantophasmatodea) – a relatively recently discovered sub-order of terrestrial invertebrates - are present at Gamsberg. Additional, more comprehensive surveys were undertaken in November 2012. A ten-day vertebrate fauna survey and aquatic ecosystem assessment was carried out at between the 20 and 29 November; a terrestrial invertebrate study was undertaken from 18 November to 1 December 2012. During the study, various methods were employed to determine the baseline biodiversity at Gamsberg.

A combination of netting, pitfall trapping, net-sweeping and ultraviolet-assisted night searching was employed to assess the terrestrial invertebrates. In 2009, the focus of the terrestrial invertebrate study was the moister southern slopes vegetation type. For the 2012 survey, ten sites, representing the eight main habitat types, were selected for detailed survey. Assessment of the vertebrate fauna included surveys of the following key groups, namely, herpetofauna (ie amphibians and reptiles), birds (avifauna) and mammals. A variety of sampling methods were employed at a number of locations throughout the study area, covering a range of available faunal habitats. Sampling methods included pitfall/funnel trap arrays, active searches, camera traps, small mammal traps, bat monitoring (mist netting, recording echolocation calls, visual inspection of roosts) and *ad hoc* sightings.

Aquatic biodiversity assessments were carried out at four key sites representing the aquatic ecosystems of Gamsberg. Four sites were sampled for diatoms during the May 2009 survey. Three of these sites were re-sampled again during the November 2012 survey. SASS5 sampling was conducted at a single site (the Gamsberg River within the kloof) during the May 2009 survey, with no additional sampling possible during the November 2012 survey due to the limited availability of sampling habitat in accordance with the SASS5 protocol. No fish were observed during surveying around the inselberg. This is not an unexpected result for these aquatic ecosystems.

The results of the terrestrial invertebrate study found that no Red Data invertebrate species were observed during the surveys; this result is not unexpected and is unlikely to change with further studies since the vast majority of invertebrate species has yet to be assessed (in terms of red data species). No Mantophasmatodea occurred at any of the sites surveyed in detail, nor in any of the other areas inspected less thoroughly. However, at least 13 ant species were collected; one of which has been confirmed as an undescribed species of *Messor*, and another is an undescribed species of the *Camponotus fulvopilosus*-group. It is probable that both of these ant species are regionally endemic to the Northern Cape / southern Namibia area; no other endemic species have yet been confirmed in the material collected during the surveys of the site. A significant observation during the 2012 survey regarding scorpion activity and diversity was that by far the highest numbers of scorpions, as well as the highest diversity, was observed in the wash area at the mouth of the kloof on the north of the Gamsberg.

In terms of herpetofauna, of the 14 species of frogs and 53 species of reptiles that potentially occur within the Gamsberg area, three and 24 species respectively were recorded from these groups. The only Red Data species, Good's Gecko *Pachydactylus goodi* listed as Vulnerable, was recorded during the survey, but nevertheless is likely to occur given its preference for rocky habitats and substrates. Two range-restricted frogs (Namaqua Stream Frog *Strongylopus springbokensis* and Paradise Toad *Vandijkophrynus robonsoni*) have been observed in the study area, although the latter more abundant. Three range-restricted endemics (Haacke's Gecko *Pachydactylus haackei*, Namaqua Mountain Gecko *Pachydactylus montanus* and Desert Mountain Adder *Bitis xeropaga),* confined to the lower Gariep River and adjacent regions and restricted to rocky, mountainous habitat were recorded during the 2012 survey (Namaqua Mountain Gecko was also recorded in the 2009 survey).

A total of 45 bird species were recorded within the study area during the May 2009 and November 2012 surveys. Lanner Falcon (*Falco biarmicus*), listed as Near Threatened, was the only Red Data bird recorded in the immediate study area during the 2009 and 2012 surveys. A population of Red Lark (*Calendulauda burra*) occurs in close proximity to Gamsberg, in the Koa dune

system, approximately 5km to the south-west. Red Lark is a habitat specialist, endemic to the Nama-Karoo in the Northern Cape and is listed as Vulnerable. Although, the proposed Gamsberg Project will not encroach directly on areas supporting known Red Lark populations, it is possible that indirect impacts (eg disturbance from noise, blasting, etc) could have an effect on the adjacent populations along the Loop 10 road. However, according to the noise specialist study, noise will be restricted to a narrow band along the Loop 10 road, with very low noise beyond 500 meters. Other Red Data birds observed in the area were recorded during previous avifaunal surveys, ie Martial Eagle (*Polemaetus bellicosus*) listed as Vulnerable, Ludwig's Bustard (*Neotis ludwigii*) listed as Vulnerable, and Secretarybird (*Sagittarius serpentarius*) listed as Near Threatened.

Altogether the mammal surveys recorded four Red Data mammals: Cape Horseshoe Bat (*Rhinolophus capensis*), Darling's Horseshoe Bat (*Rhinolophus darling*), Dassie Rat (*Petromus typicus*) and Littledale's Whistling Rat (*Parotomys littledalei*). All are listed as Near Threatened. Additionally, incidental reports of sightings of Brown Hyaena (*Hyaena brunnea*), also listed as Near Threatened, and Leopard (*Panthera pardus*) were recorded during the 2012 field visit.

Particularly sensitive areas for terrestrial invertebrates include the kloof (butterflies), the wash out area extending north from the kloof (scorpions) and the Inselberg basin (ants). Inselberg basin represents almost the entire known range for the undescribed ant species *Messor* AFRC-ZA-01 although this species is thought to be regionally endemic to the Northern Cape and Southern Namibia.

The rocky slopes and outcrops and kloof habitat are especially sensitive areas for vertebrates. Rocky habitats provide shelter and refuge for various conservation important vertebrates, notably retiles (eg Desert Mountain Adder, Good's Gecko (probable), Haacke's Gecko and Namaqua Mountain Gecko), but also a variety of other reptiles and species from other vertebrate groups. Of the amphibians recorded, the majority occurred in the pools of surface water found within the kloof.

The diversity of birds is thus relatively high within the regional context (~ 35% species representation at Gamsberg). This is driven largely by the diverse range of habitats at Gamsberg (eg plains, drainage lines and washouts, slopes, cliffs, springs and seeps, etc).

The following key impacts are noted for the proposed Gamsberg Project:

- Direct loss of fauna and faunal habitat, notably sensitive faunal features, largely due to the construction of the mining footprint covering a large area (over 1200 ha);

- Indirect loss of aquatic features and fauna due to groundwater/surface water impacts. Alteration of surface and groundwater hydrology is primarily due to decreased surface water runoff (loss of approximately 30% of the mean annual runoff) and groundwater drawdown (from 15 to 125 meters) as a result from excavation of an open pit.
- Disturbance from water contamination (eg sewerage pollution, acid mine drainage and accidental spills of fuels, lubricants, processing chemicals, etc), solid waste generation and air pollution (eg dust emissions and fallout).
- Impacts from increased noise (notably blasting and heavy machinery) and use of artificial lighting.

The significance of the aforementioned impacts has been assessed in terms of their nature (positive/negative), magnitude (extent, duration and intensity) and likelihood (definite/likely/unlikely) as detailed in Section 8.2. Most significant, is the loss of fauna and habitat during the construction phase. Impacts from decreased surface runoff/groundwater drawdown, contamination of soil and water, and increased noise and light will potentially have a major impact on fauna during the operational phase. It is therefore recommended that the proposed Gamsberg Project (and its associated infrastructure) be planned and implemented in ways that will ensure minimum disturbance and impact on associated biodiversity assets as much as possible. Mitigation measures are thus provided as recommendations for reducing impacts to terrestrial fauna and aquatic biodiversity, however, the measures will need to be detailed in the Environmental Management Plan (EMP) for the Project.

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ACRONYMS

Acronym	Definition
ASPT	Average Score Per Taxon
CBD	International Convention on the Conservation of Biological Diversity
CITES	Convention on International Trade of Endangered Species
EIA	Environmental Impact Assessment
EMP	Environmental Management Plan
EOO	Extent of Occurrence
ERM	Environmental Resources Management Southern Africa (Pty) Ltd
ESIA	Environmental and Social Impact Assessment
EWT	Endangered Wildlife Trust
FEPA	Freshwater Ecosystem Priority Areas
IBA	Important Birds Areas
ICMM	International Council on Mining and Metals
IUCN	International Union for Conservation of Nature
NCNCA	Northern Cape Nature Conservation Act
NDBP	Namakwa District Biodiversity Sector Plan
NEMA	National Environmental Management Act
NEMBA	National Environmental Management: Biodiversity Act
NEMPA	National Environmental Management: Protected Areas Act
NFEPA	National Freshwater Ecosystem Priority Areas
OECD	Organisation for Economic Co-operation and Development
PTV	Pollution Tolerant Valves
SABAP2	South African Bird Atlas Project 2
SANAS	South African National Accreditation System
SANBI	South African National Biodiversity Institute
SASS	South African Scoring System
SKEP	Succulent Karoo Ecosystem Programme
SPI	Specific Pollution sensitivity Index
WRC	Water Research Commission

1. INTRODUCTION

GroundTruth Water, Wetlands and Environmental Consultants (referred to as GroundTruth) were appointed by Environmental Resources Management Southern Africa (Pty) Ltd (referred to as ERM) to undertake a faunal biodiversity study for Black Mountain Mining(Pty) Ltd (referred to as Black Mountain), which is part of the global Vedanta mining group. Black Mountain currently operates the mine near the town of Aggeneys and intends to establish the new Gamsberg zinc mine and associated infrastructure. This study therefore forms part of the overall Gamsberg zinc mine Environmental and Social Impact Assessment (ESIA).

1.1 Project Description and Background

Black Mountain plans to mine the zinc ore deposit at Gamsberg by creating an open pit mine, approximately 330 ha in extent. The proposed pit will be located on the northern and eastern sections of the inselberg. In addition to the mine pit, several other adjacent areas will need to be developed to support a variety of mining infrastructure, including:

- a tailings dam;
- waste rock dumps;
- stock piles for topsoil, overburden, and ore;
- a processing plant;
- construction camp (including office, workshop, and temporary storage of fuel and wastes);
- contractor housing camp;
- explosive storage area;
- storm water management facilities; and
- other associated infrastructure such as access roads, haul roads, power supply, water pipelines, sewerage treatment, etc.

The extracted ore will be processed on-site at the proposed processing plant and the concentrate product will then be exported by road.

The site layout used to spatially define the abovementioned mine development, and used to inform this faunal study, is as supplied by ERM (ie Gamsberg Zinc Plant Plot Plan – Drawing number S2197-0000-1310-LYD-001; Date – 21November 2012).

1.2 Legal Framework and Policies

1.2.1 South African Legislation

National Environmental Management Act (No 107 of 1998)

The National Environmental Management Act (NEMA) states that any development must be socially, environmentally and economically sustainable. The following points therefore need to be considered in terms of achieving sustainable development within the context of the Gamsberg Project:

- Avoid disturbance of ecosystems and loss of biological diversity;
- Avoid pollution and degradation of the environment;
- Avoid generation of waste;
- Ensure responsible and equitable use and exploitation of non-renewable natural resources, taking into account the consequences of the depletion of the resource;
- Ensure that use and exploitation of renewable resources, and associated ecosystems, do not exceed the level beyond which their integrity is jeopardised;
- Apply a risk-averse and cautious approach, taking into account the limits of current knowledge about the consequences of decisions and actions; and
- Prevent negative impacts on the environment.

Where avoidance and prevention of impacts is not possible, such impacts need to be minimised and remediated.

Additionally, sensitive, vulnerable, highly dynamic or stressed ecosystems, such as wetlands, and other similar systems, require specific attention in management and planning procedures, especially where they are subject to significant human resource usage and development pressure. Furthermore, the costs of remedying pollution and environmental degradation and of preventing, controlling or minimising further pollution or environmental damage must be paid for by those responsible for harming the environment.

National Environmental Management: Biodiversity Act (No 10 of 2004)

The primary purpose of the National Environmental Management: Biodiversity Act (NEMBA) is to provide for the management and conservation of South Africa's biodiversity within the framework of NEMA. This includes protection of species and ecosystems requiring national protection, sustainable use of indigenous biological resources, the fair and equitable sharing of benefits arising from bio prospecting involving indigenous biological resources, and the establishment of the South African National Biodiversity Institute (SANBI), a national institution that focuses on

biodiversity. The following NEMBA sections are considered within the context of this study:

- Biodiversity planning and monitoring – incorporates national biodiversity frameworks and bioregions to ensure a uniform approach to biodiversity management.
- Threatened or protected ecosystems and species – includes published lists of threatened (ie Critically Endangered, Endangered and Vulnerable) and protected species and ecosystems.
- Species and organisms posing potential threats to biodiversity – attempts to prevent and control the introduction of alien species that may affect indigenous species.
- Permits –describing the procedures for obtaining permits when certain 'restricted activities' involve listed 'threatened or protected species'.

National Environmental Management: Protected Areas Act (No 57 of 2003)

The objective of the National Environmental Management: Protected Areas Act (NEMPA) is to create a national system of protected areas that preserve the ecological character and biodiversity of unique landscapes as well as conserve certain threatened and protected species. Biodiversity associated with protected areas are thus given additional protection.

Northern Cape Nature Conservation Act (No. 9 of 2009)

The objective of the Northern Cape Nature Conservation Act (NCNCA) is to provide for the sustainable utilisation of wild animals, aquatic biota and plants. The NCNCA also provides for the following:

- Implementation of the Convention on International Trade of Endangered Species (CITES) of wild fauna and flora;
- Offences and penalties for contravention of the Act; and
- Issuing of permits and other authorisations.

The Act also provides for specific regulations according to Gazette Notice (Number 1589 of 2012) and lists species of fauna that are considered "Specially Protected" and "Protected" according to the NCNCA under Schedule 1 and Schedule 2 of the Act.

1.2.2 International Standards and Policies

International Finance Corporation Performance Standards

The International Finance Corporation (IFC) Performance Standards, updated for application from 2012, define the role of clients in terms of managing large projects with the primary objective of minimising impacts on the environment by projects. With specific reference to the Gamsberg Project, this study was

carried out in accordance to Performance Standard 1 and 6, which provide the necessary guidelines relating to the management of biodiversity and ecosystem services:

- **Performance Standard 1** emphasises the importance of environmental performance throughout the duration of a project through identifying and assessing environmental impacts within the project's study area with the objective of minimising or, wherever possible, avoiding impacts. This highlights the importance of incorporating specific monitoring as part of the assessment of risks and impacts and to identify performance indicators that can be used to quantify the extent of various impacts.
- **Performance Standard 6** recognises the importance of protecting and conserving biodiversity as a fundamental component to sustainable development, through the management and use of natural resources. It is therefore a requirement to assess the relevant impacts of the project, which may affect different levels of biodiversity. A principle component to Performance Standard 6 is that environmental assessments need to take into account the threats to biodiversity caused by habitat destruction and loss, especially from the perspective of important species. Assessments also need to addresses ways of avoiding or mitigating impacts. Distinction is made between natural and modified habitats whilst recognising that habitat destruction is a major impact to the maintenance of biodiversity.

In the case of natural habitat, a project may not significantly convert or degrade the habitat, unless there are no technically and financially feasible alternatives, the project benefits outweigh the costs (including environmental), and appropriate mitigation is implemented to achieve no net loss of biodiversity. Where areas are classed as modified habitat, the project is to ensure that further degradation and conversion is minimised and where possible attempt to enhance habitat and protection of biodiversity. However, in certain situations both natural and modified habitats may be regarded as critical habitats based on having a high biodiversity value. In such instances, projects may not implement any activities unless the following requirements are met:

- There are no measurable adverse impacts on the habitats' ability to support those species that determine the habitat as being critical or the functions of the critical habitat;
- There is no net reduction in the global and/or national/regional population of any Critically Endangered or Endangered species over a reasonable period of time;
- An appropriately designed, long-term biodiversity monitoring programme and evaluation program is integrated into the client's management programme.

Where a project is able to meet the requirements listed above, the project's mitigation strategy must be described in a Biodiversity Action Plan and designed to achieve net gains of those biodiversity values for which the critical habitat was designated. Net gains may be achieved through the development of a biodiversity offset and/or through the implementation of programs that could be implemented *in situ* to enhance habitat and protect and conserve biodiversity.

Where a project is located within a legally protected area, the aforementioned criteria required for critical habitats needs to be accounted for as well as the following:

- Actions need to conform with those defined for protected area management plans;
- Consultations with various stakeholders associated with the protected area regarding the proposed project; and
- Implement additional programs that promote the conservation aims of the protected area.

Under any given situation, no alien species may be introduced, particularly those that are highly invasive, and correct action by the project is needed to prevent accidental introductions.

An additional requirement by Performance Standard 6 is the management and use of renewable natural resources. Projects are therefore required to manage these resources sustainably, particularly forests (natural and plantations) and aquatic ecosystems, which are regarded as principle providers of natural resources.

Vedanta Resources - Sustainability Framework

Vedanta Resources has developed and adopted a sustainability framework of policies and standards consistent with international standards such as the IFC, the International Council on Mining and Metals (ICMM) and the Organisation for Economic Co-operation and Development (OECD). The policies strive to align with IFC Performance Standards (2012), thus achieving international good practice. The framework includes policies and man agent approaches around Biodiversity management, Energy and Carbon management, Health, Safety and Environment, and Water Management.

The framework incorporates the following management approaches concerning biodiversity impacts:

- Assess biodiversity risks;
- Minimise impacts on ecosystems;

- Avoid any loss of IUCN Red List species;
- Conserve biodiversity within our operations; and
- Where possible, rehabilitate sites progressively and restore to a status similar to the conditions before operations commencement.

International Union for Conservation of Nature (IUCN)

The conservation status of species for all taxonomic groups was determined using the online database of the International Union for Conservation of Nature (IUCN) categories (IUCN, 2013) as summarised in Table 1.1. This system is designed to determine the relative risk of extinction, with the main purpose of the IUCN Red List to catalogue and highlight those taxa that are facing a higher risk of global extinction with those listed as Critically Endangered, Endangered and Vulnerable collectively considered as Threatened. The IUCN Red List also includes information on taxa that cannot be evaluated because of insufficient information (ie Data Deficient) as well as taxa that are close to meeting the threatened thresholds (ie Near Threatened).

Table 1.1 IUCN Categories used to assess the Conservation Status of Fauna (IUCN, 2013)

IUCN Category	Description
Extinct	Where there is no reasonable doubt that the last individual of a species has died.
Extinct in the Wild	A species that no longer occurs in the wild, and is only found in cultivation or in captivity.
Critically Endangered	A species that is considered to be facing an extremely high risk of extinction in the wild, based on IUCN criteria.
Endangered	A species that is considered to be facing a very high risk of extinction in the wild, based on IUCN criteria.
Vulnerable	A species that is considered to be facing a high risk of extinction in the wild, based on IUCN criteria.
Near Threatened	A species that does not qualify for a Threatened category but is close to qualifying for or is likely to qualify in one of those categories in the near future when evaluated against IUCN criteria.
Least Concern	A species that does not qualify for any category as Threatened or Near Threatened when evaluated against IUCN criteria. This includes widespread and abundant species.
Data Deficient	Where there is inadequate information regarding a species' population size, distribution or threats for an assessment to be made.

Convention on International Trade of Endangered Species (CITES)

The main purpose of CITES is to subject the international trade in specimens of selected species to certain controls whereby all imports, exports, and re-exports covered by the Convention have to be authorised through a licensing system. Under CITES, species are listed under one of three appendices, each reflecting the degree of protection required. These are defined as follows:

- **Appendix I** – species are those that are the most endangered among CITES-listed animals and plants. They are threatened with extinction and CITES prohibits international trade in specimens of these species except when the purpose of the import is not commercial, for instance for scientific research.
- **Appendix II** – species are not necessarily now threatened with extinction but may become so unless trade is closely controlled. International trade in specimens of Appendix-II species may be authorised by the granting of an export permit or re-export certificate.
- **Appendix III** – species identified by a party as being subject to regulation with the parties' jurisdiction. The purpose is to prevent or restrict exploitation, and with the need for cooperation from other parties in the control of international trade.

Within South Africa, CITES is implemented by provinces, whereby a permit needs to be issued by the relevant Management Authority where there is international trade of CITES listed species.

International Convention on the Conservation of Biological Diversity (CBD)

As with CITES, South Africa is also a signatory of the CBD, the objective of which include biodiversity conservation, sustainable use of biological resources, and the fair and equitable use of biological and genetic resources. The CBD encourages individual countries to develop or adapt national strategies, plans or programmes to address the provisions of the Convention. South Africa has since developed and amended legislation, for example through NEMA, NEMBA and NEMPA.

1.3 Scope of Work

The primary aim of this study is to define the faunal biodiversity of the Gamsberg inselberg in order to properly assess the potential impacts associated with the proposed Gamsberg zinc mine and associated infrastructure. The following activities were therefore considered as the scope of work in order to achieve the overall objective, namely:

- Provide an overview of legislative and regulatory requirements pertaining to the loss or translocation of fauna identified on site;
- Address any notable gaps that remain from previous studies;
- Undertake comprehensive surveys of terrestrial fauna (ie invertebrates, amphibians, reptiles, birds and mammals) and aquatic elements (where possible) associated with Gamsberg;
- Highlight species of conservation significance (ie endemic, rare and Red Data species) and determine which of those are present or likely to be present;

- Development of a faunal habitat map;
- Identify and map areas of sensitivity in terms of supporting faunal biodiversity and aquatic ecological elements;
- Provide a regional contextualization of faunal biodiversity and aquatic ecosystems with particular focus on other inselbergs and how these contribute to biodiversity and ecological stability, functioning and processes across the regional landscape;
- Attend a specialist workshop and make reports/information available for other specialists working on the Gamsberg Project to ensure specialist studies are properly aligned;
- Conduct an impact assessment report, including consideration of project alternatives through evaluating:
- magnitude, frequency of occurrence, duration and probability of impacts,
- the local, regional, national and international significance of predicted impacts, and
- the level of confidence in findings relating to potential faunal impacts.
- Recommendation of mitigation measures to address predicted impacts; and
- List required permitting and/or licensing requirements.

1.4 Notable Gaps from Previous Studies

A number of specialist studies have already been conducted at Gamsberg. These include field-based studies of invertebrates (Irish, 2000), reptiles and amphibians (Baard, 2000), birds (Harrison and Harebottle, 2000) and mammals (Anderson, 2000). Additional field studies were carried out by GroundTruth, but these were limited to a reconnaissance visit in May 2009 and a focused invertebrate survey in September 2009.

The following significant gaps in data and knowledge remain from the previous studies which need to be addressed in order to adequately define the faunal and aquatic biodiviersity baseline for the Gamsperg Project:

- **Invertebrates** – a detailed wet-season survey is required to allow for adequate sampling of taxa, covering all habitat types within the study area, and focussed on selected indicator taxa. This should include a reassessment of data collected during the previous study, in conjunction with new data, to properly evaluate the relative sensitivity and conservation importance of the invertebrate communities of the Gamsberg. Additionally, a full nocturnal scorpion survey using UV light should be carried out, ideally under moonless conditions in late January. It was also evident from the September 2009 survey that the Gamsberg inselberg supports two undescribed species of ant. This emphasises the potential for other unique terrestrial invertebrates to occur at Gamsberg, hence it is

necessary to ensure that future surveys are conducted in an attempt to uncover other possible species which may be of conservation importance.

- **Reptiles and amphibians –** previous studies were limited in terms of sampling herpetofauna at Gamsberg. Additionally, the taxonomy and conservation assessments of reptiles and amphibians have since been updated. A comprehensive survey of reptiles and amphibians, with preference for sampling the beginning of the wet season, is needed to determine which species of reptile and amphibian occure/likely to occur at Gamsberg. Desktop studies will also need to ascertain the level of conservation importance based on the survey findings in light of new taxonomical changes and new conservation assessments.
- **Birds and mammals –** an additional, wet-season mammal and avifaunal surveys will be useful in terms of supplementing the previous studies by Harrison and Harebottle (2000) and Anderson (2000). In terms of mammals, surveys should focus preferably on smaller species that may not have been detected during the previous survey. Sampling methods should also include other techniques such as pit-fall traps, camera traps and passive monitoring using bat detectors. Additionally, the conservation status of birds and mammals will need to be assessed according to updated atlases and conservation assessments.
- **Aquatic biodiversity –** only a single survey of aquatic ecosystems has been conducted at Gamsberg (ie during the reconnaissance visit in May 2000) and included assessment of benthic diatoms and macro-invertebrates. Additional sampling during the rainfall seasons is required to supplement the previous dry-season survey, thus providing a between understanding of the effects of seasonality.
- **Assessment of impacts –** For all biodiversity components, the various risk and impacts that may be encountered as a result of the proposed Gamsberg Project will need to be identified and assessed according to the mining layout plan. Appropriate management measures will need to be provided based on the outcomes of the impact assessment.

1.5 Project Team

The following persons, with relevant qualifications and contributions to the study, formed part of the faunal specialist team:

- **Dr Mark Graham –** lead author of the study has a PhD (Botany), MSc (Biological Science) and BSc (Agriculture) and was responsible for project management and oversight with specific contribution to the aquatic biodiversity component;
- **Mr G de Winnaar –** has an MSc (Hydrology) and BSc (Hydrology and Zoology) and was responsible for project management and conducted in-field surveys of vertebrate and aquatic biodiversity components;

- **Mr James Harvey** – has an MSc (Environmental Sciences) and BSc Hydrology and Zoology) and conducted in-field surveys of vertebrate biodiversity and made specific contribution to the reptile and amphibian components;
- **Mr Peter Hawkes** – has a BSc Honours (Entomology) and BSc (Entomology and Biochemistry) was responsible for the terrestrial invertebrate component of the study and was assisted by Mr Jonathan Fischer.

2. METHODOLOGY

2.1 Desktop Studies

2.1.1 Species of Conservation Importance

Information of species of fauna recorded within the study area, as well as the species expected to occur in the region as determined by the desktop assessments, were obtained through searching relevant databases. Databases included both the International Union for Conservation of Nature (IUCN) Red List and the Convention on International Trade in Endangered Species (CITES). Relevant IUCN Red List and CITES species were identified based on known distribution ranges.

2.2 Terrestrial Invertebrate Assessments

2.2.1 2009 Survey

Survey Areas

Potential survey sites were pre-selected using the available vegetation mapping as a guide (Desmet, 2010; Desmet *et al.*, 2005), with the aim to primarily cover the most likely habitats for Mantophasmatodea[2], but also to cover as many other habitat types as possible. A gap analysis of previous environmental impact assessments carried out for this project indicated, *inter alia*, that the discovery of a new insect order, the Mantophasmatodea (heelwalkers), subsequent to earlier invertebrate surveys (Irish, 2000) raised the possibility that the presence of these insects could have been overlooked. The presence of relatively moist vegetation on the southern slopes of the Gamsberg suggested that relict populations of heelwalker species similar to those occurring in the South-western and Western Cape might occur here (Picker *et al.*, 2002).

Figure 2.1 shows the spatial distribution of the 2009 survey sites with reference to the prevailing vegetation communities. Details of the sampling sites are provided in Appendix 1.1.

[2] Mantophasmatodea are a recently discovered order of predatory insects, known as Heelwalkers, which look like a cross between a preying mantis and a stick insect; adults range from about 9-20mm in length. Several species were found in Namibia and in the Western and Northern Cape Provinces of South Africa, mainly restricted to the western regions. The similarity of the southern slopes vegetation communities at Gamsberg to vegetation nearer the west coast suggested that these habitats might support isolated relict populations, or possibly additional undescribed species, of Mantophasmatodea and thus a focussed survey for this group was carried out.

Survey Methods

A combination of sweep-netting, beating and hand-collecting was carried out at each site surveyed, as appropriate to the local vegetation structure; in some areas the vegetation was too short and sparse for effective sweeping, so beating and hand-collecting were the only methods that could be employed.

The main focus of the survey was the moister southern slopes vegetation type, but as many other vegetation communities, especially those previously identified as sensitive, as could be covered in the limited time available were also surveyed. During hand-collecting and general inspection of habitats, rock-turning and other direct collecting methods were also employed to collect specimens of as many invertebrate taxa as possible.

2.2.2 2012 Survey

Survey Areas

A field survey of terrestrial invertebrates at Gamsberg was undertaken from 18 November to 1 December 2012. Ten main survey sites (see Appendix 1.1 and Figure 2.2), representing areas of eight main habitat types, were selected for detailed survey. *Ad hoc* sampling of an additional two sites, with a more limited suite of methods, was also carried out as the opportunity arose.

Survey Methods

The following invertebrate sampling techniques were employed during the 2012 survey:

- **Netting** – Within each site random hand-sampling and netting of butterflies and dragonflies was carried out, but due to the extremely dry and hot conditions prevailing during the survey and the very low rainfall experienced during the preceding year, structured hand-sampling would have been very unproductive and was thus omitted.
- **Pitfall trapping** – Pitfall trapping effort was doubled from the planned 20 to 40 traps per survey site to supplement the reduced hand sampling. At each of the ten main survey sites 40 pitfall traps were installed and run for seven days, with 20 traps along each of two parallel transects (except for those in the gorge where topography forced a less structured placement). The focus of pitfall trapping was to obtain samples of ants and other ground-living invertebrates such as carabid beetles.
- **Net-sweeping** – In eight of the survey sites structured net-sweeping (20 samples each comprising 100 sweeps) was also carried out. The two main survey areas in which net-sweeping was not performed were duplicate sites of the same habitat type as another transect along which net-sweeping had been carried out.

Figure 2.1 Distribution of the 2009 Invertebrate Survey Sites Showing Areas Surveyed thoroughly for Mantophasmatodea by using Sweep-net and Hand-Collecting/Beating methods and Areas where only Searches were Conducted

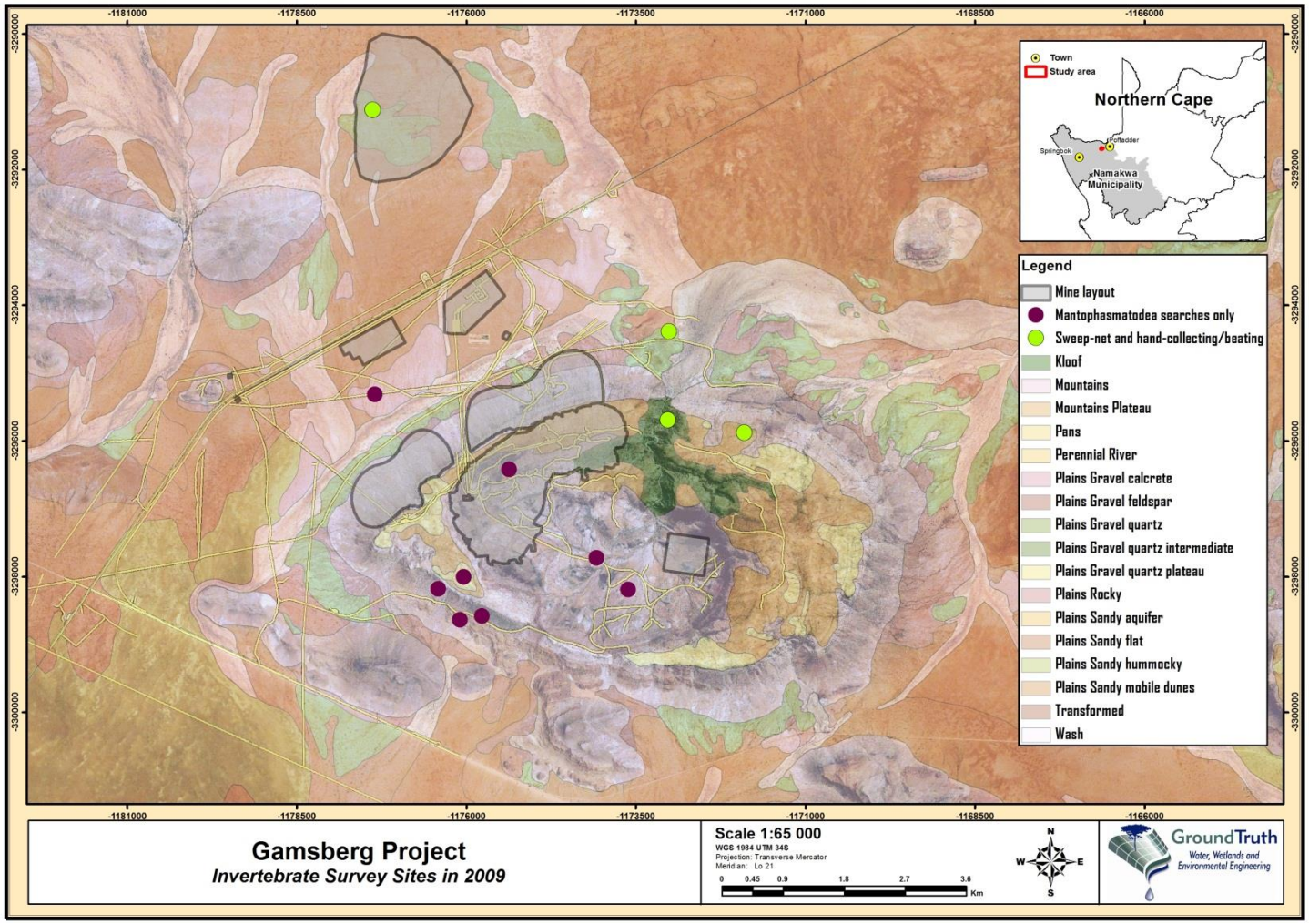
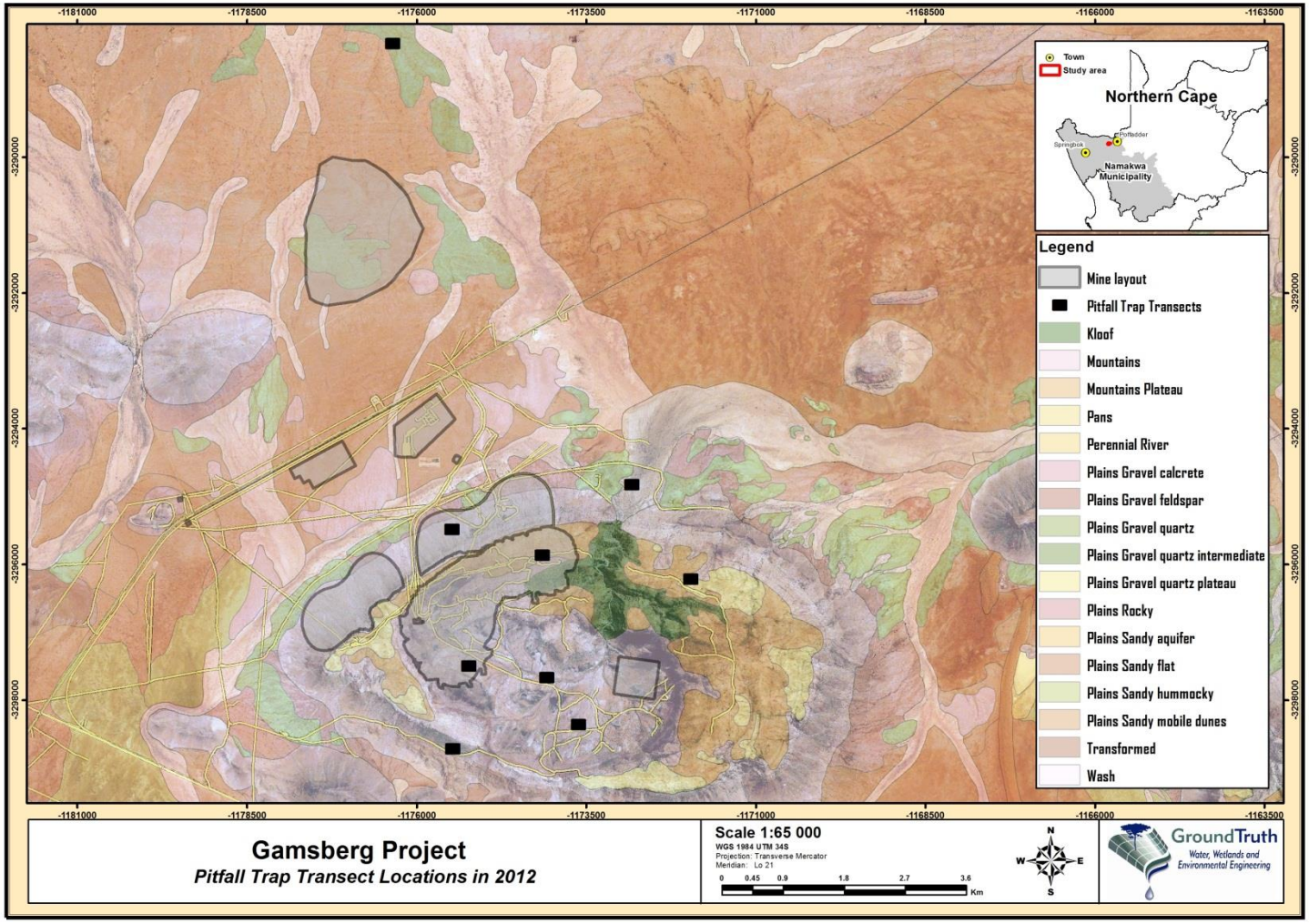


Figure 2.2 Pitfall Trap Transect Locations during 2012 Survey



- **Ultraviolet-assisted night searching** – Scorpions: scorpions were sampled during daytime surveys of the various sites by rock turning and searching for and excavating burrows and by UV-assisted night surveys of selected sites. One site (the wash area) was sampled twice to test whether the substantially higher diversity observed during the first night here was an artefact of weather conditions or a true reflection of differences between sites.

2.2.3 Storage and Delivery of Samples

All invertebrate samples were collected and preserved in 95% ethanol, 70% ethanol, propylene glycol or 50% ethanol/propylene glycol, as appropriate to the taxon and sampling method (propylene glycol is used in pitfall traps in preference to the more commonly used ethylene glycol, which is highly toxic to mammals and poses a health risk both to personnel and non-target organisms). Duplicate labels for each sample for all planned sampling were prepared in advance and laminated to ensure long-term legibility. For samples transported in plastic specimen bags, a label was placed inside the bag and another stapled to the outside. Samples were transported in preservative in sealed (Lock'n Lock) plastic containers.

2.2.4 Data Analysis and Interpretation of Data

Specimens collected for evaluation of presence/absence of species of conservation concern were identified by a reference to available literature and confirmed by relevant experts. AfriBugs is fully equipped for processing, identification and curation of ant samples, with a state-of-the-art microscope imaging system to aid in identification and allow high-quality documentation of specimens collected. AfriBugs has close links with experts in other taxonomic groups and obtain their assistance where needed in identifying specimens.

The requirement for statistically testable data means that detailed analysis of the samples collected is required, but for invertebrate species (with at least 3000[3] specimens expected from each of the sites surveyed by pitfall trapping and sweep netting); this is a time-consuming and costly process, especially if species-level identifications are needed. However, while it is essential to obtain species identifications to enable detection of exotic or invasive species for proper evaluation of rehabilitation in a monitoring programme, it should

[3] Such numbers are insignificant in comparison to the many millions of invertebrates inhabiting an area such as the Gamsberg project area and the removal of a few thousand specimens from a site is small in comparison to daily losses to natural predators. In the case of ants, where foraging workers are the main target of pitfall sampling, impacts are even less significant as the reproductive individuals (the queens) are not trapped, so there is an insignificant effect on the populations.

be sufficient to use only morphospecies[4] identifications to allow an initial evaluation of the overall diversity of the site and evaluate indicator groups for inclusion in future monitoring. Thus, specimens in several of the groups were initially assigned only to morphospecies for the purposes of this study, and should be identified further in future.

Samples collected for evaluation of biodiversity of target groups (ants, spiders, scorpions, ground beetles and leafhoppers) should be sorted to morphospecies and the number of each morphospecies in each of the 20 samples in each sample series recorded. This provides a measure of sample species richness and the information can also be used to generate a species x sample matrix for each taxonomic group for further analysis, including estimation of species richness using EstimateS (Colwell, 2005), as well as calculation of diversity indices (eg α, Simpson's and Berger-Parker). Data are not yet available from the pitfall and sweep samples so these analyses have not yet be done.

The total numbers of morphospecies encountered in each group, as well as the sample species richness and its variance, provides an indication of the effectiveness of the group as an indicator, and enables accurate cost estimates of full identifications required for effective monitoring.

The results of these analyses can be used to evaluate the contribution each group would make to an effective invertebrate biodiversity monitoring programme to enable recommendations to be made regarding the design of cost-effective monitoring. The data also provide a baseline measure of invertebrate diversity, although further identification may be required for those groups selected for inclusion in the monitoring programme.

Voucher specimens are either kept in AfriBugs collection (in the case of ants, except where new species are found, in which case type specimens are deposited at the South African Museum in Cape Town), or deposited with the National Collection of Insects, National Collection of Arachnids or Transvaal Museum, as appropriate to the taxon concerned.

2.2.5 Survey Limitations

Time constraints did not allow the delay of the 2012 sampling to late summer as would have been ideal and this, in combination with the extremely dry weather experienced in 2012 (with less than 30 mm being recorded during the

[4] A morphospecies is a temporary grouping of individuals assumed to be the same species based on morphology, still awaiting full species-level identification based on formal identification keys - which are mostly still only based on morphology.

year prior to the November field surveys), probably contributed to the very low observed activity of scorpions and other invertebrates. A true wet season survey of terrestrial invertebrates has not been carried out, and there is a strong possibility that additional species would have been observed if the surveys had been carried out later in the season.

Additionally, the ant samples collected in 2009 were not part of the focus of that survey and were collected incidentally; no budget was available at the time for analyses of these incidental samples. As such, identification of the remaining ant species found in 2009 is to be carried out while the further material collected during the November 2012 survey is being processed.

2.3 Vertebrate Faunal Assessments

Assessment of the vertebrate fauna included surveys of the following key groups, namely, herpetofauna (ie amphibians and reptiles), birds (avifauna) and mammals. Surveys were conducted over ten days between 20 and 29 November 2012 to address outstanding faunal elements following the high-level reconnaissance survey in May 2009. A variety of sampling methods were employed at a number of locations throughout the study area, covering a range of available faunal habitats. The locations of sampling sites used to sample faunal diversity are illustrated spatially in Figure 2.3 with additional site-specific detail provided in Appendix 2.1.

The various sampling techniques employed are described in the following sections according to each of the key faunal groups.

2.3.1 Herpetofauna

Pitfall/Funnel Trap Arrays

Five trap arrays were constructed within the study area during the November 2012 survey. Each array consisted of four buckets, sunk flush with the ground (pitfalls), set along a three-armed, Y-shaped drift-fence comprising heavy duty plastic, held up by wooden stakes (Figure 2.4). In addition, six funnel traps were set alongside the drift fence at each of the arrays. Trap arrays were in position for eight nights and inspected on a daily basis during the morning. Although the trap arrays were used primarily to sample herpetofauna, they also collect by-catch of other faunal groups. Invertebrate by-catches were given to the invertebrate team to supplement invertebrate sampling efforts.

Figure 2.3 Locations of Sites used to Sample Terrestrial Vertebrate Fauna during the 2009 and 2012 Surveys

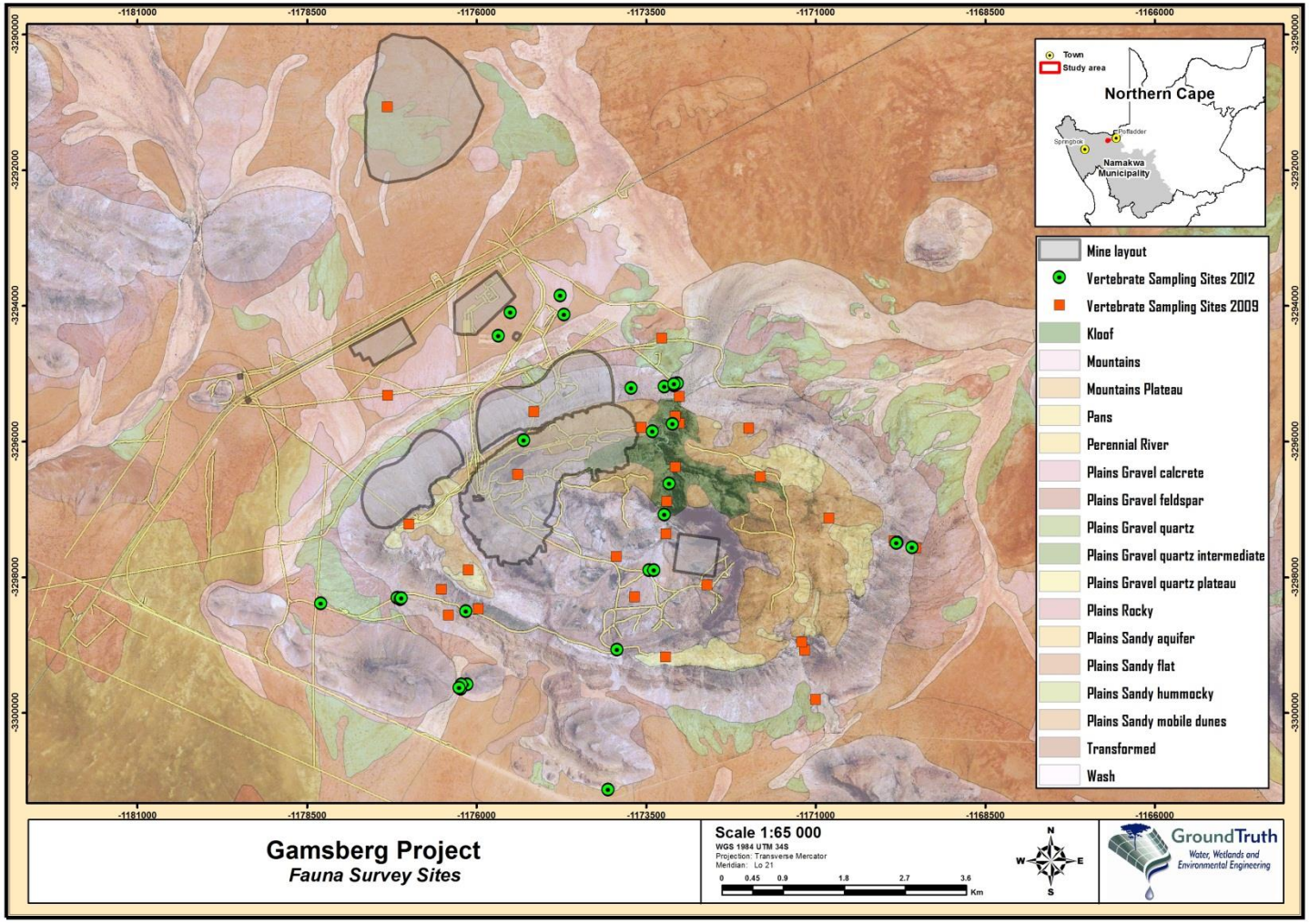
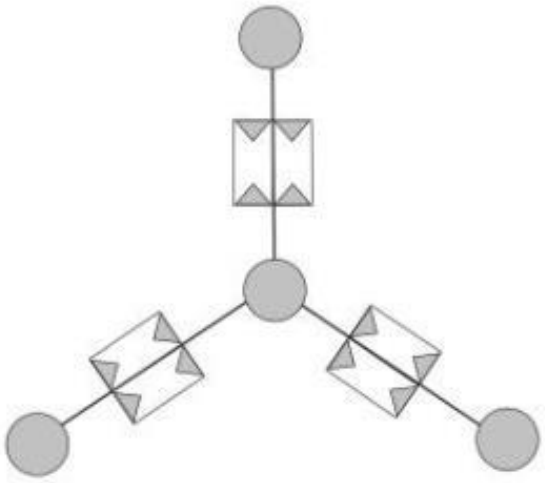


Figure 2.4 ***Schematic Diagram of a Trapping Array Circles Represent Pitfall Traps, Rectangles Represent Funnel Traps with One-way, Cone-shaped Entrances, Lines Linking Pitfall Traps Represent Drift Fences (each 8 meters long)***



The arrays were distributed across the study area in an attempt to sample as wide a range of habitat types and vegetation units as possible. These habitats included the kloof washout and plain to the north, plain and washout to the west and plain to the south of the inselberg. Unfortunately, the positioning of trap arrays was limited by soil depth and time to access and service all traps.

Active Searches

The following active sampling techniques were used for collecting frogs and reptiles (herpetofauna) during the May 2009 and November 2012 surveys as part of establishing the baseline biodiversity study:

- **Nocturnal searches (audio and visual) –** aquatic habitats were surveyed at night for amphibians. During these searches, amphibians were detected and identified by active searches of the sites; identification of species was also based on advertisement calls. Whilst moving between aquatic habitats, attempts were also made to locate reptiles.
- **Diurnal searches –** although this approach was adopted for all herpetofauna, it focused primarily on reptiles as opposed to frogs. Diurnal searches comprised random searches throughout key habitat types occurring within the study area with the idea of locating basking or actively moving reptiles. In addition to this, active turning of rocks was conducted to expose hidden reptiles. By-catch samples from other taxonomical groups were recorded during these searches.

Ancillary data collected from various sources (eg mine personnel, other specialists, etc) were also taken into consideration. This was made possible

mainly through the availability of photographs, which were used to identify vertebrate species from all groups assessed.

2.3.2 Mammals

Camera Traps

Eight motion sensor cameras (ie camera traps) were set up at various locations on the Gamsberg inselberg and surrounding plains during the November 2012 survey. The camera traps were used to detect and photograph any medium to large mammals moving across the cameras' field of detection, particularly species of carnivore (eg cats, mongooses, weasels, etc). Domestic cat food placed within the detection field was used as bait to attract mammals to camera trap sites thereby improving chances of obtaining photographic records. Fresh bait was replaced roughly every two days.

Figure 2.5 Camera Trap on the Plain South of the Inselberg

Small Mammal Traps

Ten Sherman traps, baited with peanut butter and oats, were set at eight different locations within the study area during the November 2012 survey. Sherman traps were placed along linear transects with traps positioned roughly five meters apart. Traps were checked every morning to record and release any rodents that may have been captured during the previous night.

Bat Monitoring

Bat surveys were conducted by actively sampling bats using the following techniques:

- **Mist netting** – mist nets positioned in key areas (ie over water bodies and across roost sites, such as adits and caves). The objective of using the mist nets was to intercept the flight-paths of feeding bats. A few sites were sampled during the May 2009 survey using mist nets, namely, two sites located within the kloof that had standing pools of water and a single site at one of the adits located on the northern slopes.
- **Recording echo-location calls** – an Echo Meter EM3 Handheld Ultrasonic Recorder was used during the November 2012 survey to record bats when conducting nocturnal searches for other faunal groups. A Pettersson bat detector linked to a PC running BatSound Pro was used during the May 2009 survey was used to record voucher calls of bat specimens captured using mist nets. The frequency-modulated calls recorded were used to assist with bats species identification.
- **Visual inspection of roosts** – potential daytime roosts were inspected whilst travelling between survey sites for other faunal components. This process was restricted mainly by the time taken for locating sizeable caves/adits as well as their accessibility. This form of sampling was therefore considered opportunistic. Only a single cave, found on the southern slopes, was inspected for the presence of bats.

Figure 2.6 ***Typical Pool of Water at Gamsberg, Creating Active Feeding Zones for Bats, Particularly during Dry Periods***

Sightings

Visual sightings of any mammals were recorded at all times whilst traversing the study areas, both day and night. Indirect evidence of mammals was also recorded, eg through observations of spoor and scats.

2.3.3 Birds

All birds were identified visually or by their calls. Given that bird species composition for the Gamsberg is reasonably well accounted for based on previous surveys (eg Harrison and Harebottle, 2000), additional records were

nevertheless recorded to supplement previous. Thus, bird surveying done during this study was primarily incidental, ie performed whilst travelling between and around survey sites.

2.3.4 Data Analysis and Interpretation of Data

As with terrestrial invertebrates, vertebrates (ie herpetofauna, mammals, and birds) were assessed according to their conservation value/status. The conservation status of all vertebrate species was determined using the most recent International Union for the Conservation of Nature (IUCN) categories (IUCN, 2013). This system is designed to determine the relative risk of extinction, with the main purpose of the IUCN Red List to catalogue and highlight those taxa that are facing a higher risk of global extinction with those listed as Critically Endangered, Endangered and Vulnerable collectively considered as Threatened. The IUCN Red List also includes information on taxa that cannot be evaluated because of insufficient information (ie Data Deficient) as well as on taxa that are close to meeting the threatened thresholds (ie Near Threatened).

Any Red Data, and other notable species, that occur within the study area were assessed further to see whether they are listed according to the Convention for the International Trade of Endangered Species (CITES). The main purpose of CITES is to subject the international trade in specimens of selected species to certain controls whereby all imports, exports, and re-exports covered by the Convention have to be authorized through a licensing system.

2.4 Aquatic Ecosystem Assessments

The aquatic ecosystems of the Gamsberg were assessed using appropriate aquatic biomonitoring techniques, such as benthic diatoms and aquatic macroinvertebrates. The type of sampling technique used depended largely on the availability of aquatic habitats at each of the respective sampling sites. Details of the aquatic sampling sites are provided in Appendix 3.1 and displayed spatially in Figure 2.7.

Fish surveys (disturbance, visual observations and netting of the clear kloof pools) were attempted during the 2009 survey, but no fish were seen or caught during that survey. Available habitat for fish surveys was even further reduced during the 2012 surveys and hence no additional fish surveying was undertaken in 2012. It is therefore assumed there are no fish present in these ephemeral river systems at this stage. Only those aquatic biota collected or sampled are detailed below.

2.4.1 Benthic Diatoms

The protocol for diatom sampling is relatively straight-forward and in this study the collection, preparation and analysis methodologies of Taylor *et al.* (2007) were employed. In summary, this involved taking a random collection of five sub-samples, consisting of mainly submerged aquatic medium (eg stones and vegetation). The diatoms are then scrapped or brushed off these sub-samples and combined into one sample, to represent the sampled site. Four sites were sampled for diatoms during the May 2009 survey, and of these only three which were wet and with available habitat, were re-sampled again during the November 2012 survey.

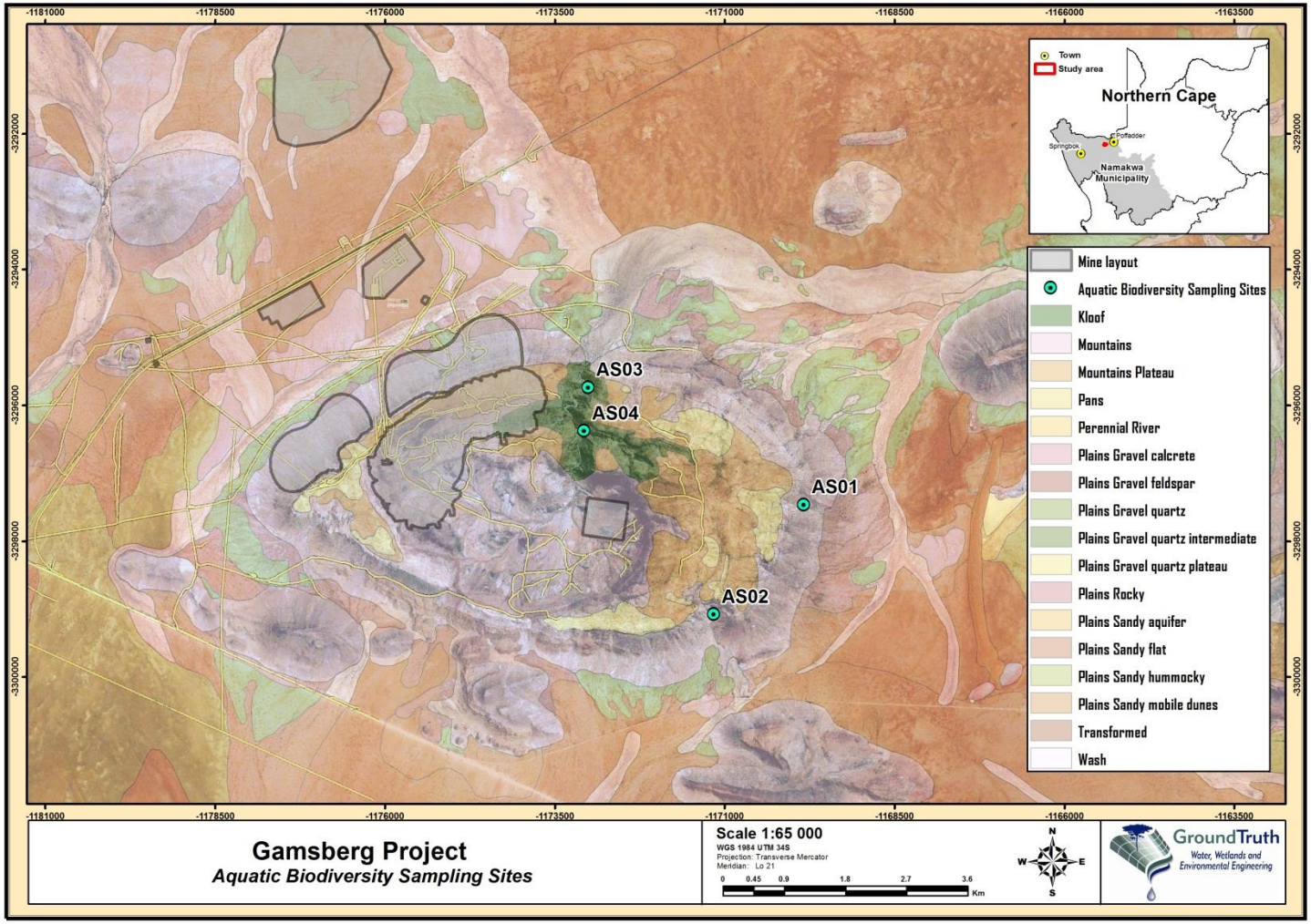
2.4.2 Aquatic Macro-invertebrates

Aquatic macro-invertebrates were assessed according to the South African Scoring System, Version 5 (SASS5). Only a single site (ie the Gamsberg River within the kloof) was sampled during the May 2009 survey with no additional SASS5 sampling possible during the November 2012 survey due to the limited availability of sampling habitat. This is typical of the arid environment (eg Uys and O'Keefe, 1997) with responses from aquatic macro-invertebrates only possible following sufficient rainfall and habitat availability within these systems. For the single site sampled in 2009, attempts were made to sample the full spectrum of available biotopes (sampling habitats) as required by SASS5 methodology, namely, stones (rocky riffle sections), marginal vegetation within the main stream, and sediments (gravel/sand/mud) (Dickens and Graham, 2002).

2.4.3 Water Chemistry

Water quality samples were taken to determine various chemical parameters that potentially may affect the aquatic biodiversity due to mining developments. A water quality sample was taken at the SASS5 sampling site (ie Site AQ03) during the 2009 survey. The sample was stored in a cool environment prior to being sent to a SANAS accredited laboratory at Umgeni Water, Pietermaritzburg, for analysis. Parameters included in the analysis included pH, alkalinity and various nutrients (eg total phosphate, total nitrogen, and soluble reactive phosphate).

Figure 2.7 Locations of Sites used to Sample Aquatic Biodiversity during the 2009 and 2012 Surveys



2.4.4 Storage and Delivery of Samples

Benthic **d**iatoms samples were stored in a bottle with 10% ethanol and sent to the University of the North West for specialist microscopic analysis to identify diatoms to species level. These samples formed part of the South African Diatom Collection curated and housed at this university.

2.4.5 Data Analysis and Interpretation of Data

Data obtained during the assessment of aquatic habitats were analysed using index scores specific to each aquatic biomonitoring technique.

Species data information of benthic diatoms was interpreted according to the Specific Pollution sensitivity Index (SPI) (WRC, 2004). Additionally, the percentage of Pollution Tolerant Valves (%PTV) was also determined as it is a useful parameter for indicating the presence of diatoms that are tolerant to reasonable amounts of pollution. Using the SPI values obtained from the respective sampling sites, with some reference to the %PTV, the ecological status of each aquatic system sampled was determined (see Table 2.1).

An additional bio-indicator assessment was conducted based on the occurrence of aquatic macro-invertebrates and the specific pollution tolerance ratings associated with each of the macro-invertebrate taxa. This assessment, similar to the diatom bio-indicator assessment, provides an indication of the present state of river health. However, the macro-invertebrate approach includes two different but complimentary measures (or indices) obtained from each aquatic macro-invertebrate sample, viz., the SASS score and the average score per taxon (ASPT) (Dickens and Graham, 2002). The SASS score is most useful in interpreting the health of a site in polluted rivers, whilst the ASPT is most useful in cleaner rivers (Chutter, 1998). Generally the higher the index (eg SASS score, ASPT, or SPI) the better the health, or condition, of a river.

Reference Sites for the respective Ecoregion as well as data available from the University of the North West and the South African Diatom Collection, were used to establish the benchmark against which to measure the current "state" or "river health" of monitored sites. Based on actual data collected during this work, and the available reference sites, respective indices were then used to define the class boundaries for both diatom and macro-invertebrate approaches (de La Rey *et al.*, 2004; Taylor pers. comm., 2009a).

Table 2.1 ***Aquatic Macro-invertebrate SASS5 Index and Benthic Diatom Scores used to Define River Health Class Boundaries***

River Health Class		Macro-invertebrate SASS5 ASPT health condition class boundaries	Benthic diatom Specific Pollution Sensitivity Index (SPI) health condition class boundaries
Natural	> or =	6.0	> 17
Good	>	5.5	13 – 17
Fair	>	5.3	9 – 13
Poor	< or =	5.3	<9

Table 2.2 ***River Health Classes and their Attendant Ecological and Management Perspectives***

River Health Classes	Ecological perspective	Management perspective
Natural	No or negligible modification of in-stream and riparian habitats and biota.	Protected rivers; relatively untouched by human hands; no discharges or impoundments allowed
Good	Ecosystems essentially in good state; biodiversity largely intact	Some human-related disturbance but mostly of low impact potential
Fair	A few sensitive species may be lost; lower abundances of biological populations may occur.	Zones of competing uses; developmental pressures are dominant feature.
Poor	Habitat diversity and availability have declined; mostly only tolerant species present; species present are often diseased; population dynamics have been disrupted (eg biota can no longer breed or alien species have invaded the ecosystem).	Often characterised by high human densities or extensive resource exploitation. Management intervention is needed to improve river health – eg to restore flow patterns, river habitats or water quality.

3. REVIEW OF REGIONAL FAUNAL FEATURES

3.1 Study Area

The study area, located approximately 40 km west of the town of Poffadder, for the faunal biodiversity study corresponds with that of the Gamsberg inselberg and the adjacent flat plains that surround the inselberg (Figure 3.1). The Gamsberg inselberg is located within the Khai Ma local municipality which lies to the East of the Richtersveld and contains virtually the entire extent of the Bushmanland Inselberg priority area - one of the nine zones identified through the Succulent Karoo Ecosystem Programme (SKEP) process as important conservation areas in the Succulent Karoo (NDBP, 2008).

Numerous sampling sites were distributed across the study area, each site being used to cover a range of biodiversity components to assess the terrestrial fauna and aquatic biodiversity. These sites were generally positioned according to their accessibility as well as the availability of suitable sampling habitat.

3.2 Ecological Regions

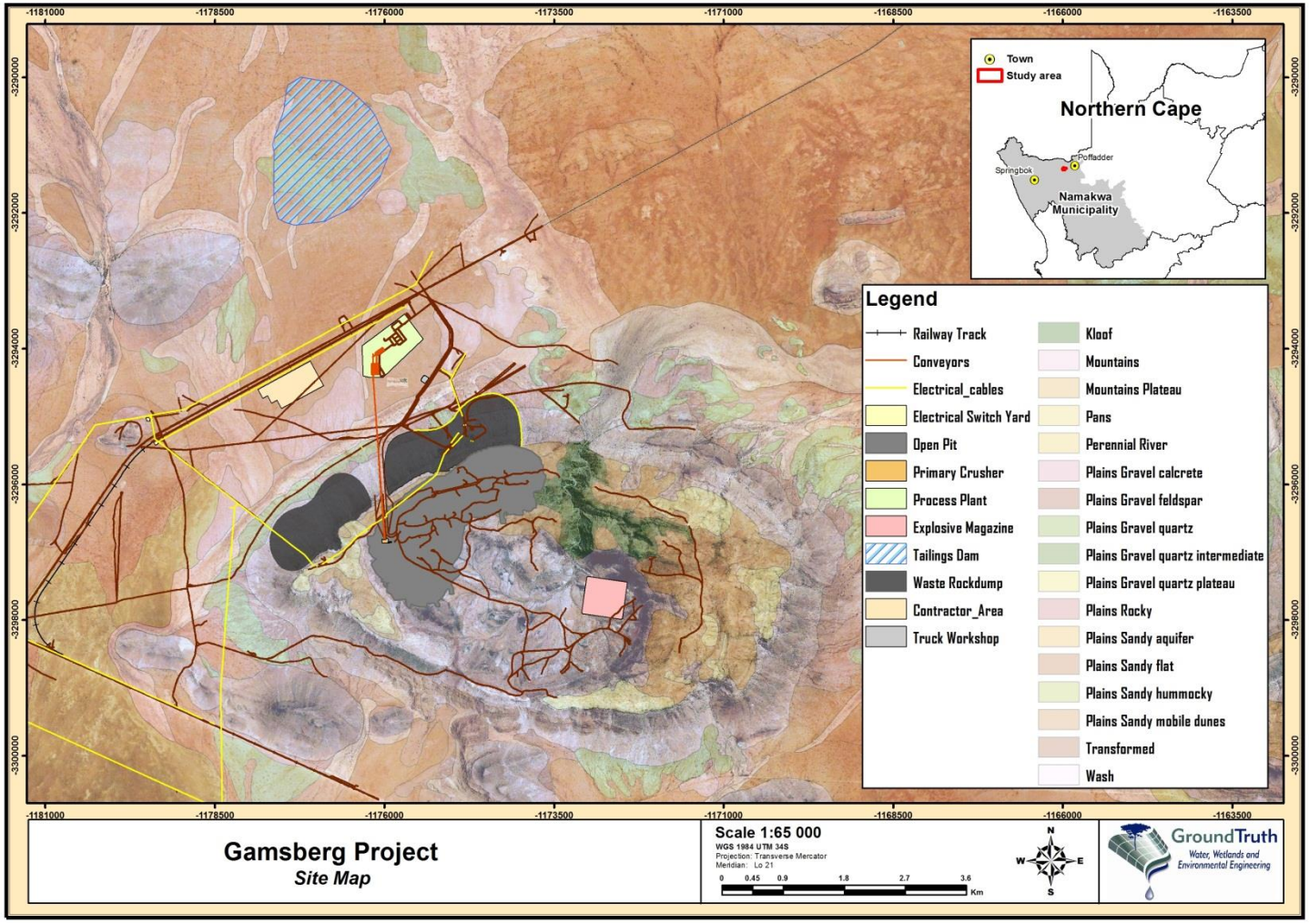
Ecological regions (ecoregions) are relatively large areas that exhibit relative homogeneity of ecosystems through the integration of ecological and geographical mapping and are thus important units of analysis particularly in terms of environmental assessment and management (Loveland and Merchant, 2004). The faunal diversity and ecosystems that characterise an ecoregion therefore tend to be distinct from other ecoregions.

Ecoregions within which the Gamsberg study area occurs are classified for both terrestrial and freshwater systems.

3.2.1 Nama Karoo Terrestrial Ecoregion

With reference to the 119 terrestrial ecoregions covering Africa and Madagascar as defined by Burgess *et al.* (2004), the Gamsberg study area falls within the Nama Karoo ecoregion. It is a vast, open, arid region dominated by low shrub vegetation, punctuated by rugged relief (Dean and Milton, 1999). The climate of the Nama Karoo is harsh with droughts common and extreme temperature fluctuations both daily and seasonally. Rainfall, ranging between 100 and 500 mm, is unseasonal, but generally peaks between December and March (Palmer and Hoffman, 1997). In terms of fauna, the Nama Karoo is considered to be relatively species poor, with only a few strict endemics to the Nama Karoo ecoregion (Vernon, 1999).

Figure 3.1 Study Area Map for the Faunal Biodiversity Study



3.2.2 Karoo Freshwater Ecoregion

The Gamsberg study area falls strictly within the Karoo freshwater ecoregion, a semi-arid landscape with numerous intermittent rivers, but transitional and draining to the Western Orange ecoregion, just to the north of the study area (Thieme *et al.,* 2005). For this former ecoregion these rivers remain dry for most of the year, experiencing short periods of flow following rainfall events. Rainfall is unpredictable, patchy and low, with temperatures also fluctuating dramatically , both daily and seasonally (Thieme *et al.,* 2005). The river systems typically consist of dry river beds for most of the time, and pans. Consequently, aquatic fauna in the region have specialised adaptations, allowing them to withstand long periods of drought by remaining in a state of dormancy.

Fish fauna are depauperate with only four species known from this ecoregion's waters (Thieme *et al.* 2005). Pools provide refugia for these species during dry periods from which they may disperse during more favourable conditions (Hocutt and Skelton 1983). Thieme *et al.* (2005) note that aquatic fauna from this ecoregion are able to withstand long periods of drought in a state of diapause, and once wet conditions return, the animals break their diapause and mature rapidly, often reproducing asexually several times during the short wet season and then sexually only as conditions deteriorate and water dries up. These authors also note that standing water is a rare habitat in this ecoregion. These features highlight that the Gamsberg springs and inselberg driven river systems are a unique feature of the ecoregion and spatially highly isolated.

Frogs in the area are limited to opportunistic species, although several species are endemic to the region (eg Namaqua Caco and Paradise Toad (Harrison *et al*., 2001) – the latter found at the site). These species have adaptations to that allow them to survive long periods without water as adults, with usually short larval stages, allowing them to capitalise on short wet periods (Thieme *et al.* 2005).

In terms of generic threats to this aquatic ecoregion, Thieme (*et al.,* 2005) have identified that groundwater depletion is one of the future threats to the area.

3.3 Areas of Conservation Importance

3.3.1 Succulent Karoo Ecosystem Programme (SKEP)

The Succulent Karoo Ecosystem Programme (SKEP) highlights unique areas of biodiversity within the Succulent Karoo. The programme divides the Succulent Karoo into nine biodiversity hotspots. Gamsberg falls within one of these: the Bushmanland Inselberg Priority Region, an area of 31 400 hectares. The Red Lark *(Certhilauda albescens)* is an important endemic species of the

region (NDBP, 2008) and is considered as one of the flagship species of the Bushmanland Inselberg Priority Region.

3.3.2 Namakwa District Biodiversity Sector Plan (2008)

The Namakwa District Biodiversity Sector Plan (NDBP) is *"intended to help guide land-use planning, environmental assessments and authorisations; and, natural resource management in order to promote development which occurs in a sustainable manner. It has been developed to further the awareness of the unique biodiversity in the area, the value this biodiversity represents to people as well as the management mechanisms that can ensure its protection and sustainable utilisation"* (NDBP, 2008).

The NDSP (2008) describes the Bushmanland Inselberg Priority Region as '*a unique and dynamic region that contains many rare and fragile habitat types*', that is an important refugia for plants and animals. The plan notes the threat of mining initiatives in the area to local biodiversity.

3.3.3 Important Birds Areas (IBAs)

The Important Bird Areas (IBA) Programme identifies and works to conserve a network of sites critical for the long-term survival of bird species that:

- are globally threatened
- have a restricted range
- are restricted to specific biomes/vegetation types.

A fourth category encompasses sites that have significant populations; for example, 20 000 water birds or 10 000 pairs of a species of seabird. South Africa has 101 Global IBAs and an additional 21 Regional IBAs (www.birdlife.org.za).

Gamsberg sits immediately adjacent to the Bitterputs Conservation area (IBA number SA 036) (www.birdlife.org.za). This is one of few sites protecting both the globally threatened Red Lark (*Certhilauda burra)*, which inhabits the red sand dunes, and the near-threatened Sclater's Lark (*Spizocorys sclateri)*, which occurs erratically on the barren stony plains. This site also holds 16 of the 23 Namib-Karoo biome-restricted assemblage species and a host of other arid-zone birds.

3.3.4 Protected areas

Protected areas are fundamental from a conservation and biodiversity perspective and require necessary protection to ensure safeguarding of habitat and inherent biodiversity. These areas are particularly important where certain habitat types are threatened. They also provide some surety against the loss of valuable ecosystems and their associated goods and services. The

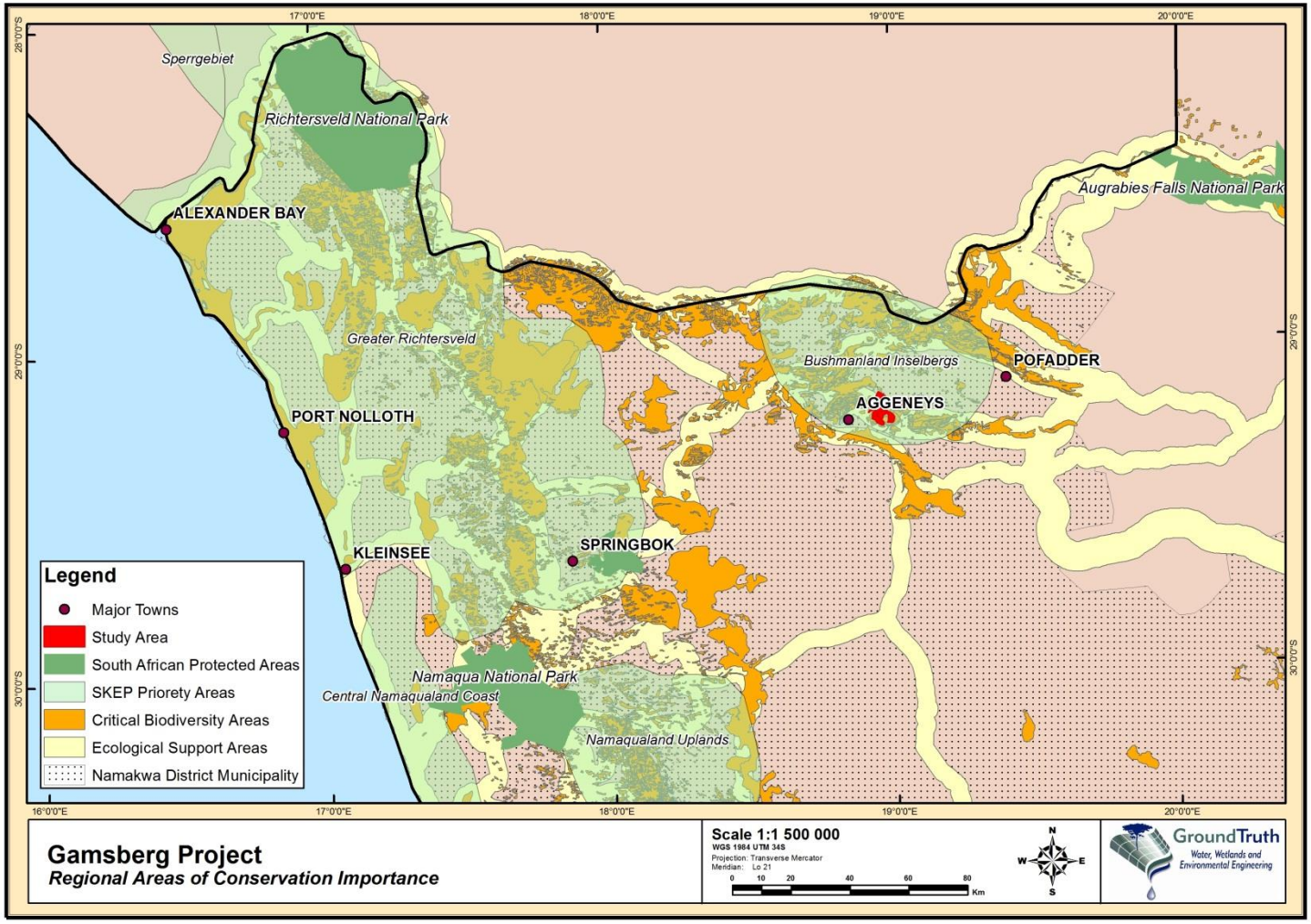
Northern Cape has a number of protected areas, some of which are located in close proximity to the study area as illustrated in Figure 3.2.

Currently there are no statutory protected areas in the Khai Ma local municipality; however, there is a private conservation initiative with Anglo Base Metals Black Mountain mine, covering approximately 23 000 ha of mine holdings around Aggeneys (NDBP, 2008). As previously discussed, the study area falls within one of the SKEP Priority Areas, as shown in Figure 3.2.

3.3.5 National Freshwater Ecosystem Priority Areas (NFEPAs)

In terms of the national classification of freshwater ecosystem priority areas, the rivers draining the Gamsberg inselberg have a classification of 4, ie identified as "catchments in which human activities need to be managed to prevent degradation of downstream river Freshwater Ecosystem Priority Areas (FEPAs) and Fish Support Areas". The river condition used by NFEPA was classified as AB, ie "considered intact and able to contribute towards river ecosystem biodiversity targets". The DWA 1999 classification of the Present Ecological State (PES) of these rivers is a B, ie largely natural with few modifications.

Figure 3.2 Areas of Conservation Importance Located in Proximity to the Gamsberg Study Area



4. DESCRIPTION OF THE INVERTEBRATE FAUNA

4.1 Diversity and Abundance of Invertebrate Groups

4.1.1 Mantophasmatodea (Heelwalkers)

No Mantophasmatodea were found at any of the sites searched in 2009 or 2012. There remains a small possibility that there might be summer-active (wet season) species of this group at Gamsberg, but this could not be determined during the 2012 survey as conditions at this time remained extremely dry. Additional studies are justified on the basis that a true wet season survey of terrestrial invertebrates has not been carried out, and there is a strong possibility that additional species would have been observed if the surveys had been carried out later in the season.

4.1.2 Formicidae (Ants)

At least 13 ant species were collected during the brief 2009 survey, despite it being carried out during the cool dry season and this group not being the primary focus of the survey; it is likely that this number would rise substantially after a wet season survey. It is expected that the final tally would significantly exceed the total of 12 obtained in the Irish (2000) study. Although the conditions during the November 2012 survey were extremely dry, additional ant species not previously collected were found and once processing of the sweep net and pitfall trap samples is complete, a higher total number will be obtained, though probably not as high as would be obtained after significant rain. Two undescribed ant species, belonging to the genera *Camponotus* and *Messor*, were found during the early September 2009 field visit; additional material of both was subsequently collected in 2012 and these species are discussed in more detail below. Identification of the remaining ant species found in 2009 will be carried out while the further material collected during the November 2012 survey is being processed.

The two ant species collected in 2009 that stood out immediately as being of interest were a very pale *Messor* species (Figure 4.1) and a *Camponotus fulvopilosus*-group species (Figure 4.2). The latter is distinct from the Karoo form of *C. fulvopilosus* commonly occurring in the region. Both are large ant species and thus a restricted distribution would be the most likely explanation for their not having been discovered previously. The *Messor* species could not be identified using available keys (Bolton 1982) and has now been confirmed as being undescribed. Hamish Robertson (South African Museum) and Barry Bolton (the leading authority on African ant taxonomy) have confirmed that they have not seen anything like it from sub-Saharan Africa; Barry Bolton

suggested that it may be nocturnal, as is the case with other pale *Messor* species in other parts of the world, and this should be investigated during future field surveys. The *Camponotus fulvopilosus*-group species required further investigation, including comparison with material at the South African Museum, to determine whether it was a new discovery, or a previously collected species that had been erroneously classified as a form of *C. fulvopilosus* (to which it keys using Robertson and Zacharides (1997). The undescribed *Camponotus* species collected during the 2009 survey has now been assigned the code *Camponotus* AFRC-ZA-52 in the AfriBugs collection, while the undescribed *Messor* has been assigned the code *Messor* AFRC-ZA-01. Strict use of these codes to refer to these ants until formal description of the species has been carried out will eliminate any possibility of confusion with other ant species.

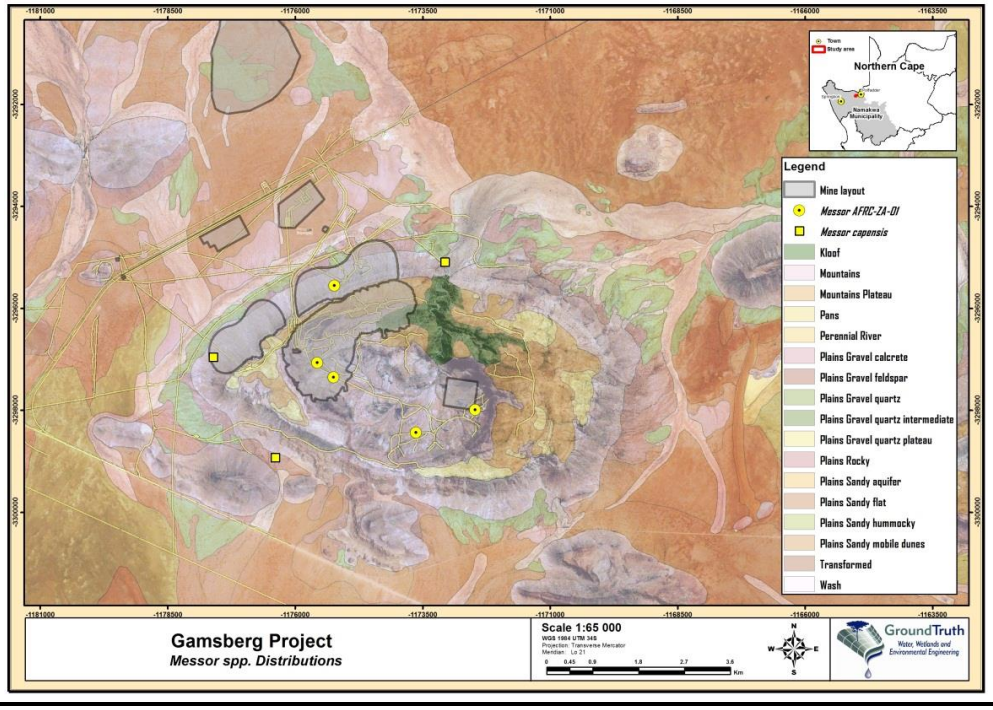
Figure 4.1 ***Undescribed Messor AFRC-ZA-01 Found in the Gamsberg Basin***

Figure 4.2 ***Undescribed Camponotus AFRC-ZA-52 (Left) Compared with the Karoo Form of C. fulvopilosus (Right) Commonly Found at Gamsberg and in the Surrounding Regions***

A single nest of *Messor* AFRC-ZA-01 was discovered during the September 2009 survey. A further five nest sites were located during the 2012 survey, all

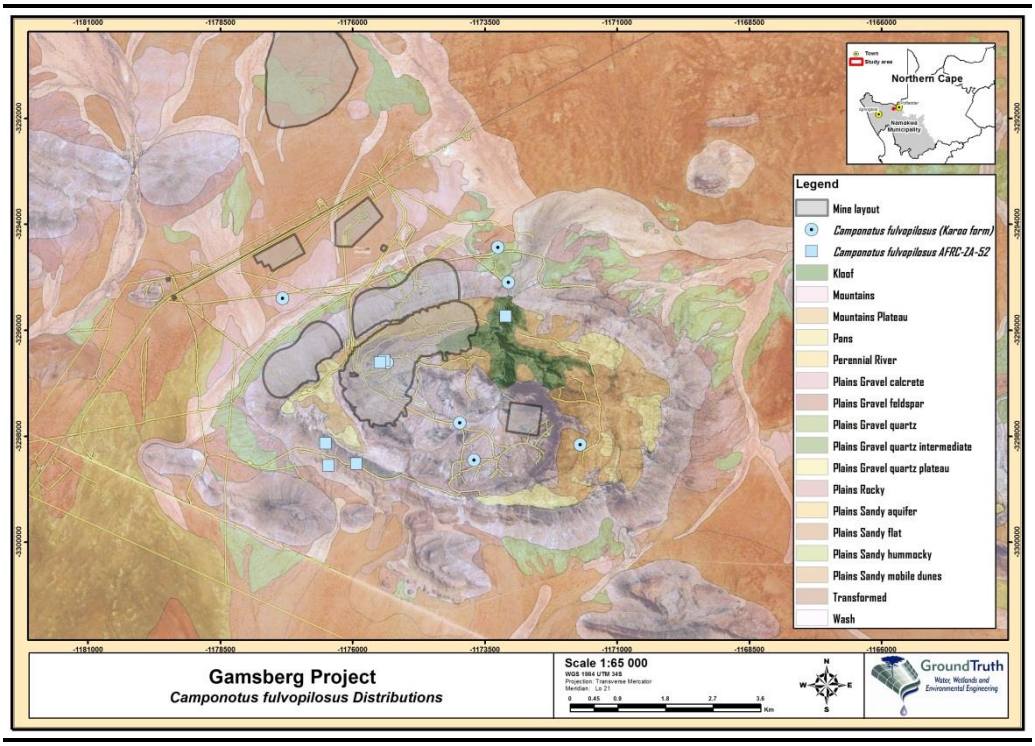
close to drainage lines within the inselberg basin; an additional single specimen was found in a pitfall trap sample at survey site 3, on the northern slopes of the inselberg (see Figure 4.3). Interestingly, while two nests and some additional foraging workers of *Messor capensis* (a species widespread in South Africa) were located in the areas surrounding the inselberg, none have yet been located on the plateaux or within the basin, where all but one of the known specimens of *Messor* AFRC-ZA-01 have been found. *Messor* are seed-harvesters, and it was observed during the 2012 survey that many drainage lines form natural traps for wind-blown seeds, which accumulate in these sheltered areas. This has led to the hypothesis that *Messor* AFRC-ZA-01 may favour such drainage lines due to the relatively high availability of food compared to other habitats in the generally depauperate environment of the Bushmanland region. Further, a more detailed study is required to determine whether or not such a habitat preference is characteristic of the species and also to determine whether or not the species is truly restricted in distribution or has simply been overlooked due to possible nocturnal foraging habits and inconspicuous colouration. Based on current data, with the species known from only a single location which is currently under threat, *Messor* AFRC-ZA-01 could be classified under the IUCN Red List criteria as Critically Endangered, but probably should more correctly be treated as Data Deficient given the lack of distribution information for *Messor* AFRC-ZA-01.

Figure 4.3 ***Sites where the Undescribed Messor AFRC-ZA-01 and the Widespread Messor capensis were Recorded at Gamsberg, Based on Data from 2009 and 2012***



Based on current records and analyses for *Camponotus* AFRC-ZA-52, the species has an Extent of Occurrence (EOO) of 5470 km² and is known from a total of only 5 locations[5], at least one of which is currently threatened. A Red List assessment based on current data would therefore indicate that the species should be classified as Vulnerable (it only just misses an Endangered classification by virtue of the EOO being slightly greater than 5000 km²). It is felt that further investigation will probably reveal additional localities and a more extensive distribution, which may result in a downgrade of the assessment, most likely to Near Threatened. As for *Messor* AFRC-ZA-01, treating the species as Data Deficient but in urgent need of further study seems the most prudent option.

Figure 4.4 ***Distribution of the Karoo Form of Camponotus fulvopilosus and the Undescribed C. fulvopilosus-group Species at Gamsberg Based on 2009 and 2012 Data***



4.1.3 Butterflies

Based on distribution maps in Woodhall (2005) only 37 butterfly species are likely to occur in the Gamsberg area; given the very hot and dry conditions

[5] The definition of a location in the context of IUCN Red List assessments groups nearby sites that would be expected to all be affected by a single threatening event, so all records from the Gamsberg inselberg must be treated as a single location.

prevailing during the field survey it is therefore not surprising that a very low total of only ten butterfly species was observed over the entire survey area (Table 4.1).

Table 4.1 Observed Butterfly Diversity during November 2012 Gamsberg Survey.

Species& Common name	Site										
	Washout from Kloof	Sandy Plains at Proposed Tailings site	Northern rocky slopes	Main Kloof	Western Plateaux	Central Basin (Site 1)	Drainage Line	Basin (Site 2)	Eastern Plateaux	Southern Rocky Slopes	Settling Ponds on Northern Plain
Brephidium metophis Tinktinkie Blue											x
*Cacyreus (?) lingeus** Bush Bronze				x							
Cacyreus dicksoni Dickson's Geranium Bronze				x							x
Colotis agoye Speckled Sulphur Tip	x			x							
Colotis eris eris Banded Gold Tip				x							
Colotis lais Kalahari Orange Tip				x							
Deudorix antalus Brown Playboy	x			x			x				
Iolas bowkeri Bowker's Sapphire				x							
Pontia helice helice Meadow White				x							
Ypthima asterope African Ringlet				x							
Totals	**2**	**0**	**0**	**9**	**0**	**0**	**1**	**0**	**0**	**0**	**2**

* The identity of the two specimens tentatively identified as this species remains to be confirmed as they have atypical markings and the closest known record of *C. lingeus* to Gamsberg is approximately 130 km distant.

None of the species predicted for or observed at Gamsberg are considered of conservation significance, but two of the observed species are of interest in that they may represent significant range extensions. Dickson's Geranium Bronze (*Cacyreus dicksoni*) occurs along the west coast of South Africa from the Cape Peninsula to the Namibian border, but is generally found no further than 100 km from the coast. Its occurrence at Gamsberg, nearly 200 km from the coast, is thus unexpected and confirms the view that the kloof represents an important refuge for species that would not normally be able to survive in the region. Also of interest is the apparent presence of the Bush Bronze (*Cacyreus lingeus*) whose South African range extends mainly around the coastal regions, with fewer records further inland. While there are some

isolated records further inland than Gamsberg, there appear to be no records closer than 130 km from the study site.

Despite the lack of quantified sampling of butterflies, it is considered that it is highly significant that nine of the ten species observed during the survey were found within the kloof or at either the north or south entrances to the kloof. Only three butterfly species were observed at sites outside of the kloof; while this pattern would be expected to alter substantially after rains, it highlights the importance of the sheltered environment within the kloof as a refuge during dry periods, especially for species near the limit of their ranges. Changes to the local microclimate through proposed mining may have significant impact on these species and their ranges.

4.1.4 Dragonflies and Damselflies (Odonata)

A limited number of Odonata species is expected to occur in the Gamsberg region and all are common, widespread species of no conservation concern; three of these species (*Orthetrum chrysostigma*, *Trithemis furva* and *Trithemis kirbyi*) were observed during the 2012 field survey and were restricted in their occurrence to the Kloof habitat.

4.1.5 Scorpions

At least 24 scorpion species are expected to occur in the Gamsberg and surrounding areas, which are well known for exhibiting exceptionally high diversity of this group. A few scorpion specimens were found by turning rocks and excavating burrows during the 2009 survey, but the season and weather were not conducive to scorpion surveys. The specimens collected included *Opistophthalmus pallipes* (a widespread species) and *Opistophthalmus granifrons*. Only six species were found during the November 2012 survey, bringing the total including those observed during 2009 to eight. Confirmed scorpion diversity for the inselberg and surroundings to date (see Table 4.2) remains very low; this is almost certainly an under representation of this group and an artefact of weather conditions and inappropriate timing of surveys (the ideal time to survey for scorpions in this region is during the second half of summer, Ian Engelbrecht, pers. comm.). Assessment is therefore considered inadequate.

Figure 4.5 ***Photographs of Parabuthus schlechteri (Left) and Parabuthus laevifrons (Right) Recorded from the Gamsberg Study Area***

The most significant observation during the 2012 survey regarding scorpion activity and diversity was that by far the highest numbers of scorpions, as well as the highest diversity, was observed in the wash area at the mouth of the kloof on the north of the Gamsberg. It seems likely that this is due to relatively higher soil moisture levels here during the dry season resulting in more growing vegetation and consequently a higher abundance of the associated invertebrate prey on which the scorpions could feed. In the surrounding areas (with the exception of the kloof itself, where the very steep rocky habitat is suitable for only a limited number of specialised scorpion species) the extremely dry conditions resulted in most vegetation being dormant and very low levels of invertebrate activity.

Table 4.2 ***Observed Numbers of Scorpions Identified during Gamsberg Surveys.***

Common name	Site											
	Washout from Kloof *	Sandy Plains at Proposed Tailings site	Northern rocky slopes	Main Kloof	Western Plateaux	Central Basin (Site 1)	Drainage Line	Basin (Site 2)	Eastern Plateaux	Southern Rocky Slopes	Washout from Kloof	South-western Slopes near gate at bottom of pass
Hadogenes zumpti				1		1						
Opistophthalmus gigas					1	2						
Opistophthalmus sp. aff. pygmaeus	0 /1											
Parabuthus laevifrons												1
Parabuthus schlechteri	10/7					1					1	
Uroplectes carinatus	6 /1	5										
Totals	**16/9**	**5**	**0**	**1**	**1**	**4**	**0**	**0**	**0**	**0**	**1**	**1**

* Second figure indicates numbers observed during repeat sampling on 29/11/2012

4.2 Red Data and Conservation Important Species

No Red Data invertebrate species were observed during the very brief 2009 or the more extensive 2012 surveys. This result is not unexpected and is unlikely to change with more detailed studies since the majority of South African Red Data invertebrates are butterflies (the status of the vast majority of invertebrate species has yet to be assessed), and no Red Data butterflies were predicted for the Gamsberg area.

Three species of scorpion recorded in the study area are protected under the Biodiversity Act (ie *Hadogenes zumpti, Opistophthalmus gigas*, *O. pallipes* and *O.* sp. aff. *pygmaeus*) with the addition of *H. minor*, which is likely to occur at Gamsberg. However, all of these species are protected in terms of the threat of over-collecting rather than habitat transformation due to mining and other development, so their presence is not of major significance to the current programme.

4.3 Endemics and Other Notable Species

The two ant species described above are probably regionally endemic to the Northern Cape / Southern Namibia area; no other endemic species have yet been confirmed in the material collected during the surveys of the site.

5. DESCRIPTION OF THE VERTEBRATE FAUNA

5.1 Amphibians

Three species of frog were recorded within the study area during the herpetofaunal surveys, namely Paradise Toad (*Vandijkophrynus robonsoni*), Cape Sand Frog (*Tomopterna delalandii)* and Marble Rubber Frog (*Phynomantis annectens*), although Gamsberg may support a slightly greater diversity of frogs in total, with up to nine species possible (Appendix 2.2) (Minter *et al*., 2004). In a biogeographical context, the site falls within the 'Namqualand Assemblage' (Alexander *et al*., 2004), an area that supports relatively low amphibian diversity (generally <11 species per quarter degree grid cell). Those recorded occurred predominantly in the pools of surface water found within the kloof along the Gamsberg River, particularly during the severe dry period experienced during the November 2012 survey. A Paradise Toad was found in May 2009 within the abandoned drillers' camp, some distance away from the available aquatic systems, indicating that these frogs do disperse widely away from aquatic habitat when not breeding. Gamsberg is likely to support a greater diversity of frogs with up to nine species possible (Appendix 2.2).

Figure 5.1 Photographs of Paradise Toad (Left) and Cape Sand Frog (Right) Recorded from the Kloof at Gamsberg

5.1.1 Red Data and Conservation Important Species

No Red Data species are known or expected to occur within the study area. One species, Namaqua Stream Frog (*Strongylopus springbokensis*), was previously listed as Vulnerable, but has recently been downgraded to Least Concern.

All three species of frog recorded within the study area are listed under Schedule 2 of the Northern Cape Nature Conservation Act (Act 9 of 2009) as "Protected".

5.1.2 Endemics and Other Notable Species

Two of the frogs recorded from Gamsberg are localised endemics, confined to the Nama Karoo in the Northern Cape (ie Namaqua Stream Frog and Paradise Toad). These species both have fairly specialised habitat requirements, ie being reliant on rocky areas with streams and seeps.

Another localised Northern Cape endemic frog, Namaqua Caco (*Cacosternum namaquense*), was not recorded during the surveys, but has been recorded at Gamsberg previously (Minter *et al*., 2004), and is also confined to rocky areas, where it breeds in temporary waterbodies.

5.1.3 Important Habitats/Areas for Frogs

All areas at Gamsberg supporting natural surface water are vital for supporting frog populations. These areas include the ephemeral river, springs/seeps and pools of water in the kloof as well as the springs and pools located on the eastern and southern slopes. Modifications to these habitats through mining activities (most notably altered surface run-off and localised drawdowns on springs) will have negative impacts on these groups.

5.2 Reptiles

Twenty-four species of reptile were recorded during the herpetofaunal surveys, including four snakes, 16 lizards, comprising eight species of gecko, and one tortoise (Appendix 2.3). It is likely that the full species richness is closer to 40-50 species (Bates *et al*., In prep.) The Gamsberg area supports a relatively rich diversity of reptiles, given the diversity of habitats and the presence of mountainous, rocky terrain, which supports a number species that do not occur on the surrounding low-lying plains that make up much of the broader landscape.

5.2.1 Red Data and Conservation Important Species

One Red Data species is expected to occur within the study area, namely Good's Gecko (*Pachydactylus goodi*). Good's Gecko is a recently described endemic (Bauer *et al*., 2006), which although was not recorded during the surveys, is likely to occur on the slopes and cliffs of Gamsberg. It is restricted to a small area associated with the lower Gariep River and is threatened by mining in parts of its range. As a result, it will be listed as Vulnerable in the latest South African Reptile Red Data Book (Bates *et al*., In Prep.).

Figure 5.2 ***Various Geckos Recorded from the Study Area, clockwise from top-left, Common Barking Gecko, Haacke's Gecko, Rough-skinned Gecko, Quartz Gecko, Striped Dwarf Leaf-toed Gecko and Namaqua Mountain Gecko***

Most of the lizzards and snakes are listed as "Protected" under Schedule 2 of the Northern Cape Nature Conservation Act (Act 9 of 2009) (Appendix 2.3). No "Specially Protected" species under Schedule 1 of the Act were recorded in the study area.

All tortoises, chameleons and girdled lizards are listed under CITES Appendix II.

Figure 5.3 ***Desert Mountain Adder Located on the Northern Plateaux at Gamsberg.***

5.2.2 Endemics and Other Notable Species

Haacke's Gecko *Pachydactylus haackei*, Namaqua Mountain Gecko *Pachydactylus montanus* and Desert Mountain Adder *Bitis xeropaga*, are three other species that are range-restricted endemics confined to the lower Gariep River and adjacent regions, and are habitat specialists, restricted to rocky, mountainous habitat. All three of these species were recorded in the study area during the November 2012 survey (Namaqua Mountain Gecko was also recorded in the 2009 survey).

5.3 Birds

A total of 45 bird species have been recorded within the study area during the May 2009 and November 2012 surveys (Appendix 2.4). These sightings update and supplement previous detailed avifaunal surveys conducted in April 1999 (Harrison and Harebottle, 2000), which recorded 59 bird species. Including records from the South African Bird Atlas Project 2 (SABAP2), based on a number of surveys at various times of the year, the total number of birds recorded from Gamsberg is 86 species. The diversity of birds is thus relatively high within the regional context (~ 35% species representation at Gamsberg). This is driven largely by the diverse range of habitats at Gamsberg (eg plains, drainage lines and washouts, slopes, cliffs, springs and seeps, etc). Appendix 2.4 provides a list of species identified from visual sightings and calls during the above-mentioned surveys. Appendix 2.4 also provides an indication of other bird species that could potentially occur within the study area.

The birds recorded at Gamsberg area can broadly be divided into four main communities based on the broader, topographical habitat types that are present. These are described as follows:

- **Plains** – The plains surrounding the Gamsberg inselberg support the greatest bird species richness. Typical species include Southern Pale Chanting Goshawk (*Melieraxcanorus*), Pygmy Falcon (*Polihierax semitorquatus*), Secretarybird (*Sagittarius serpentarius*), Namaqua Sandgrouse (*Pterocles namaqua*), Namaqua Dove (*Oena capensis*), Fawn-coloured Lark (*Calendulauda africanoides*), Karoo Long-billed Lark (*Certhilauda subcoronata*), Grey-backed Sparrowlark (*Eremopterix verticalis*), Capped Wheatear (*Oenanthe pileata*), Anteating Chat (*Myrmecocichla formicivora*), Ashy Tit (*Parus cinerascens*), Pied Crow (*Corvus albus*), Grey Tit (*Parus afer*), Karoo Chat (*Cercomela schlegelii*), Rufous-eared Warbler (*Malcorus pectoralis*), White-browed Sparrow-Weaver (*Plocepasser mahali*) and Sociable Weaver (*Philetairus socius*).
- **Slopes and kloof** – These areas include birds favouring scrub-dominated, rocky habitat, such as Verreaux's Eagle (*Aquila verreauxii*), Speckled Pigeon

(*Columba guinea*), Cape Eagle-Owl (*Bubo capensis*), White-backed Mousebird (*Colius colius*), Short-toed Rock-Thrush (*Monticola brevipes*), Mountain Wheatear (*Oenanthe monticola*), Cinnamon-breasted Warbler (*Euryptila subcinnamomea*), Pale-winged Starling (*Onychognathus nabouroup*), Dusky Sunbird (*Cinnyris fuscus*), Scaly-feathered Finch (*Sporopipes squamifrons*), Black-headed Canary (*Serinus alario*), White-throated Canary (*Crithagra albogularis*), Cinnamon-breasted Bunting (*Emberiza tahapisi*), and Orange River White-eye (*Zosterops pallidus*).

- **Plateaux** – Lanner Falcon (*Falco biarmicus*), Alpine Swift (*Tachymarptis melba*), Fawn-coloured Lark (*Calendulauda africanoides*), and Bokmakierie (*Telophorus zeylonus*).
- **Basin** – Jackal Buzzard (*Buteo rufofuscus*), Laughing Dove (*Streptopelia senegalensis*), Acacia Pied Barbet (*Tricholaema leucomelas*), Grey-backed Sparrowlark (*Eremopterix verticalis*), Grey Tit (*Parus afer*), African Red-eyed Bulbul (*Pycnonotus nigricans*), Karoo Chat (*Cercomela schlegelii*), Familiar Chat (*Cercomela familiaris*), Karoo Scrub-Robin (*Cercotrichas coryphoeus*), Long-billed Crombec (*Sylvietta rufescens*), and Common Fiscal (*Lanius collaris*).

Figure 5.4 ***Karoo Long-billed Lark (Certhilauda subcoronata), a Relatively Common Bird in Karoo Scrub and Grassland on the Plains around the Gamsberg Inselberg***

5.3.1 Red Data and Conservation Important Species

Lanner Falcon (*Falco biarmicus*), listed as Near Threatened, was the only Red Data bird recorded during the 2009 and 2012 surveys. Three other Red Data species were confirmed during the earlier 1999 avifauna survey by Harrison

and Harebottle (2000), namely Martial Eagle (*Polemaetus bellicosus*), Ludwig's Bustard (*Neotis ludwigii*) and Secretarybird (*Sagittarius serpentarius*), listed respectively as Vulnerable and Near Threatened.

A population of Red Lark (*Calendulauda burra*) occurs in close proximity to Gamsberg, in the Koa dune system, approximately 5km to the south-west. Red Lark is a habitat specialist, endemic to the Nama-Karoo in the Northern Cape. It has a highly restricted range due to the limited availability of preferred habitat (ie red sand dunes). Suitable Red Lark habitat runs roughly parallel to the district road south-west of Gamsberg, about 2.5 km further south-west from the road. Although, the proposed Gamsberg Project will not encroach directly on areas supporting known Red Lark populations, it is possible that indirect impacts (eg disturbance from exacerbated noise, dust fallout, etc) could have an effect on the adjacent populations.

Table 5.1 lists Red Data bird species for the Gamsberg area.

Table 5.1 Red Data Bird Species Occurring/Potentially Occurring at Gamsberg (Recorded Species are in Bold[#]) (Barnes, 2000)

Species	Common name	Habitat
Vulnerable		
Polemaetus bellicosus	**Martial Eagle**	**Range of habitats including savannah, open woodland, grassland, Karoo veld and semi desert**
Ardeotis kori	Kori Bustard	Open habitats of semi-arid savannah and grassland
Neotis ludwigii	**Ludwig's Bustard**	**Karoo scrub and arid grassland and savannah**
Calendulauda burra	**Red Lark**	**Sand dunes covered with scrub vegetation and Nama-Karoo plains**
Near Threatened		
Sagittarius serpentarius	**Secretarybird**	**Savannah and open grassland**
Falco peregrinus	Peregrine Falcon	Range of open habitats. Requires high cliffs and kloofs to breed
Falco biarmicus	**Lanner Falcon**	**Wide range of habitats from mountains to deserts and open grassland**
Circus maurus	Black Harrier	Highland grasslands, Karoo scrub, open plains with low shrubs and croplands
Spizocorys sclateri	Sclater's Lark	Arid and semi-arid gravel and stony plains with scattered shrubs and grasses, but usually within accessible distance to surface water

[#] Recorded by GroundTruth (2009/2012) and/or Harrison and Harebottle (2000)

Most of the abovementioned species of conservation concern depend on habitats associated with plains and flat areas. Such habitats are well

represented across the Nama-Karoo, and broader Karoo, region. Most of the Red Data birds listed in Table 5.1 have wide distributions, with exception to Red Lark and Sclater's Lark.

The following birds are listed under CITES Appendix II:

- Secretarybird;
- all Falcons;
- all Bustards; and
- all Owls.

With regards to the Northern Cape Nature Conservation Act (Act 9 of 2009), the following bird species recorded during the 2009 and 2012 surveys (Appendix 2.4,) are listed under Schedule 1 of the Act as "Specially Protected":

- Lanner Falcon *Falco biarmicus*;
- Greater Kestrel *Falco rupicoloides*;
- Verreaux's Eagle *Aquila verreauxii*;
- Jackal Buzzard *Buteo rufofuscus*;
- Southern Pale Chanting Goshawk *Melierax canorus*;
- Cape Eagle-Owl *Bubo capensis*; and
- Red Lark *Calendulauda burra.*

5.3.2 Endemics and Other Notable Species

Several range and biome-restricted species, excluding Red Data species listed in Table 5.1, are known to occur in the region (birdlife.org.za). A number of these were recorded in the study area (Table 5.2) and it is likely that those species not recorded may be present within the area.

Table 5.2 Range and Biome Restricted Species (Recorded Species are in Bold)

Species	Common name	Habitat
Eupodotis vigorsii	**Karoo Korhaan**	**Karoo scrub**
Certhilauda subcoronata	**Karoo Long-billed Lark**	**Karoo scrub**
Spizocorys starki	Stark's Lark	Desert scrub and gravel plains
Eeremopterix australis	**Black-eared Sparrow-lark**	**Karoo scrub and gravel and sandy plains**
Cercomela tractrac	**Tractrac Chat**	**Karoo and desert scrub**
Cercomela sinuata	**Sickle-winged Chat**	**Karoo scrub and grassland**
Cercomela schlegelii	**Karoo Chat**	**Karoo and semi desert scrub**
Parisoma layardi	Layard's Titbabbler	Karoo scrub, often in rocky areas

Species	Common name	Habitat
Eremomela gregalis	**Karoo Eremomela**	**Karoo scrub**
Euryptila subcinnamomea	**Cinnamon-breasted Warbler**	**Scrub-covered, rocky hillsides**
Phragmacia substriata	Namaqua Warbler	Dense vegetation along drainage lines in semi desert areas
Onychognathus nabouroup	**Pale-winged Starling**	**Mountainous terrain in semi desert areas**
Philetairus socius	**Sociable Weaver**	**Karoo scrub and arid savannah**
Serinus alario	**Black-headed Canary**	**Karoo scrub**

Other notable observations include:

- Verreaux's Eagle (formally Black Eagle) sightings during the 2012 and 2009 GroundTruth studies as well as the previous avifaunal study conducted by Harrison and Harebottle (2000). Harrison and Harebottle (2000) also noted that the Gamsberg inselberg is a suitable site for Verreaux's Eagles to nest. During the 2009 survey two nests were identified on the southern slopes of Gamsberg that looked to have been used fairly recently.
- The uncommon Cape Eagle Owl was seen on the northern slopes at dusk during the 2009 study.

5.4 Mammals

A total of 36 species of mammal have been recorded from the Gamsberg area. This includes the 29 species recorded during the Anderson (1999) survey with an additional six species recorded during the May 2009 and November 2012 surveys. Appendix 2.5 provides a more detailed list of the mammals that were recorded during the 1999, 2009 and 2012 surveys. Appendix 2.6 includes the diversity of species recorded from the camera traps during the 2012 surveys. The results from these surveys highlights that the Gamsberg area supports over 50% of the expected regional diversity. Results from the camera traps are presented in Appendix 2.6.

Figure 5.5 Photographs of Small Mammals Recorded from the Gamsberg Study Area (from left to right), Western Rock Elephant-shrew, Short-tailed Gerbil and Namaqua Rock Mouse

5.4.1 Red Data and Conservation Important Species

The mammal surveys recorded four Red Data mammals, namely:

- Cape Horseshoe Bat (*Rhinolophus capensis*) – Listed as Near Threatened and recorded during the 1999 Anderson study.
- Darling's Horseshoe Bat (*Rhinolophus darling*) – Listed as Near Threatened with a single specimen recorded during the May 2009 survey. A recording of its echolocation call was taken using a Pettersson bat detector linked to a PC running BatSound Pro. The frequency-modulated call was then recorded using BatSound Pro, which was used in determining the species identification.
- Dassie Rat (*Petromus typicus*) – Listed as Near Threatened and recorded during all surveys, predominantly through the identification of middens marked by droppings and dried urine. Dassie Rats are restricted to rocky habitats and rock outcrops.
- Littledale's Whistling Rat (*Parotomys littledalei*) – Listed as Near Threatened and recorded on the sandy plains surrounding Gamsberg during the 1999 mammal study.

During the 2012 survey, incidental reports of the species listed below were recorded (these species were not observed during the field surveys):

- Brown Hyaena (*Hyaena brunnea*) – Listed as Near Threatened. There was a recent report of a Brown Hyaena in the town of Aggeneys.

Two of the mammal species recorded during the 2009 and 2012 surveys are listed as "Specially Protected under the NCNCA (2009) Schedule 1:

- African Wild Cat *Felis silvestris*
- Striped Polecat *Ictonyx striatus.*

The following species of mammal relevant to the study area fall within CITES appendices I, II or III:

- Chacma Baboon (*Papio ursinus*) – Appendix II
- Vervet monkey (*Cercopithecus aethiops*) – Appendix II
- Aardwolf (*Proteles cristatus*) – Appendix III
- Leopard (*Panthera pardus*) – Appendix I
- Caracal (*Caracal caracal*) – Appendix II
- Small Spotted Cat (*Felis nigripes*) – Appendix I
- African Wild Cat (*Felis silvestris*) – Appendix II.

5.4.2 Endemics and Other Notable Species

The only endemic mammal known to occur within the study is Cape Horseshoe Bat (*Rhinolophus capensis*), which was recorded by Anderson (1999). Cape Rock Elephant-shrew is endemic to South Africa and restricted to the Western and Northern Cape. Other mammals, endemic to South Africa, which potentially occur in the area, include Cape Rock Elephant-shrew (*Elephantulus edwardii*) and Spectacled Dormouse (*Graphiurus ocularis*). None of the strict Nama Karoo endemics, ie Visagie's Golden Mole (*Chrysochloris visagiei*) and Grant's Rock Mouse (*Micaelamys granti*), are expected to occur in the area. A sighting of Leopard *Panthera pardus* near the base of Gamsberg was claimed by a member of the mining personnel during the 2012 field visit.

Figure 5.6 Photographs of Darling's Horseshoe Bat (Rhinolophus darlingii), Recorded from the Entrance to the Kloof at Gamsberg during May 2009

6. DESCRIPTION OF THE AQUATIC BASELINE

6.1 General Description of Aquatic Baseline

The aquatic baseline may be characterised by two main aquatic ecosystems present within and around the Gamsberg inselberg, namely the springs within the kloof and on the north and northeast of the inselberg, and the river intermittently running through the kloof to the north and a much smaller drainage line on the east of the inselberg.

Springs appear to be artesian and fed by the local groundwater table. From all accounts and observations during fieldwork, they are also largely perennial in nature and form regular freshwater inputs to the system. At times, their flow is obviously greater and contributes to the surface flow along drainage lines. However, this is likely to be intermittent. Most of the flow from the springs disappears within a short distance from their origin or "daylighting".

The other aquatic features are the temporary rivers draining the main basin of the inselberg, through the kloof and out onto the floodplain/washout zone to the north of the inselberg, and a weaker drainage line to the east of the inselberg. These river types may be broadly defined as those in which surface flow ceases and surface water may disappear for some period of most years. They are the dominant river systems in arid and semiarid zones (Boulton and Suter 1986). In terms of the classification proposed by Uys and O'Keefe (1997) for temporary rivers, this system may be characterised by having only intermittent flows, with low predictability of flows and a high co-efficient of flow variability.

The main channel of these systems is predominantly bedrock in nature and contained within the kloof. The main channel consists of a repeating sequence of bedrock pools and dry riffle/cobble sections. These riffle sections would only activate during intermittent flow periods associated with rainfall within the inselberg main basin.

Pools may be present for lesser or greater periods of the year, particularly within the kloof, and these are maintained to some extent by the springs. During particularly wet periods (largely thunderstorms or sustained rainfall from frontal systems extending over the region), the main flow and hence channel shaping and maintaining drivers are from surface wash and runoff within the main basin of the inselberg which drains out through the kloof. At the entrance and exit to the kloof are present alluvial gravel bars with boulders and cobbles also present at the outflow from the kloof.

Besides the springs, the pools are the most persistent aquatic feature within this system and a key feature of the uniqueness of this environment. A number of other ecosystem processes are co-dependent on these water sources; eg as a direct water sources but also for food material and as a conduit and resupply route for material on the washout zone to the north of the inselberg.

Based on the nature of these systems, benthic diatoms and aquatic macroinvertebrates were the most reliable and persistent features to be used to characterise the aquatic ecosystems. From a longer term perspective they would also represent the most reliable aquatic biomonitoring features for these systems.

6.2 Benthic Diatoms

Results from benthic diatom analyses for sites sampled during the May 2009 and November 2012 surveys, based on the number of species, Specific Pollution sensitivity Index (SPI) and percentage of Pollution Tolerant Valves (% PTV), are presented in Table 6.1. Interpretation and classification of the data is based on Table 2.1 and Table 2.2. A full list of all species encountered at each site is presented in Appendix 3.3 of this report.

Table 6.1 Summarised Benthic Diatom Indices and River Health Classification

Site	Number of species	Specific Pollution sensitivity Index (SPI[6])	% Pollution Tolerant Valves (% PTV [7])	River Health Classification
May 2009				
Gamsberg spring	12	8.7	6.3	**Poor**
Gamsberg River	16	8.5	0.8	**Poor**
Southern spring	19	5.5	46.3	**Poor**
Eastern spring	13	7.4	48.5	**Poor**
November 2012				
Gamsberg spring	11	7.4	61.2	**Poor**
Gamsberg River	11	5.2	86.5	**Poor**
Southern Spring	Spring dry and not sampled			
Eastern spring	10	11.8	36.2	**Fair**

[6] SPI is a measure of river health/condition where a higher index value indicates a better river health.

[7] PTV is a measure of the proportion of sampled diatoms that are tolerant to reasonable amounts of pollution.

In terms of river health, the results in Table 6.1 indicate that the aquatic ecosystems of Gamsberg, as represented by the sampling sites, are generally in a "poor" ecological state. Given that there were no obvious signs of water quality/river heath degradation, it would seem that this is rather a consequence of the sampled systems consisting of stagnant pools. The likely effect of this would be that any nutrients (or other water quality parameters) will accumulate, resulting in these parameters becoming more concentrated. Possible sources of nutrients could include any organic matter that enters into the pools. This in turn would influence the composition of benthic diatoms as well as the indices (eg % PTV).

Diatom indices are designed to reflect a number of potential environmental impacts, the chief of these being plant nutrients, organic matter and salts. An increase in any of these water quality variables is generally deemed to be indicative of some form of pollution. However, when variables such as salts are naturally high in stream the index values still show this as an impact. In the Gamsberg samples a common dominant species is *Planothidium engelbrechtii*, this species was originally described from the Jakkals River in the Western Cape – this stream has naturally high levels of sodium chloride to which *P. engelbrechtii* is tolerant. Other species found in the Gamsberg samples such as *Eolimna minima* and *Sellaphora seminulum* are also typically considered to be indicators of pollution, however, these species are also considered as pioneer species and colonise habitats with irregular flow and are also tolerant of osmotic fluctuations. Although diatom indices in general give a good indication of environmental conditions they may show a pollution impact were none exists in the case of naturally highly saline waters or waters with intermittent flow.

Interestingly, there was an increase in the proportion of pollution tolerant valves (diatoms) within each of the sites between the 2009 and 2012 surveys. This corresponds with the drier conditions experienced within this system during 2012 compared to 2009. The drier conditions would have increased the salt/"pollutant" concentrations (due to higher evaporation) and hence the apparent pollution effect. Hence, the apparent "poor" results, which may need to be regionally modified to account for the conditions within this particular system. The baseline species data will however form a key component of future monitoring.

6.3 Aquatic Macro-Invertebrates

Only a single site was deemed suitable for sampling according to SASS5[8] methodology, ie the Gamsberg River draining through the main gorge. This site was therefore sampled for aquatic macro-invertebrates. As it is, the SASS5 method is typically applied in flowing (lotic) river systems, but as mentioned earlier, these systems only flow for short periods in response to rainfall. However, the SASS5 method provides a standardised sampling and analytical protocol for future sampling and potential monitoring. In those other systems where the full SASS5 method could not be employed (primarily due to limited available sampling habitat), then the benthic diatoms formed the basis of the aquatic baseline assessment.

Based on the physiographic layout of Gamsberg, the kloof site receives the majority of the water draining the central basin of Gamsberg. Therefore information on the macro-invertebrates (as well as diatoms) from this site provides an indication of the overall condition of the central basin area. Identification of the macro-invertebrate taxa was done to family level, as per the SASS5 method, and results of family composition are summarised below in Table 6.2. A list of the macro-invertebrate taxa collected during the SASS5 survey is provided in Appendix 3.4.

Table 6.2 Aquatic Macro-invertebrate River Health Metrics (Scores) Established for the Gamsberg River, during May 2009

Health metrics (scores)	Gamsberg River (Site AQ04)
SASS5 Score	66
Average Score per Taxon (ASPT)	4.7
Number of Families	14
River Health Classification	**Poor**

Indications from the SASS5 assessment (comparing these results with Table 2.1) shows that the ecological condition of the Gamsberg River is currently "poor" as reflected by the aquatic macro-invertebrates present, the families and their respective tolerances to water quality. This result is initially congruent with the diatom results reported earlier for this same site (Table 6.1). However, as described under the diatom results, the diatoms are probably principally responding to elevated salts within the system. On the

[8] SASS5 is a biotic index designed for assessing the condition of South African rivers using aquatic macro-invertebrate assemblages due to its practicality of adopting family-level identifications to define SASS indices.

other hand, the aquatic macroinvertebrates are probably responding to the limited available habitat for typical SASS5 sampling. Typically the "richest" habitat type is usually the fast flowing, rocky riffle (rheophilic) habitat where a large proportion of the sensitive invertebrate families (rheophiles) would be resident. However, under no flow conditions, the rheophilic species would not survive and are hence not present at this site. This may partially account for the results obtained in the above table. Hence, these results need to be interpreted with caution. These biotopes in turn were considered limited from a macro-invertebrate perspective.

7. MAPPING OF FAUNAL HABITAT AND SENSITIVE AREAS

The following sections describe the sensitive habitat areas associated with the Gamsberg inselberg and surrounding plains required for terrestrial invertebrates, vertebrates and aquatic biodiversity.

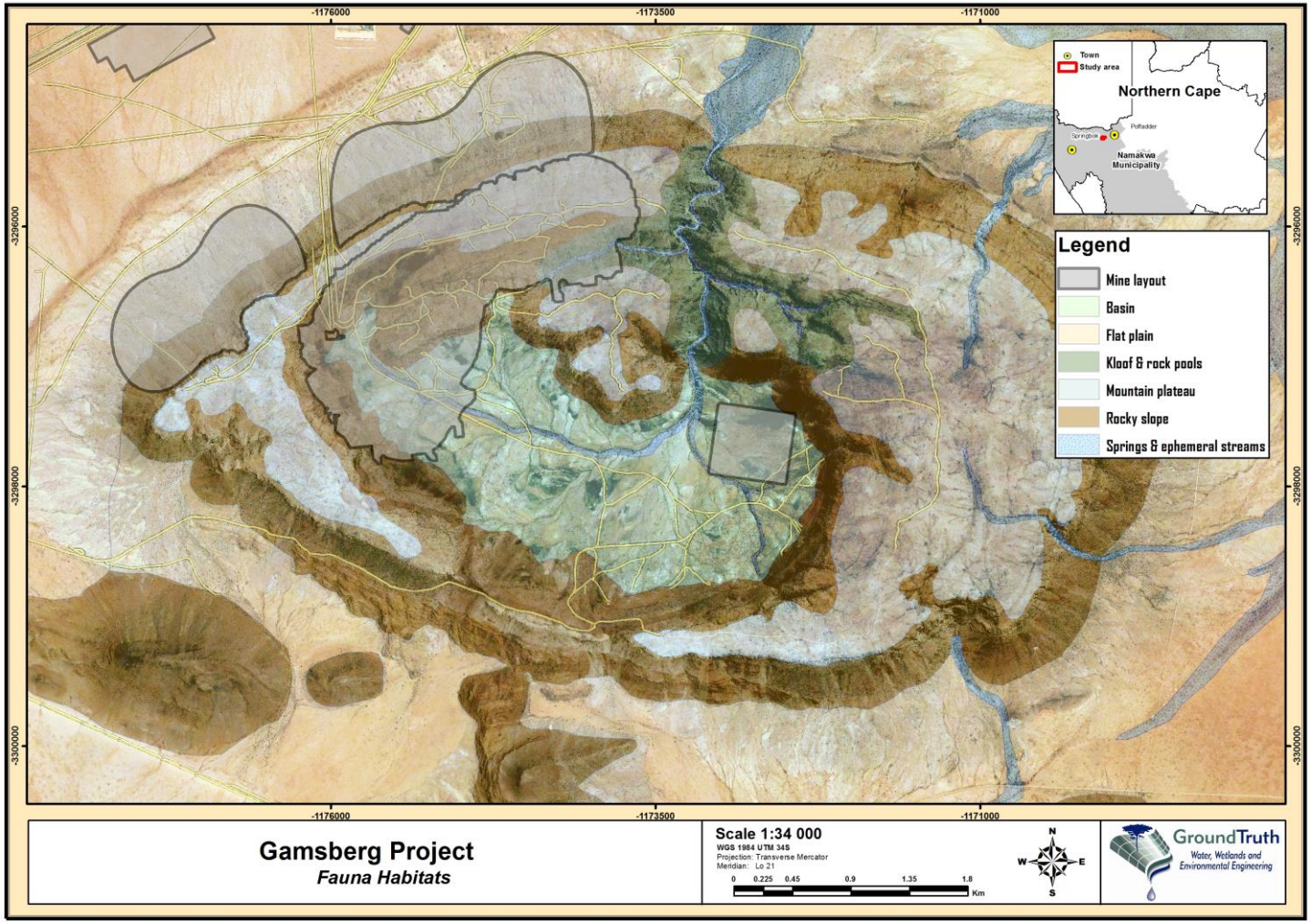
7.1 Faunal Habitats

The Gamsberg inselberg and surrounding plains include a wide range of terrestrial and aquatic habitats, providing a natural template for the support of faunal biodiversity. These include:

- **flat plains** – sandy and arid grassland areas on flat topography, typical of bushmanland vegetation types that make the Nama Karoo;
- **cliffs, rocky slopes, outcrops, and crevices** – relatively steep to steep rocky slopes and cliff faces;
- **kloof** – a deeply incised, rocky gorge through which the Gamsberg stream drains;
- **mountain plateaux** – flat to relatively flat areas, dominated by rocks and gravel quartz patches located on the top of the Gamsberg inselberg;
- **drainage basin** – dominated by scrub vegetation located within the central basin of the Gamsberg inselberg;
- **ephemeral watercourses** – dry rivers and streams typical of arid and semi-arid environments, only flowing during heavy and/or persistent rainfall events with cessation of flow within a few hours/days; and
- **springs, seeps and rock pools** – aquatic systems that maintain permanent/near-permanent source of surface water.

A preliminary mapping exercise was carried out in June 2012 prior to undertaking field surveys. The purpose was to map the spatial distribution and extent of faunal habitat units. The mapping relied on available spatial information and datasets including the vegetation map produced by Desmet *et al.* (2005), flora habitats of conservation concern (Desmet, 2010), contours, and aerial imagery. Figure 7.1 below provides a spatial illustration of the faunal habitats occurring on the Gamsberg inselberg and surround plains.

Figure 7.1 Fauna Habitats Associated with the Gamsberg Project Study Area



7.2 Assessment of Species and Species-specific Habitats

Information of fauna recorded from the study area and their respective species-specific habitats was used to assess the level of dependence of fauna on the available habitats in the area. Habitats were grouped into three categories based on local and regional importance and sensitivity, these being:

- **Irreplaceable[9] (H1) –** kloof, ephemeral watercourses, springs, seeps and rock pools;
- **Constrained[10] (H2) –** cliffs, rocky slopes, outcrops, and crevices, mountain plateaux and drainage basin; and
- **Flexible[11] (H3) –** flat plains.

Key faunal species present within the Gamsberg study area were then evaluated according to their dependence on each of the three habitat categories and against the habitats that will be lost, heavily affected and unaffected. The evaluation tables from this process are provided in Appendix 4.

The information obtained from the evaluation tables highlights key species that are potentially affected by the proposed Gamsberg Project, providing further insight to assessing their degree of sensitivity within the context of the project. Table 7.1 provides a consolidation of key fauna (including Red Data and range restricted species), assessed on their level of habitat dependence, the significance of impact on each group and their offset potential.

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9 Irreplaceable – habitat that is rare or unique within the context of the regional landscape (ie the Bushmanland Inselberg region) and is essential maintaining viable populations.

10 Constrained – habitat that is limited withint the context of the regional landscape and thus important for maintaining viable populations.

11 Flexible – habitat that is relatively common within the cotext of the regional landscape and thus does not limit the viability of populations

Table 7.1 Overview of the potential level of impact caused by the mining development on key faunal species present within the Gamsberg study area

Group	Species & common name	Level of dependence on habitat #	Proportion of range affected (intensity of impact)	Significance of impact on the species	Offset potential
Invertebrates	*Camponotus* AFRC-ZA-52	Medium (occurs in H1 and H2)	High	High (a propable Red Data Vulnerable species)	Low (very restricted distribution range with only 5 known localities)
	Messor AFRC-ZA-01	High (occurs only in H2)	Very High	Very High (a propable Red Data Critically Endangered species)	Very Low (distribution range is largely unknown and currently restricted to Gamsberg)
Amphibians	*Vandijkophrynus robinsoni* Paradise Toad	Low (occurs in H1, H2 and H3)	Medium	Low	High (range restricted but with low dependence on habitat)
	Strongylopus springbokensis Namaqua Stream Frog	Medium (occurs in H1 and H2)	High	Medium	Low to Medium (range restricted but with a high dependence on habitat)
	Cacosternum namaquense * Namaqua Caco	Medium (occurs in H1 and H2)	High	Medium	Low to Medium (range restricted but with a high dependence on habitat)
Reptiles	*Pachydactylus goodi* Good's Gecko	Medium (occurs in H1 and H2)	High	Medium (a Red Data Vulnerable species)	Medium (range restricted, habitat specialist)
	Pachydactylus haackei Haacke's Gecko	Medium (occurs in H1 and H2)	Medium	Medium	Medium (range restricted, habitat specialist)
	Pachydactylus montanus Namaqua Mountain Gecko	Medium (occurs in H1 and H2)	Medium	Medium	Medium (range restricted, habitat specialist)
	Bitis xeropaga Desert Mountain Adder	High (occurs only in H2)	Medium	Medium to High	Medium (range restricted, habitat specialist)
Birds	*Falco biarmicus* Lanner Falcon	Low (occurs in H1, H2 and H3)	Very Low	Low (a Red Data Near Threatened species)	Not necessary (widely distributed species)
	Polemaetus bellicosus Martial Eagle	Medium (occurs in H2 and H3)	Very Low	Low (a Red Data Vulnerable species)	Not necessary (widely distributed species)

Group	Species & common name	Level of dependence on habitat #	Proportion of range affected (intensity of impact)	Significance of impact on the species	Offset potential
	Neotis ludwigii Ludwig's Bustard	High (occurs only in H3)	Low	Medium (a Red Data Vulnerable species)	High
	Calendulauda burra Red Lark	High (occurs only in H1 and is a habitat specialist)	Medium	Medium to High (a Red Data Vulnerable species susceptible to indirect impacts)	Low to Medium (habitat specialist with highly restricted range)
Mammals	*Rhinolophus capensis* Cape Horseshoe Bat	Medium (occurs in H1 and H2)	Low	Medium (a Red Data Near Threatened species)	Medium
	Rhinolophus darlingi Darling's Horseshoe Bat	Medium (occurs in H1 and H2)	Low	Medium (a Red Data Near Threatened species)	Medium
	Parotomys littledalei Littledale's Whistling Rat	High (occurs only in H3)	Low	Low (a Red Data Near Threatened species)	High
	Petromus typicus Dassie Rat	Medium (occurs in H1 and H2)	Low	Medium (a Red Data Near Threatened species)	Medium

Habitats defined according to habitat categories, namely:

- H1 (Irreplaceable habitat) – kloof, ephemeral watercourses, springs, seeps and rock pools;
- H2 (Constrained habitat) – cliffs, rocky slopes, outcrops, and crevices, mountain plateaux and drainage basin; and
- H3 (Flexible habitat) – flat plains.

* Not observed during the the 2009 and/or 2012 surveys, but a regionally important species

7.3 Sensitive Areas/Habitats for Invertebrates

7.3.1 Kloof

This is clearly a unique habitat and provides a significant refuge for many species (and interrelated ecosystems) that could not otherwise inhabit the region due to prolonged dry periods, as well as enabling species that do inhabit the surrounding areas to continue developing and breeding for a much larger proportion of the year than would otherwise be possible.

7.3.2 Washout Area Extending North from the Kloof

While less sheltered than the kloof, the higher dry season availability of soil moisture here, compared to the surrounding regions, also renders this area a significant refuge for species and enables activity to extend through a longer season than would otherwise be possible. The wash out area thus probably acts as a reservoir from which species recolonize the surrounding areas after prolonged dry periods (both seasonally and after unusually prolonged droughts), though this may be less important for long-lived organisms.

7.3.3 Inselberg Basin

At present, this habitat represents almost the entire known range for the undescribed ant species *Messor* AFRC-ZA-01 although this species is thought to be regionally endemic to the Northern Cape and Southern Namibia. Current data indicate that an IUCN Red List assessment would result in either a Critically Endangered or Data Deficient classification and there is an urgent need for more data on its distribution. Unless this species is confirmed to exist in significant populations outside of the Gamsberg study area, the basin must be considered of high importance to the conservation of this species.

7.4 Sensitive Areas/Habitats for Vertebrates

7.4.1 Rocky Slopes and Outcrops

Rocky habitats provide shelter and refuge for various conservation important vertebrates, notably retiles (eg Desert Mountain Adder, Good's Gecko (probable), Haacke's Gecko and Namaqua Mountain Gecko), but also a variety of other reptiles and species from other vertebrate groups. These areas also provide suitable refuge for species from various faunal groups unable to survive unfavourable times/conditions on arid plains. The southern and eastern slopes offer a greater diversity of topographical habitats and niches for fauna in general. These aspects are also more likely to safe guard fauna from potential long-term climate change impacts. Additionally, the southern slopes

provide suitable nesting sites and feeding territories for various species of bird, notably Verreaux's Eagle (formally Black Eagle) and Cape Eagle Owl.

7.4.2 Kloof

The deeply incised, rocky kloof, through which the Gamsberg stream drains, also provides refuge for a broader range of vertebrate fauna, particularly species that are unable to survive the harsh conditions on the surrounding arid plains.

7.5 Aquatic Ecosystems

Ephemeral streams, typical of arid and semi-arid environments, and springs are recognized by the National Water Act (Act 36 of 1998) under the definition of a 'watercourse'. Ephemeral watercourses only flow during heavy and/or persistent rainfall events and surface flow usually ceases within a matter of hours/days. Aquatic biota associated with these systems have specialised adaptations that enable them to remain dormant for most of the year, only becoming active in response to rainfall and intermittent surface flow runoff.

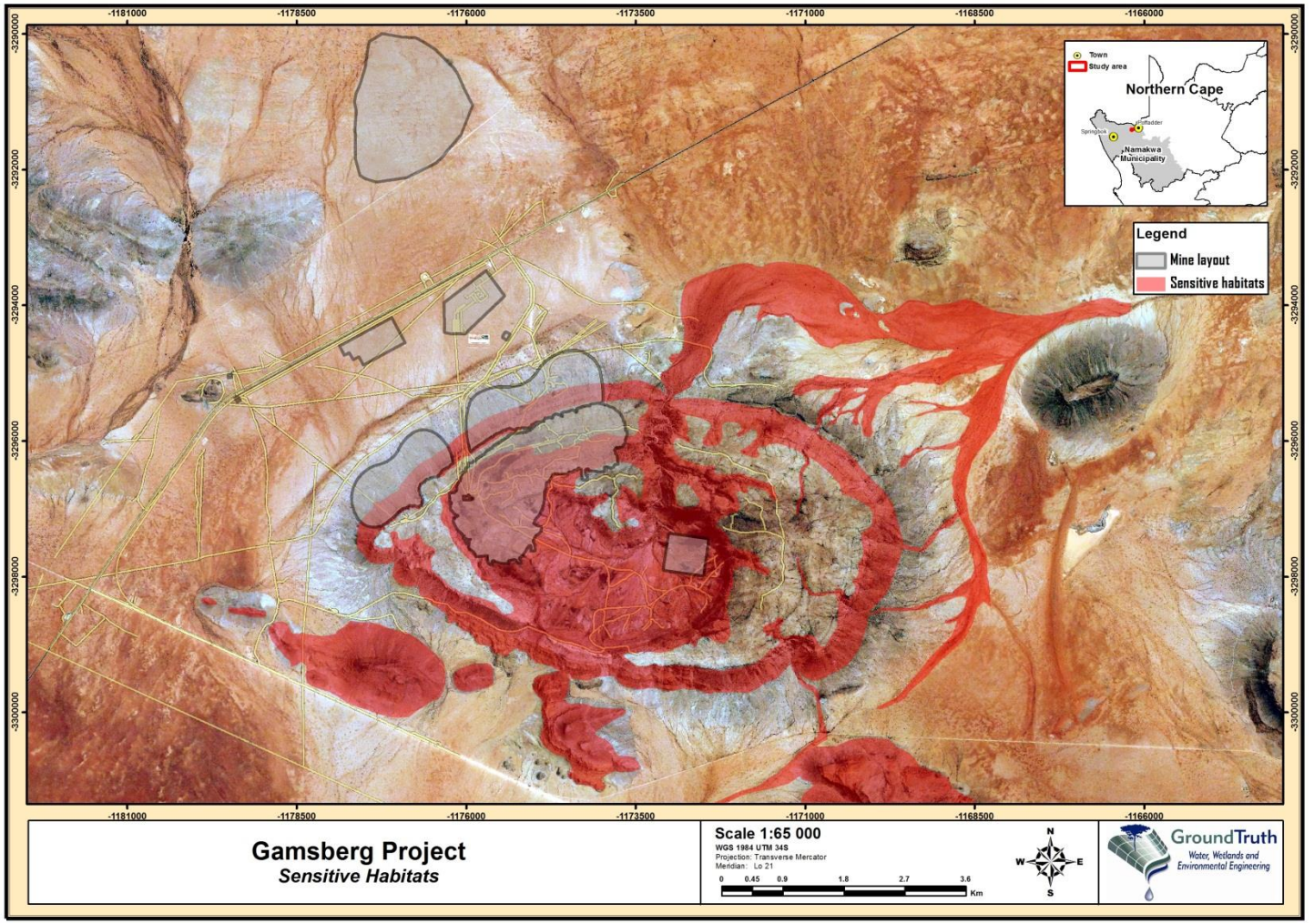
Springs, on the other hand, are vital for the continuous supply of groundwater and play an important role in sustaining aquatic ecosystems during dry periods. Springs and rock pools are thus critical in terms of providing freshwater throughout the year. A number of faunal communities are highly dependent on the constant supply of water, particularly on a regional scale for large/mobile fauna. Frog populations, which include Northern Cape endemics such as Namaqua Stream Frog and Namaqua Caco, are almost entirely dependent on these permanent bodies of water.

7.6 Mapping of Sensitive Habitats

A preliminary mapping exercise was carried out in June 2012 prior to undertaking field surveys. The purpose was to map the spatial distribution and extent of faunal habitat units, identify habitats supporting important fauna and ecosystem functionality, and highlight which areas are considered sensitive in terms of supporting faunal biodiversity. The mapping relied on available spatial information and datasets including the vegetation map produced by Desmet *et al.* (2005), flora habitats of conservation concern (Desmet, 2010), contours, and aerial imagery.

The initial mapping was then finalised following the November 2012 surveys with findings used to verify and refine the preliminary sensitivity mapping. The final mapping process resulted in a single spatial layer, integrating the abovementioned sensitive habitats. This sensitivity map is illustrated in Figure 7.2 below.

Figure 7.2 Sensitive Areas Supporting Important Fauna and Faunal Features



8. DISCUSSION

8.1 Assumptions, Limitations and Gaps in Knowledge

This report has been produced covering only two field visits, ie a reconnaissance visit during May 2009 (with a focused invertebrate survey in September 2009) followed by a more comprehensive survey in November 2012 in an attempt to sample during the active, wet season. By the nature of the work, seasonality, budget constraints, timing to finalise the report, etc, the report is constrained in a number of areas and represents the best efforts that were possible under these conditions. Notwithstanding these indicated constraints, which are probably a normal "state of affairs" for most projects of this nature, a number of key constraints remain which may have a significant impact on the findings made in this report. As such, the authors of this report reserve the right to update the findings and assessment of likely impacts of the proposed mining in the light of final identifications of relevant biota once these are available.

Specific constraints associated with this study include the following:

- In terms of the terrestrial invertebrates, a number of species level identifications are still outstanding. Species-level outcomes could alter perceptions associated with various aspects of the project; in some cases this could be considered significant (eg new species records, species of conservation concern, etc). The implication of this is that the assessment of impacts can only partially evaluated based on the information that is available.
- Extremely low activity levels of vertebrate and invertebrate groups were experienced during the November 2012 surveys. This was most likely due to the extremely long, dry period experienced during the preceding year. This increases the likelihood of certain species of fauna (possibly key/significant species) remaining undetected. Despite this, attempts were made to survey as many different habitat types as possible in order to gain a more complete representation of the surveyed groups of fauna. However, such efforts will only be representative of the prevailing climatic conditions, which naturally, is extremely variable and unpredictable.
- Limited aquatic sampling habitat was available during the 2009 and 2012 surveys in response to the lack of rainfall over the time of the survey.
- Very little regional information/data is available, particularly in terms of understanding and assessing the undescribed ant species. Thus a conservative approach is required in terms of assessing impacts that may arise from the proposed Gamsberg Project.

- Further investigation of the specimens is under way as there are some inconsistencies with the usual appearance of the butterfly *C. lingeus* and there is a small chance that the Gamsberg specimens might represent a new form, but it is most likely that they do in fact belong to this species.
- Processing of the 400 pitfall trap samples is still under way and it is expected that significant additional data on the distributions of *Camponotus* AFRC-ZA-52 and *C. fulvopilosus* within the study area will be obtained when this is complete. Further information on the distributions of these and other ant species will be obtained from analysis of the 150 sweep net samples, which are currently being processed. It is hoped that this data will help to elucidate habitat preferences and explain the apparently limited distribution of *Camponotus* AFRC-ZA-52. Data from both methods will be more structured than that obtained by incidental hand-collecting, is not prone to operator bias and will thus provide a sound basis for evaluation of habitat preferences and distribution patterns. It is possible that additional undescribed species may be found in the samples still to be processed. However, evidence so far suggests that in these samples there are no further very large undescribed ant species that would have been expected to remain undiscovered only because of limited distributions or cryptic habits.
- While abundance of leafhoppers appeared very low during the survey, it is expected that data from the analysis of the 150 sweep net samples currently being processed will provide an objective test of the hypothesis that the wash and kloof provide important refuge areas within which invertebrates can exist in non-dormant stages through dry periods. This is in contrast to many other habitats in the region where many species can survive the dry season only through dormancy.
- At present, in the absence of a Reserve study, it is only possible to make assumptions as to the significance of reduced flows within the kloof's rivers and springs, based on the severity of reduced groundwater and surface water impacts that can be expected from the project.

8.2 Identification and Assessment of Impacts

The following sections describe the impacts relating to the proposed Gamsberg Project in terms of affecting fauna and aquatic biodiversity. The impact assessment methodology used in this study was supplied by ERM with the purpose of evaluating impacts by determining impact significance, providing suitable mitigation measures, and establishing residual impacts in an objective manner.

8.2.1 Direct Loss of Fauna and Faunal Habitats

The Gamsberg inselberg and surrounding plains include a wide variety of habitats supporting a number of invertebrate and vertebrate species. Types of habitats include flat, sandy plains; rocky slopes, outcrops, crevices and kloofs; the mountain plateaux; ephemeral watercourses; springs, seeps and rock pools. Consequently, the area supports a rich diversity of fauna, particularly in the context of the Nama Karoo region, with different faunal assemblages associated with each range of available habitat types. The importance of fauna and faunal habitats within the context of the proposed Gamsberg Project was evaluated in the preceding chapter (*cf* Section 7, Mapping of Faunal Habitat and Sensitive Areas) and used as the basis for assessing the significance of impacts. Impacts from direct loss of fauna and faunal habitats are discussed according to both the construction and operation phases and summarised in Table 8.1.

Construction Phase Impacts

The construction phase will include the construction of mine infrastructure and facilities, including:

- an open pit zinc mine on the northern side of the inselberg running from the west of the kloof to south-west with a total area covering approximately 330 ha and a depth approximately 700 m;
- a crusher (0.1 ha) on northern side slope of the inselberg, approximately 70m from the top of the inselberg;
- concentrator plant (45 ha) located between N14 and the inselberg;
- tailings dam (280 ha) located approximately 2 km north of the inselberg, north of the N14;
- waste rock dump (270 ha) located on the north side of the inselberg;
- a modular sewage plant and sewage collection sump and treated sewage effluent dam near the concentrator plant;
- a construction camp (2 to 4 ha) on the south side of the concentrator plant;
- haul (45 m wide) and mine access roads (10 m wide);
- other linear infrastructure such as powerlines and pipelines;
- ore stockpiles;
- explosives magazine (4 ha);
- storm water dam (0.5 ha) near the concentrator plant; and
- a 2.5 km conveyor system (2 m wide) from the primary crusher located at open pit to the northern face of the inselberg up to the stockpiles.

Development of the open pit and associated infrastructure will result in the clearing of a large area (over 1200 ha). This will include a number of faunal habitats, including over 400 ha of sensitive habitats, notably cliffs and rocky slopes and a large section of the inselberg basin. Key species of fauna affected include:

- Cliffs and rocky slopes – Desert Mountain Adder, Good's Gecko (not observed at Gamsberg, but likely to occur on the basis of its known distribution and specific habitat requirements), Haacke's Gecko, Namaqua Mountain Gecko, and an undescribed *Camponotus* ant species; and
- Inselberg basin – supporting an undescribed *Messor* ant species (see Figure 4.1).

In addition to the clearing of land for the open pit and mine infrastructure are other impacts, such as:

- direct loss of fauna due to increased road kills, hunting/trapping/poaching of animals, etc;
- increased habitat fragmentation (decreased ecological connectivity), compromising the movement and dispersal patterns of fauna, locally and regionally.
- construction of the open pit will create a "pit-trap" effect for fauna associated with the rocky slopes, plateaux and basin of the inselberg;
- exacerbated bird collisions and mortalities due to construction of powerlines and sub-stations, especially birds of prey and other large birds, notably Secretarybird (Near Threatened), Martial Eagle (Vulnerable), Kori Bustard (Vulnerable), Ludwig's Bustard (Vulnerable); and
- disturbance of habitat through unnatural factors such as fires, off-road driving, increased movement of people, rock slides resulting in soil compaction, removal of cover/refugia, etc.

Operation Phase Impacts

Impacts noted for the construction phase will continue and/or become exacerbated through continued expansion of the open pit and with the increase of numbers of people, vehicles, etc.

Table 8.1 Impact Characteristic: Direct Loss of Fauna and habitat

Summary	Construction	Operation
Project Aspect/Activity	Loss of fauna and faunal habitat due to the clearing of land for the proposed open pit and associated infrastructure (ie waste rock	Continued loss of fauna and faunal habitat due to the operation and expansion of the proposed open pit and associated infrastructure (ie

Summary	Construction	Operation
	dump, tailings, processing plant, haul/access roads, camps, offices, storage facilities, etc.	waste rock dump, tailings, processing plant, haul/access roads, camps, offices, storage facilities, etc.
Impact Type	Direct	Direct
Receptors Affected	Fauna, including a number of sensitive species, and habitats supporting a diverse array of species.	Fauna, including a number of sensitive species, and habitats supporting a diverse array of species.
Nature	Negative impact from the direct loss of fauna and faunal habitat	Negative impact from the direct loss of fauna and faunal habitat
Impact Magnitude • Extent • Duration • Intensity	High • On-site • Permanent • High	Medium • On-site • Permanent • Medium
Likelihood	Definite	Likely
Impact Significance (Pre-Mitigation)	Major	Moderate
Degree of Confidence	Medium	Medium

8.2.2 Indirect Loss of Aquatic Features and Fauna due to Groundwater/Surface Water Impacts

Alteration of surface and geohydrology within the inselberg basin and kloof is a particular concern, as this would result in various impacts to fauna, for example:

- Groundwater flows – these are the primary driver of faunal features within the kloof, and are critical for maintaining surface water within pools and seeps, which for most of the time is the only water available (especially during long dry periods, as experienced in 2012). These isolated aquatic features support a variety of aquatic fauna, notably frog populations (including localised endemics, Namaqua Stream Frog and Paradise Toad) and other aquatic biota unique to the Nama-Karoo. Stable populations of these groups will also support other fauna such as foraging snakes and bats with the kloof. These and other fauna will also frequent available pools of water, which provide a constant source of drinking water, a highly limited resource in the semi-arid environments. Any drawdown of the groundwater table will thus have a significant impact on faunal biodiversity, not only in the Gamsberg study area, but also in the broader regional landscape.
- Surface water flows – although less obvious as a driver, surface flows could be important for various reasons, eg shaping channel and substrate morphology within the kloof, sediment deposition, providing natural

cues/signals for breeding, etc. Fauna within arid and semi-arid environments have evolved mechanisms to endure the harsh xeric climate as experienced in the region. Aquatic invertebrates, for example, remain dormant until wet conditions prevail, while naturally occurring species of frog have specialised adaptations to survive long periods without water (ie rapid breeding with short larval stages, reduced metabolic rates during hibernation, etc). Although not observed at Gamsberg, it can only be expected that aquatic fauna will respond strongly to rainfall and surface runoff events. Less certain at this point, however, is whether aquatic invertebrates depend on a certain amount of sediment deposition as part of their life cycles.

Impacts from groundwater drawdown and decreased surface runoff are discussed according to both the construction and operation phases and summarised in Table 8.2.

Construction Phase Impacts

Groundwater and surface water impacts are not likely to be an issue during the construction phase of the proposed Gamsberg Project, particularly as these impacts will only be initiated once excavation of the pit commences.

Operation Phase Impacts

According to the groundwater and surface water studies, the natural groundwater and surface water situation of the Gamsberg inselberg is inherently complex. The water table varies in depth up to 50 m from the ground level and it appears that localised structural controls allow water to seep to surface at the springs. The modelled groundwater results indicate a significant drawdown along the kloof of between 15 and 20 m from the natural water table during mining. At 100 years post closure, groundwater levels in the kloof are expected to decrease even further by 100 to 125 m, resulting from drawdown and increase evaporation from the pit. In terms of surface water, mean annual runoff (MAR) will be reduced by around 30%, resulting in a significant reduction of surface runoff entering through the kloof.

Table 8.2 Impact Characteristic: Groundwater Drawdown and Decreased Surface Runoff

Summary	Construction	Operation
Project Aspect/Activity	Alteration of surface water runoff due to construction activities causing changes in surface/vegetation cover.	Decreased surface runoff and groundwater drawdown resulting from excavation of an open pit.

Summary	Construction	Operation
Impact Type	Direct	Indirect
Receptors Affected	Fauna and faunal habitats positioned downstream of flow paths.	Frog breeding and foraging habitat; frog populations and conservation important frog species; alteration of vegetation cover and associated faunal assemblages within the gorge washout; drinking water sources, unique aquatic invertebrate and plant communities.
Nature	Negative impact from increased surface runoff and accelerated soil erosion.	Negative impact due to removal of surface aquatic ecosystems from groundwater drawdown and decreased surface runoff.
Impact Magnitude • Extent • Duration • Intensity	Low • On-site • Short-term • Low	High • On-site • Permanent • High
Likelihood	Likely	Likely
Impact Significance (Pre-Mitigation)	Minor	Major
Degree of Confidence	Medium	Medium

8.2.3 Disturbance from Water Contamination, Waste Generation and Air Pollution

Mining effluents may result in changes in the chemistry of receiving water bodies (groundwater and surface water), particularly due to increases in suspended solids, dissolved solids, hardness, sulphates and trace metals (Clarke, 1974). This would not only have a negative impact on aquatic ecosystems, but also terrestrial fauna that depend of the supply of freshwater. Additionally, large quantities of solid waste are produced and air pollution is enhanced due to the increase of dust and various chemical constituents, released into the air. Dust generation, in particular, would result in vegetation, habitats and forage thus creating uninhabitable areas for fauna. Effects from dust fallout would be greatest for terrestrial invertebrates.

Impacts from water contamination and air pollution are discussed according to both the construction and operation phases and summarised in Table 8.3.

Construction Phase Impacts

Problems caused by water contamination and air pollution will commence from the construction phase and will include:

- Dust emissions and fallout, smothering suitable habitat and forage with negative "knock-on" effects to fauna. Dust would a have a direct impact on invertebrates through effects on respiratory systems, feeding capabilities, etc.
- Contamination of soil, groundwater, and surface water from sewerage pollution, acid mine drainage (zinc and related elements) and accidental spills (eg fuels, lubricants, processing chemicals, etc).
- Accidental, as well as intentional, poisoning of animals through solid waste, toxic substances, etc.
- Generation of domestic food waste resulting in increased opportunities for scavenging fauna.

Operation Phase Impacts

Impacts from water contamination, waste generation and air pollution will continue into the operation phase with certain aspects becoming exacerbated, such as dust fallout and contamination of groundwater and surface water resources.

Table 8.3 Impact Characteristic: Water contamination and Air Pollution

Summary	Construction	Operation
Project Aspect/Activity	Generation of dust from open pit mining and movement of vehicles and heavy machinery along dust roads; operation of the concentrator plant, tailings dam and waste rock dumps; increased access and movement of people into the area; and the disposal of solid waste by mine personnel.	Generation of dust from open pit mining and movement of vehicles and heavy machinery along dust roads; operation of the concentrator plant, tailings dam and waste rock dumps; increased access and movement of people into the area; and the disposal of solid waste by mine personnel.
Impact Type	Direct/Indirect	Direct/Indirect
Receptors Affected	Fauna, faunal habitats and aquatic ecosystems.	Fauna, faunal habitats and aquatic ecosystems.
Nature	Negative impact from excessive dust fallout, water contamination and poor waste disposal.	Negative impact from excessive dust fallout, water contamination and poor waste disposal.
Impact Magnitude • Extent • Duration • Intensity	Medium • Local • Short-term • Medium	High • Regional • Long-term • Medium
Likelihood	Likely	Likely
Impact Significance (Pre-	Moderate	Major

Summary	Construction	Operation
Mitigation)		
Degree of Confidence	Low	Low

8.2.4 Impacts from Noise and Lighting

Certain fauna are more susceptible to impacts from increased noise and/or artificial lighting. For example, artificial lighting can have a significant impact on normal life cycles of invertebrates as well as increase mortality rate. Noise impacts will affect noise-sensitive birds and mammals. The result from noise and light impacts includes direct loss of fauna, especially invertebrates, and displacement of population away from the noise impact area of the mine. Notable impacts include displacement of the Red Lark (Red Data Vulnerable) population located within 5km south-west of the project footprint. Indications from the noise specialist study conducted by Dracoulides (2013) is that noise will be restricted to a narrow band along the Loop 10 road, with very low noise beyond 500 meters.

Construction Phase Impacts

Problems caused by increased noise and introduction of artificial lighting will commence from the construction phase and will include:

- excessive and/or continuous noise from vehicles, heavy machinery, and people; and
- invertebrates, particularly during flight life-cycle stages, and nocturnal fauna will become affected by the introduction of artificial lighting used to illuminate areas to allow for construction activities to take place.

Operation Phase Impacts

Impacts from noise and use of artificial lighting will continue into the operation phase with an expected increase in the intensity of noise and light pollution due to:

- blasting and commencement of mining activities (eg waste rock dumps, conveyor system, concentrator plant, tailings dam, etc) during the operation of the open pit;
- Continual expansion of the project footprint, resulting in increased numbers of people, vehicles, etc; and
- Increased utilisation of artificial lighting to allow mining activities to take place over a 24-hour period.

Table 8.4 Impact Characteristic: Noise and Lighting

Summary	Construction	Operation
Project Aspect/Activity	All construction activities generating high levels of noise (eg people/vehicles/ machinery) and activities requiring artificial lighting.	Blasting in the open pit, additional movement of people/vehicles/machinery and night-time project activities.
Impact Type	Direct	Direct
Receptors Affected	Noise-sensitive fauna, such as birds and mammals, and light-sensitive fauna, such as invertebrates and nocturnal vertebrates.	Noise-sensitive fauna, such as birds and mammals, and light-sensitive fauna, such as invertebrates and nocturnal vertebrates. Notably is the potential negative impact on the Red Lark population located southwest of Loop 10 road.
Nature	Negative impact from introduction of unnatural noise levels and artificial lighting.	Negative impact from increasing levels of noise and expanding footprint requiring artificial lighting.
Impact Magnitude • Extent • Duration • Intensity	Low • On-site • Short-term • Medium	Medium • Local • Long-term • Medium
Likelihood	Likely	Likely
Impact Significance (Pre-Mitigation)	Minor	Moderate
Degree of Confidence	Medium	Medium

8.3 Changes to the Waste Rock Dump and Explosives Magazine

Since the completion of the above impact assessment process, there has been changes to the layout of the proposed Gamsberg Project in terms of the waste rock dump and explosives magazine. Issues associated with these chages are discussed as follows:

- Waste rock dumps – the extent has changed from 270 ha to 290 ha, extending up to a maximum of 490 ha. The site of the waste rock dumps remain on the northern slopes of the Gamsberg inselberg. This will result in an expansion to the overall footprint by up to 220 ha, affecting a greater area of rocky and foot slope habitat. However, the significance of the impact interms of "direct loss of fauna and faunal habitat" will remain as per the assessment (*c.f.* Section 8.2.1 Direct Loss of Fauna and Faunal Habitat).

- Explosives magazine – the extent remains the same (ie four hectares), however, the position has changed from the inselberg basin to the northern plains, about one kilometre east of the processing plant. The change in position is preferred on the basis that mining infrastructure will be grouped closer together, reducing impacts from habitat fragmentation, particularly when including the need for access roads to the explosives magazine. The changes in terms of assessment of impacts will be insignificant with impacts from "direct loss of fauna and faunal habitat" remaining unchanged (*c.f.* Section 8.2.1 Direct Loss of Fauna and Faunal Habitat).

8.4 Recommended Mitigation Measures

The following points outline various mitigation measures recommended in order to address the potential impacts that may arise from the proposed Gamsberg Project:

- Reduce mining footprint as far as possible. This was incorporated during earlier phases of the Gamsberg Project. An additional consideration would be to limit the extent and network of linear infrastructure such as fences, roads and pipelines, which otherwise limit faunal movement.
- Avoid sensitive areas, ie aquatic systems and habitats supporting key faunal species. This was incorporated during earlier phases of the Gamsberg Project, for example selection of the north western tailings dam option in the least sensitive area. An additional consideration includes pulling back the surface footprint of the open pit to avoid the spring and headwater system of the western drainage line feeding into the kloof.
- Group mining facilities (including linear features such as roads, powerlines and pipelines) together to reduce fragmentation of natural habitats supporting a rich diversity of fauna. This has been achieved to some degree with majority of the mining infrastructure positioned on the plains and slopes to the north and north-west of the inselberg. An additional consideration would be to re-route the powerline to the south to run parallel to the N14.
- Design and construct powerlines and substations according to best practice in consultation with avifaunal specialists, such as from the Endangered Wildlife Trust (EWT). Position powerlines away from water bodies and use bird deterrents (e.g. flappers) to reduce bird collisions.
- Develop and implement environmental awareness programme for mining personnel and contractors which emphasises faunal biodiversity issues such as road kills, damage to habitat, etc. Signed contracts must include policy to ensure compliance is achieved. Any contravention should then be followed by appropriate disciplinary action.

- Devise and implement management plans to deal with waste, stormwater, faunal recovery and relocation, spills, etc. All operational waste should be contained and disposed of in the appropriate manner with strict adherence to waste disposal protocols maintained. All waste, rubble and debris are to be kept clear of the kloof, washout and inselberg basin and confined to designated areas within already degraded areas.
- Rehabilitate transformed and disturbed areas during all phases of the Gamsberg Project to reinstate natural habitat. Where applicable, a rehabilitation plan is to be designed by an appropriate specialist. The rehabilitation plan is to include erosion control structures, as well re-vegetation measures of damaged areas, using indigenous shrubs and grasses only. These areas will provide habitat for fauna to re-colonising the area. Special attention needs to be paid to ensuring that critical topography is reconstructed as far as practical; this is of special significant to the two ant species highlighted in this report, both of which appear to have specific topographic habitat requirements. Rehabilitation measures will be particularly important during the decommissioning phase of the Project.
- Prohibit personnel and contractors from having domestic dogs and cats. Implement a feral dog and cat control programme.
- Restrict and control the movement of people and vehicles during all mining phases and ensure that prohibited access areas are clearly demarcated.
- Implement and enforce speed limits, particularly along the N14 and Loop 10 route.
- Maintain access/haul roads and implement dust control measures as far as is practical given the prevailing water scarcity.
- Light pollution from the mine must be kept to a minimum so as not to interfere with insect life cycles and nocturnal vertebrates. For this reason, it is recommended that low pressure sodium vapour lights/or LED lights with wavelengths of limited attractiveness to insects be used, and that these face into the mine operations and associated infrastructure and not outwards.
- Ensure that natural groundwater/surface water flows are maintained through the gorge and into the washout on the northern plains. Indications are that the post-mining lake levels in the pit will affect recharge of springs and hence and flow of sub-surface water through the kloof. A possible solution would be to artificially pump water to feed into the kloof. This could be appended to the water pumping scheme from the Orange River, but would need to be maintained post-mining to ensure the survival of the kloof and its associated ecosystems, processes and biota. This is on the assumption that no suitable offset options would be developed. The

effectiveness of artificially supplying water to the kloof, however, would need to be carefully monitored and tested.

- Because of the strong driver that the water within and moving through the the kloof system provides to the local ecology, a Reserve study should ideally be undertaken to fully understand and appreciate the consequences of a modified flow regime through this system.
- An aquatic biomonitoring plan that covers the construction, operation, decommissioning and post-mining phases should be designed by an appropriate specialist. This will inform management regarding the impacts of the mine on both water quality and associated biodiversity. Biomonitoring will be particularly significant during early mining and prior to the drawdown of water from the kloof area, as well as during that phase when/if Orange River water is pumped into the system as a possible mitigation/replacement.
- Improve knowledge gaps through a detailed regional study of key fauna in order to assess impacts with higher confidence as well as to better inform offset opportunities for conservation of fauna. This should include determination of key habitat requirements for and distribution of the undescribed *Camponotus* and *Messor* ant species to enable formal conservation (IUCN Red List) assessments to be carried out, to allow potential offsets to be properly evaluated and to allow more precise determination of rehabilitation requirements.
- The possibility that summer-active species of Mantophasmatodea may be present, while small, must still be considered and should be checked during a true wet season survey.
- Monitoring of key invertebrate indicator groups (e.g. leafhoppers and ants) should be implemented to enable the effectiveness of mitigation measures to be evaluated and also to allow monitoring of progress of rehabilitation.
- Devise and implement a programmes to monitor Red Lark populations. Disturbance thresholds need to be defined with appropriate interventions followed when thresholds are exceeded.
- Fixed-point camera trapsbe installed at key points, in and around the inselberg, to monitor the presence and diversity of mammals and birds during the construction, operation and decomissing phase of the mining operation. This will give a useful indication as to the movement and presence of species within the system and therefore monitor the effects of the mine on biodiversity. The mine could also collaborate with an independent NGOs or academic institutions to conduct faunal monitoring studies to both expand on the current baseline study, as well as to monitor for unexpected changes to the faunal baseline.

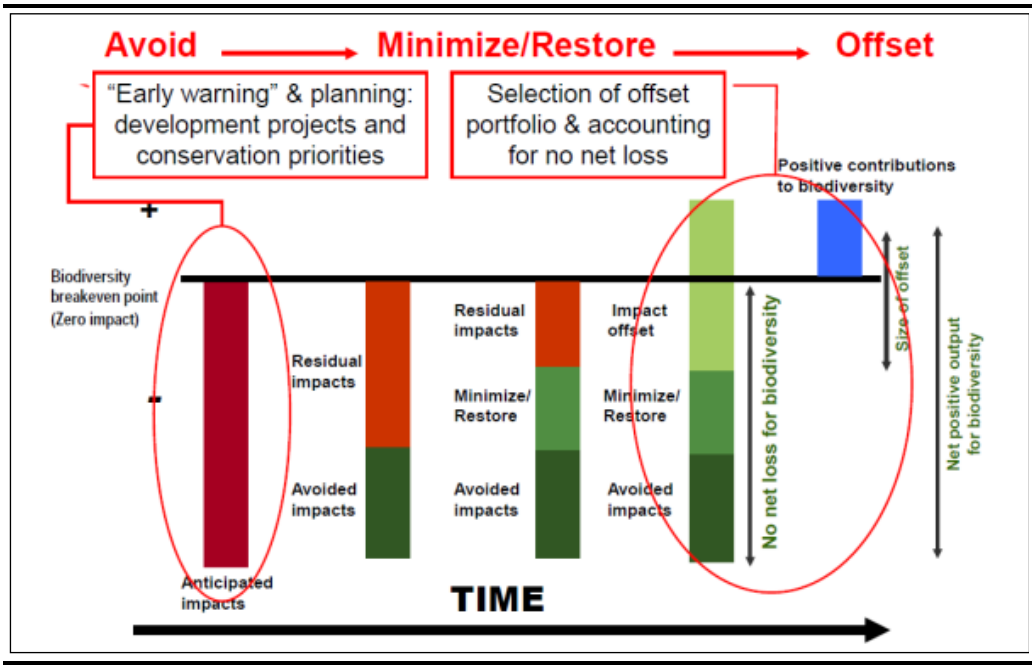
- Implement a biodiversity offset programme to properly identify and set aside areas for conservation. This should include unimpacted habitats as possible set aside area.

8.5 Residual Impact and Offsetting

Biodiversity offsetting is a key approach in terms of compensating residual environmental impacts of planned developments after appropriate steps have been taken to avoid, minimize or restore impacts (McKenny and Kiesecker, 2010).
Figure 8.1 below illustrates the concept of achieving a net benefit within the environment by identifying, incorporating and implementing mitigation steps of avoid, minimize, restore and offset.

Adopting an offset approach will be key to the Gamsberg Project not only to managing impacts, but also to manage unforeseen outcomes following implementation of various mitigation measures during the life of the mine.
A clear link and understanding will need to be established between the offset proposals and specific impacts identified within this specialist study. Furthermore, planning will need to ensure specific habitat requirements for notable species and biological processes highlighted within this report are properly encompassed in the offsetting procedure.

Figure 8.1 A strategic approach for mitigating potential impacts across a site (after Kiesecker et al., 2009)



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10. APPENDICES

APPENDIX 1

Addendum Information Pertaining to Invertebrate Fauna

APPENDIX 1.1: Description of the Terrestrial Invertebrate Sampling Sites Assessed During the September 2009 and November 2012 Surveys (Site Co-ordinates in Decimal Degrees)

Site	Description	Sampling Method	Latitude	Longitude
September 2009				
V1.1-S2-t1	White quartzite subcommunity	sweep/beat/search	-29.24907	18.94729
V3-t1	Basin	sweep/beat/search	-29.25479	18.97156
V4-S5-t2	Ecotone community of lower slopes - Lower southern slopes	sweep/beat/search	-29.25464	18.94364
V4-S7-t1	Ecotone community of lower slopes - Low quartzite hill	search only	-29.22153	18.97957
V5-t3	Slope community on scree	sweep/beat/search	-29.23729	18.95611
V6-S4-t1	Southern slope community	sweep/beat/search	-29.25424	18.94815
V6-S4-t3	Southern slope community	sweep/beat/search	-29.25121	18.94298
V7-S8-t1	Plains community - calcrete outcrops	sweep/beat/search	-29.22526	18.93800
V8-t1	Drainage lines community	sweep/beat/search	-29.24930	18.96946
V9-S6-t1	Kloof community	search only	-29.23185	18.98033
WP3	Proposed slimes dam - plains	search only	-29.18773	18.94243
WP17	Darker quartzite sub-community	search only	-29.23443	18.99109
November 2012				
Site 1	Wash	sweep/pitfall/UV/search	-29.22445	18.98474
Site 2	Tailings option 1	sweep/pitfall/UV/search	-29.16780	18.95049
Site 3	North slopes	sweep/pitfall/UV/search	-29.22862	18.95572
Site 4	Kloof	sweep/pitfall/UV/search	-29.23414	18.97836
Site 5	West plateaux	pitfall/UV/search	-29.23292	18.96900
Site 6	Basin 1	sweep/pitfall/search	-29.24562	18.95670
Site 7	Drainage line	sweep/pitfall/search	-29.24860	18.96673
Site 8	Basin 2	pitfall/UV/search	-29.25517	18.97245
Site 9	East plateaux	sweep/pitfall/search	-29.23789	18.99020
Site 10	South slopes	sweep/pitfall/UV/search	-29.25653	18.95172
Site 11	Evaporation ponds	search	-29.21900	18.95523
Site 12	West slopes	UV	-29.23937	18.93199

APPENDIX 1.2: Summary of Sampling Sites, Methods and Dates for the November 2012 Terrestrial Invertebrate Survey

Sampling method	Sites/Sampling Dates											
	Washout from Kloof	Sandy Plains at Proposed Tailings site	Northern rocky slopes	Main Kloof	Western Plateaux	Central Basin (Site 1)	Drainage Line	Basin (Site 2)	Eastern Plateaux	Southern Rocky Slopes	Settling Ponds on Northern Plain	Western Rocky Slopes
Pitfall trapping (40 traps set for 7 days)	20/11/2012 to 27/11/2012	20/11/2012 to 27/11/2012	21/11/2012 to 28/11/2012	21/11/2012 to 28/11/2012	22/11/2012 to 29/11/2012	22/11/2012 to 29/11/2012	22/11/2012 to 29/11/2012	22/11/2012 to 29/11/2012	23/11/2012 to 30/11/2012	23/11/2012 to 30/11/2012	-	-
Net sweeping (20 samples of 100 sweeps each)	20/11/2012	24/11/2012	21/11/2012	24/11/2012*	-	25/11/2012	27/11/2012	-	23/11/2012	26/11/2012	-	-
UV night searches (2hours search with two UV lamps)	19/11/2012 29/11/2012	20/11/2012	21/11/2012	23/11/2012	27/11/2012	-	-	24/11/2012	-	26/11/2012	-	27/11/2012
Manual search (unstructured, one to several hours per site), including netting, rock-turning and general hand-collecting.	x	x	x	x	x	x	x	x	x	x	x	-

* Due to topographic constraints, 10 samples of 200 sweeps each were collected here

APPENDIX 2

Addendum Information Pertaining to Vertebrate Fauna

APPENDIX 2.1: Sites used to Sample Occurrence of Frogs, Reptiles, Birds and Mammals During the 2009 and 2012 Surveys (Site Co-ordinates in Decimal Degrees)

Site	Description	Sampling method	Vertebrate Group/s	Latitude	Longitude
May 2009					
TS09-01	Alluvial pan on northern plateaux	Active search (nocturnal/diurnal)	Amphibians/Reptiles	-29.22936	18.98129
TS09-02	Cliffs/rocky slopes on southern escarpment	Active search (nocturnal/diurnal)	Amphibians/Reptiles	-29.26303	18.97521
TS09-03	Cliffs/rocky slopes on eastern escarpment	Active search (diurnal)	Amphibians/Reptiles	-29.24722	19.00157
TS09-04	Cliffs/rocky slopes on north-eastern escarpment	Active search (diurnal)	Amphibians/Reptiles	-29.24090	18.99202
TS09-05	Southern plateaux	Active search (diurnal)	Amphibians/Reptiles	-29.27062	18.99679
TS09-06	Cliffs/rocky slopes on western escarpment	Active search (nocturnal/diurnal)	Amphibians/Reptiles	-29.24227	18.93918
TS09-07	Cliffs/rocky slopes on northern escarpment	Active search (nocturnal/diurnal)	Amphibians/Reptiles	-29.23287	18.97515
TS09-08	Central basin at entrance to main kloof	Mist netting	Bats	-29.24703	18.97717
TS09-09	Adit on northern slopes	Active search (nocturnal/diurnal); mist netting	Bats	-29.22937	18.95944
TS09-10	Main kloof	Mist netting	Bats	-29.24282	18.97779
TS09-11	Cave on southern slopes	Active search (diurnal)	Bats	-29.26294	18.99563
TS09-12	Eastern plateaux	Active search (diurnal)	Amphibians/Reptiles	-29.25227	19.01404
TS09-13	Central basin at old drillers camp site	Active search (nocturnal/diurnal)	Amphibians/Reptiles	-29.25422	18.98247
November 2012					
TS12-01	Rock outcrop	Active search (diurnal)	Reptiles/birds/mammals	-29.27955	18.96461
TS12-03	Southern, sandy plains	Sherman trap	Small mammals	-29.26443	18.94433
TS12-04	Southern plains on deep sands	Trap array	Frogs/reptiles/small mammals	-29.26426	18.94415
TS12-06	Rock outcrop	Sherman trap, Active search (diurnal)	Reptiles/birds/mammals	-29.26393	18.94532
TS12-07	Southern, sandy plain	Camera trap	Mammals	-29.26385	18.94451
TS12-10	Rocky slope	Sherman trap, Active search (diurnal)	Reptiles/birds/mammals	-29.26146	18.96810
TS12-11	Southern, rocky slope	Sherman trap, Active search (diurnal)	Reptiles/birds/mammals	-29.25443	18.94632
TS12-12	Basin	Active search (diurnal/nocturnal)	Reptiles	-29.25422	18.98247
TS12-13	Eastern foot slope and plain	Active search (diurnal)	Reptiles	-29.25227	19.01404
TS12-15	Western plain, scrub vegetation	Trap array	Frogs/reptiles/small mammals	-29.25197	18.93675
TS12-16	Western plain, scrub vegetation	Sherman trap	Small mammals	-29.25185	18.93693
TS12-17	Western plain, scrub vegetation	Camera trap, Active search (diurnal)	Reptiles/birds/mammals	-29.25171	18.93636
TS12-18	Basin, drainage line	Sherman trap	Small mammals	-29.25164	18.97480

Site	Description	Sampling method	Vertebrate Group/s	Latitude	Longitude
TS12-19	Basin, drainage line	Camera trap, Active search (diurnal/nocturnal)	Reptiles/birds/mammals	-29.25158	18.97410
TS12-20	Western, sandy plain	Trap array	Frogs/reptiles/small mammals	-29.25141	18.92491
TS12-21	Eastern rocky slope	Camera trap, Active search (diurnal)	Reptiles/birds/mammals	-29.25136	19.01120
TS12-22	Eastern spring	Aquatics, Site 02	Frogs/reptiles	-29.25103	19.01094
TS12-24	Basin, main drainage line	Active search (nocturnal)	Retiles/bats	-29.24703	18.97717
TS12-25	Basin, main drainage line	Camera trap, Active search (diurnal)	Reptiles/birds/mammals	-29.24453	18.97724
TS12-26	Kloof, drainage line	Active search (nocturnal)	Retiles/bats	-29.24282	18.97779
TS12-27	Western plateaux	Active search (diurnal)	Reptiles	-29.24227	18.93918
TS12-29	Kloof, drainage line	Active search (nocturnal)	Frogs/reptiles/bats	-29.24059	18.97843
TS12-31	Kloof, rocky slope	Active search (nocturnal)	Reptiles	-29.23355	18.97675
TS12-32	Northern plateaux	Active search (diurnal)	Reptiles/birds/mammals	-29.23298	18.95752
TS12-33	Kloof, drainage line	Camera trap, Active search (diurnal/nocturnal)	Frogs/reptiles/birds/mammals	-29.23288	18.97984
TS12-34	Northern plateaux	Active search (nocturnal)	Reptiles	-29.23287	18.97515
TS12-35	Kloof, drainage line	Active search (diurnal/nocturnal)	Frogs/reptiles/birds/mammals	-29.23287	18.98084
TS12-36	Northern, rocky slopes	Active search (diurnal)	Retiles/birds/mammals	-29.22937	18.95944
TS12-37	Northern washout	Active search (diurnal/nocturnal)	Reptiles/birds/mammals	-29.22936	18.98129
TS12-38	Northern, rocky slopes	Sherman trap, Active search (diurnal)	Reptiles/birds/mammals	-29.22791	18.97918
TS12-39	Northern washout	Camera trap	Mammals	-29.22789	18.98067
TS12-40	Northern washout	Trap array	Frogs/reptiles/small mammals	-29.22767	18.98070
TS12-41	Northern washout	Sherman trap	Small mammals	-29.22762	18.98121
TS12-42	Northern, rocky slopes	Active search (diurnal)	Reptiles/birds	-29.22761	18.97428
TS12-43	Northern, settling ponds	Camera trap	Mammals	-29.21904	18.95537
TS12-44	Northern, sandy plain	Trap array	Reptiles/small mammals	-29.21719	18.96543
TS12-45	Northern, sandy plain	Active search (diurnal)	Reptiles/birds/mammals	-29.21613	18.95754
TS12-46	Northern, sandy plain	Active search (nocturnal)	Reptiles	-29.21463	18.96515

APPENDIX 2.2: Regional list of amphibians potentially occurring at Gamsberg, including species recorded at Gamsberg during the May 2009 and November 2012 surveys (Minter *et al.*, 2004)

Family	Scientific Name	Common Name	Conservation Status#	Habitat Requirements	2009	2012
Bufonidae	*Vandijkophrynus robinsoni*	Paradise Toad	RR; P2	Natural springs and waterholes in arid areas in the Northern Cape.	•	•
Microhylidae	*Phrynomantis annectens*	Marbled Rubber Frog	P2	Arid environments, closely associated with inselbergs and rocky areas.	•	
Petropedetidae	*Xenopus laevis*	Common Platanna	P2	Restricted to aquatic habitats but can be found in any form of wetland, natural or fabricated.		
Pyxicephalidae	*Cacosternum boettgeri*	Boettger's Caco	P2	Variety of habitats, but favours open areas especially grassland.		
Pyxicephalidae	*Cacosternum namaquense*	Namaqua Caco	RR; P2	Upland succulent Karoo, breeding during rainy weather in temporary rain-filled rock pools, river beds, permanent pools, seeps and springs.		
Pyxicephalidae	*Strongylopus springbokensis*	Namaqua Stream Frog	RR; P2	Mountainous areas of Namaqualand close to seeps and springs to survive the harsh conditions.		
Pyxicephalidae	*Tomopterna cryptotis*	Tremelo Sand Frog	P2	Variety of habitats in savannah and grassland		
Pyxicephalidae	*Tomopterna delalandii*	Cape Sand Frog	P2	Lowlands and valleys in fynbos and succulent Karoo.		•
Pyxicephalidae	*Tomopterna tandyi*	Tandy's Sand Frog	P2	Nama Karoo grassland and savanna. Breeds in small streams, pans and farm dams as well as temporary rain pools.		
Totals					**2**	**2**

#Conservation Status defined under various levels of importance/sensitivity, namely:

- Red Data species as defined according to the IUCN (2013) categories, ie CR (Critically Endangered), EN (Endangered), VU (Vulnerable), NT (Near Threatened) and DD (Data Deficient) (see IUCN definitions under Section 1.2.2 International Standards and Policies);
- CITES – refers Convention on International Trade of Endangered Species according to the relevant CITES appendices, CI (Appendix I), CII (Appendix II) and CIII (Appendix III) (see CITES definitions under Section 1.2.2 International Standards and Policies);
- P1 – refers to "Specially Protected" as listed under Schedule 1 of the Northern Cape Nature Conservation Act (Act 9 of 2009);
- P2 – refers to "Protected" as listed under Schedule 2 of the Northern Cape Nature Conservation Act (Act 9 of 2009); and
- RR – refers to range restricted, ie species with limited distribution ranges, restricted to part of the Northern Cape.

APPENDIX 2.3: Regional list of reptiles potentially occurring at Gamsberg, including species recorded at Gamsberg during the May 2009 and November 2012 surveys (Bates *et al.,* In Prep.)

Family	Scientific Name	Common Name	Conservation Status #	Habitat Requirement	2009	2012
Lizards						
Scincidae	*Acontias tristis*	Namaqua Dwarf Legless Skink	Endemic; P2	Sandy areas on plains	•	
Scincidae	*Trachylepis occidentalis*	Western Three-striped Skink	P2	Open, sandy veld in arid savanna, Karoo scrub and desert	•	•
Scincidae	*Trachylepis sulcata*	Western Rock Skink	P2	Rocky areas in arid savanna, Karoo scrub and desert	•	•
Scincidae	*Trachylepis variegata*	Variegated Skink	P2	Rocky outcrops in in wide variety of habitat types	•	
Agamidae	*Agama aculeata*	Ground Agama	P2	Range of terrestrial substrates in semi-desert and savanna		
Agamidae	*Agama anchietae*	Anchieta's Agama	P2	Rocky areas in semi-desert and arid savanna		•
Agamidae	*Agama atra*	Southern Rock Agama	P2	Rocky areas in a wide range of habitats		
Agamidae	*Agama knobeli*	Knobel's Agama	P2	Rocky areas		
Chameleonidae	*Chameleo namaquensis*	Namaqua Chameleon	CII; P2	Sandy regions with scrub vegetation		
Gekkonidae	*Chondrodactylus angulifer*	Giant Ground Gecko	P2	Sandy flats and gravel plains		•
Gekkonidae	*Chondrodactylus bibronii*	Bibron's Gecko	P2	Rocky areas and buildings in Karoo scrub and semi-desert	•	•
Gekkonidae	*Chondrodactylus turneri*	Turner's Gecko	P2	Rocky areas and buildings in semi-desert and arid savanna		
Gekkonidae	*Goggia lineata*	Striped Dwarf Leaf-toed Gecko	P2	Rock outcrops with some vegetation and dead material		•
Gekkonidae	*Lygodactylus bradfieldi*	Bradfield's Dwarf Gecko	P2	Mainly arboreal habitats in arid savanna and succulent desert		
Gekkonidae	*Pachydactylus goodi*	Good's Gecko	RD VU (probable); RR; Endemic; P2	Broken, rocky areas, on slopes and cliffs		
Gekkonidae	*Pachydactylus haackei*	Haacke's Gecko	RR; Endemic; P2	Broken, rocky areas, on slopes and cliffs		•
Gekkonidae	*Pachydactylus latirostris*	Quartz Gecko	P2	Sandy, open areas		•
Gekkonidae	*Pachydactylus montanus*	Namaqua Mountain Gecko	RR; P2	Range of rocky habitats on mountain slopes, outcrops, and cliffs	•	•
Gekkonidae	*Pachydactylus rugosus*	Rough-skinned Gecko	P2	Dry river beds with loose bark and vegetation in semi-	•	•

Family	Scientific Name	Common Name	Conservation Status #	Habitat Requirement	2009	2012
				desert and succulent Karoo		
Gekkonidae	*Ptenopus garrulous maculatus*	Barking Gecko	P2	Flat, stable, sandy substrates with sparse vegetation in desert and semi-desert habitats		•
Cordlyidae	*Karusasaurus polyzonus*	Karoo Girdled Lizard	CII; P2	Rock outcrops and lower mountain slopes in Karoo veld	•	
Gerrhosauridae	*Cordylosaurus subtessellatus*	Dwarf Plated Lizard	P2	Small rock outcrops with succulent vegetation in succulent and Karoo veld		
Lacertidae	*Meroles knoxii*	Knox's Desert Lizard	P2	Sandy, vegetated areas in succulent Karoo veld		
Lacertidae	*Meroles suborbitalis*	Spotted Desert Lizard	P2	Flat gravel or sandy plains with scattered vegetation in arid savanna and desert		
Lacertidae	*Nucras tesellata*	Western Sandveld Lizard	P2	Rocky areas in arid savanna and Karoo veld		
Lacertidae	*Pedioplanis inornata*	Plain Sand Lizard	P2	Flats and footslopes in semi-desert		•
Lacertidae	*Pedioplanis laticeps*	Cape Sand Lizard	Endemic; P2	Compact, well-vegetated soils in grassland and succulent Karoo veld		
Lacertidae	*Pedioplanis lineoccellata*	Spotted Sand Lizard	P2	Flat, rocky areas in a wide range of habitats		
Lacertidae	*Pedioplanis namaquensis*	Namaqua Sand Lizard	P2	Open, sparsely vegetated sand and gravel flats in Karoo veld, arid savanna and semi-desert		•
Lacertidae	*Pedioplanis pulchella*	Common Sand Lizard	P2			
Snakes						
Typhlopidae	*Rhinotyphlops lalandei*	Delalande's Beaked Blind Snake				
Typhlopidae	*Rhinotyphlops schinzi*	Schinz's Beaked Blind Snake		Karoo scrub and desert		•
Lamprophiidae	*Boaedon capensis*	Brown House Snake	P2	Karoo, grassland and savannah		
Lamprophiidae	*Boaedon 'mentalis'*	Western' Brown House Snake	P2	Karoo scrub		
Lamprophiidae	*Lamprophis guttatus*	Spotted House Snake	P2	Rocky areas in a variety of vegetation types		
Prosymnidae	*Prosymna bivittata*	Two-striped Shovel-snout	P2	Karoo and savanna areas		
Prosymnidae	*Prosymna frontalis*	South-western Shovel-snout	P2	Rocky areas in Karoo and desert scrub		
Psammophiidae	*Dipsina multimaculata*	Dwarf Beaked Snake		Stony and sandy areas in Karoo and desert scrub		
Psammophiidae	*Psammophis notostictus*	Karoo Sand Snake			•	
Psammophiidae	*Psammophis trinasalis*	Kalahari Sand Snake		Open Karoo scrub and grassland		

Family	Scientific Name	Common Name	Conservation Status #	Habitat Requirement	2009	2012
Pseudaspidae	*Pseudaspis cana*	Mole Snake	P2	A variety of habitats		
Colubridae	*Dasypeltis cf scabra*	Rhombic' Egg-eater	P2	Savanna, grassland and Karoo scrub		
Colubridae	*Telescopus beetzi*	Beetz's Tiger Snake		Karoo scrub		•
Elapidae	*Aspidelaps lubricus*	Coral Shield Cobra		Rocky outcrops in Karoo and semi desert regions		•
Elapidae	*Naja nigricollis woodi*	Black Spitting Cobra		Karoo and desert scrub, often in rocky areas and drainage lines	•	
Elapidae	*Naja nivea*	Cape Cobra		Fynbos, Karoo and desert scrub	•	
Viperidae	*Bitis arietans*	Puff Adder		Widespread		
Viperidae	*Bitis caudalis*	Horned Adder		Arid savanna, Karoo and desert scrub		
Viperidae	*Bitis xeropaga*	Desert Mountain Adder	RR	Confined to dry, rocky mountain slopes	•	
Tortoises						
Testudinidae	*Psammobates tentorius*	Tent Tortoise	CII; P2		•	
Totals					**13**	**16**

#Conservation Status defined under various levels of importance/sensitivity, namely:

- Red Data species as defined according to the IUCN (2013) categories, ie CR (Critically Endangered), EN (Endangered), VU (Vulnerable), NT (Near Threatened) and DD (Data Deficient) (see IUCN definitions under Section 1.2.2 International Standards and Policies);
- CITES – refers Convention on International Trade of Endangered Species according to the relevant CITES appendices, CI (Appendix I), CII (Appendix II) and CIII (Appendix III) (see CITES definitions under Section 1.2.2 International Standards and Policies);
- P1 – refers to "Specially Protected" as listed under Schedule 1 of the Northern Cape Nature Conservation Act (Act 9 of 2009);
- P2 – refers to "Protected" as listed under Schedule 2 of the Northern Cape Nature Conservation Act (Act 9 of 2009); and
- RR – refers to range restricted, ie species with limited distribution ranges, restricted to part of the Northern Cape.
- Endemic refers to species with distributions confined to South Africa; and
- Near-endemic refers to species with distribution largely confined to South Africa.

APPENDIX 2.4: List of birds potentially occurring at Gamsberg, including data from the South African Bird Atlas Project 2 (SABAP2) and species recorded during the May 2009 and November 2012 surveys (Barnes, 2000)

Scientific Name	Common Name	Conservation Status	SABAP2	2009	2012
Struthio camelus	Common Ostrich	P[2]			
Ardea melanocephala	Black-headed Heron	P[2]			
Bubulcus ibis	Cattle Egret	P[2]			
Scopus umbretta	Hamerkop	P[2]			
Ciconia ciconia	White Stork	P[2]			
Threskiornis aethiopicus	African Sacred Ibis	P[2]			
Bostrychia hagedash	Hadeda Ibis	P[2]			
Alopochen aegyptiacus	Egyptian Goose	P[2]			
Tadorna cana	South African Shelduck	P[2]	•		
Anas sparsa	African Black Duck	P[2]			
Sagittarius serpentarius	Secretarybird	RD NT; P[1]			
Falco peregrinus	Peregrine Falcon	RD NT; P[1]			
Falco biarmicus	Lanner Falcon	RD NT; P[1]	•		•
Falco chicquera	Red-necked Falcon	P[1]			
Falco rupicoloides	Greater Kestrel	P[1]	•	•	•
Falco rupicolus	Rock Kestrel	P[1]	•		
Milvus migrans	Black Kite	P[1]			
Milvus aegyptius	Yellow-billed Kite	P[2]			
Elanus caeruleus	Black-shouldered Kite	P[1]			
Aquila verreauxii	Verreaux's Eagle	P[1]	•	•	•
Aquila pennatus	Booted Eagle	P[1]			
Polemaetus bellicosus	Martial Eagle	RD VU; P[1]	•		
Circaetus pectoralis	Black-chested Snake-Eagle	P[1]	•		
Buteo rufofuscus	Jackal Buzzard	Endemic; P[1]		•	
Buteo vulpinus	Steppe Buzzard	P[1]			
Melierax gabar	Gabar Goshawk	P[1]			
Melierax canorus	Southern Pale Chanting Goshawk	Near-endemic, P[1]	•	•	•
Circus maurus	Black Harrier	RD NT, Endemic; P[1]			
Pternistis capensis	Cape Spurfowl	Endemic			
Coturnix coturnix	Common Quail	P[2]			
Numida meleagris	Helmeted Guineafowl	P[2]			
Ardeotis kori	Kori Bustard	RD VU			
Neotis ludwigii	Ludwig's Bustard	RD VU; Near-endemic; P[1]	•		
Eupodotis vigorsii	Karoo Korhaan	Endemic; P[2]	•		
Afrotis afraoides	Northern Black Korhaan	Endemic; P[2]	•		
Afrotis afra	Southern Black Korhaan	Endemic; P[2]			
Vanellus coronatus	Crowned Lapwing	P[2]	•		
Vanellus armatus	Blacksmith Lapwing	P[2]			
Burhinus capensis	Spotted Thick-knee	P[2]			
Cursorius rufus	Burchell's Courser	Near-endemic; P[2]			
Rhinoptilus africanus	Double-banded Courser	P[2]			
Pterocles namaqua	Namaqua Sandgrouse	Near-endemic;	•	•	•

Scientific Name	Common Name	Conservation Status	SABAP2	2009	2012
		P2			
Pterocles bicinctus	Double-banded Sandgrouse	Near-endemic; P2			
Columba guinea	Speckled Pigeon	P2	•	•	•
Columba livia	Rock Dove	P2			
Streptopelia semitorquata	Red-eyed Dove	P2			
Streptopelia capicola	Cape Turtle-Dove	P2	•	•	
Streptopelia senegalensis	Laughing Dove	P2	•		•
Oena capensis	Namaqua Dove	P2	•		
Agapornis roseicollis	Rosy-faced Lovebird	Near-endemic; P2			
Chrysococcyx caprius	Diderick Cuckoo	P2			
Tyto alba	Barn Owl	P1			
Bubo capensis	Cape Eagle-Owl	P1		•	•
Bubo africanus	Spotted Eagle-Owl	P1			
Caprimulgus rufigena	Rufous-cheeked Nightjar	P1			
Caprimulgus tristigma	Freckled Nightjar	P1			
Apus apus	Common Swift	P2			
Apus bradfieldi	Bradfield's Swift	Near-endemic; P2			
Apus caffer	White-rumped Swift	P2			
Apus affinis	Little Swift	P2	•		
Tachymarptis melba	Alpine Swift	P2	•		
Cypsiurus parvus	African Palm-Swift	P2			
Colius colius	White-backed Mousebird	Endemic		•	•
Urocolius indicus	Red-faced Mousebird				
Merops apiaster	European Bee-eater	P2			
Merops hirundineus	Swallow-tailed Bee-eater	P2			
Upupa africana	African Hoopoe	P2			
Rhinopomastus cyanomelas	Common Scimitarbill	P2			
Tricholaema leucomelas	Acacia Pied Barbet	Near-endemic; P2	•	•	•
Indicator indicator	Greater Honeyguide	P2			
Geocolaptes olivaceus	Ground Woodpecker	Endemic; P2			
Dendropicos fuscescens	Cardinal Woodpecker	P2			
Certhilauda subcoronata	Karoo Long-billed Lark	Endemic; P2	•		•
Mirafra apiata	Cape Clapper Lark	Endemic; P2	•		
Calendulauda africanoides	Fawn-coloured Lark	P2	•		•
Calendulauda sabota	Sabota Lark	Near-endemic; P2	•		
Calendulauda albescens	Karoo Lark	Endemic; P2			
Galerida magnirostris	Large-billed Lark	Endemic; P2			
Chersomanes albofasciata	Spike-heeled Lark	Near-endemic; P2	•		
Calendulauda burra	Red Lark	RD VU; Endemic; P1	•		•
Eremopterix verticalis	Grey-backed Sparrowlark	Near-endemic; P2	•		•
Eremopterix australis	Black-eared Sparrowlark	Endemic; P2	•		
Calandrella cinerea	Red-capped Lark	P2			
Spizocorys conirostris	Pink-billed Lark	Near-endemic; P2			

Scientific Name	Common Name	Conservation Status	SABAP2	2009	2012
Spizocorys sclateri	Sclater's Lark	RD NT; Endemic; P[1]			
Spizocorys starki	Stark's Lark	Near-endemic; P[2]	•		
Hirundo rustica	Barn Swallow	P[2]	•		
Hirundo albigularis	White-throated Swallow	P[2]			
Hirundo dimidiata	Pearl-breasted Swallow	P[2]			
Hirundo fuligula	Rock Martin	P[2]	•		
Delichon urbicum	Common House-Martin	P[2]			
Riparia riparia	Sand Martin	P[2]			
Riparia paludicola	Brown-throated Martin	P[2]			
Parus cinerascens	Ashy Tit	Near-endemic; P[2]			•
Dicrurus adsimilis	Fork-tailed Drongo	P[2]			
Corvus albus	Pied Crow		•	•	•
Corvus capensis	Cape Crow		•	•	
Parus afer	Grey Tit	Endemic, P[2]		•	•
Anthoscopus minutus	Cape Penduline-Tit	Near-endemic; P[2]		•	
Pycnonotus nigricans	African Red-eyed Bulbul	Near-endemic		•	•
Turdus smithi	Karoo Thrush	Endemic; P[2]			
Monticola brevipes	Short-toed Rock-Thrush	Near-endemic; P[2]		•	
Oenanthe monticola	Mountain Wheatear	Near-endemic; P[2]	•	•	•
Cercomela schlegelii	Karoo Chat	Near-endemic; P[2]	•		•
Oenanthe pileata	Capped Wheatear	P[2]	•		
Cercomela familiaris	Familiar Chat	P[2]	•	•	•
Cercomela tractrac	Tractrac Chat	Near-endemic; P[2]	•		•
Cercomela sinuata	Sickle-winged Chat	Endemic; P[2]	•		
Myrmecocichla formicivora	Anteating Chat	Endemic; P[2]	•		•
Saxicola torquatus	African Stonechat	P[2]		•	
Cossypha caffra	Cape Robin-Chat	P[2]			
Cercotrichas coryphoeus	Karoo Scrub-Robin	Endemic; P[2]	•	•	•
Cercotrichas paena	Kalahari Scrub-Robin	Near-endemic; P[2]			
Hippolais icterina	Icterine Warbler	P[2]			
Phylloscopus trochilus	Willow Warbler	P[2]			
Eremomela icteropygialis	Yellow-bellied Eremomela	P[2]	•		
Acrocephalus gracilirostris	Lesser Swamp-Warbler	P[2]			
Acrocephalus baeticatus	African Reed-Warbler	P[2]			
Euryptila subcinnamomea	Cinnamon-breasted Warbler	Endemic; P[2]		•	•
Malcorus pectoralis	Rufous-eared Warbler	Endemic; P[2]	•		•
Sylvietta rufescens	Long-billed Crombec	P[2]	•	•	
Eremomela gregalis	Karoo Eremomela	Endemic; P[2]	•		
Cisticola juncidis	Zitting Cisticola	P[2]			
Cisticola aridulus	Desert Cisticola	P[2]			
Cisticola subruficapilla	Grey-backed Cisticola	Near-endemic; P[2]	•		
Cisticola tinniens	Levaillant's Cisticola	P[2]			

Scientific Name	Common Name	Conservation Status	SABAP2	2009	2012
Prinia maculosa	Karoo Prinia	Endemic; P2			
Prinia flavicans	Black-chested Prinia	Near-endemic; P2	•		
Phragmacia substriata	Namaqua Warbler	Endemic; P2			
Muscicapa striata	Spotted Flycatcher	P2			
Parisoma subcaeruleum	Chestnut-vented Tit-Babbler	Near-endemic; P2			
Parisoma layardi	Layard's Tit-Babbler	Endemic; P2			
Bradornis mariquensis	Marico Flycatcher	Near-endemic; P2			
Bradornis infuscatus	Chat Flycatcher	Near-endemic; P2	•		
Sigelus silens	Fiscal Flycatcher	Endemic; P2			
Zosterops pallidus	Orange River White-eye	Endemic; P2		•	
Batis pririt	Pririt Batis	Near-endemic; P2		•	
Stenostira scita	Fairy Flycatcher	Endemic; P2	•		
Motacilla aguimp	African Pied Wagtail	P2			
Motacilla capensis	Cape Wagtail	P2			
Anthus cinnamomeus	African Pipit	P2			
Anthus pseudosimilis	Kimberley Pipit	Endemic; P2			
Anthus similis	Long-billed Pipit	P2			
Anthus crenatus	African Rock Pipit	Endemic; P2			
Lanius minor	Lesser Grey Shrike	P2			
Lanius collaris	Common Fiscal	P2	•	•	
Lanius collurio	Red-backed Shrike	P2			
Laniarius atrococcineus	Crimson-breasted Shrike	Near-endemic; P2			
Telophorus zeylonus	Bokmakierie	Near-endemic; P2	•		•
Nilaus afer	Brubru	P2			
Sturnus vulgaris	Common Starling				
Creatophora cinerea	Wattled Starling	P2			
Lamprotornis nitens	Cape Glossy Starling	P2			
Onychognathus nabouroup	Pale-winged Starling	Near-endemic; P2	•	•	•
Nectarinia famosa	Malachite Sunbird	P2			
Cinnyris chalybeus	Southern Double-collared Sunbird	Endemic			
Cinnyris fuscus	Dusky Sunbird	Near-endemic	•	•	•
Plocepasser mahali	White-browed Sparrow-Weaver	P2	•		
Philetairus socius	Sociable Weaver	Endemic; P2	•	•	•
Passer domesticus	House Sparrow				
Passer motitensis	Great Sparrow	Near-endemic; P2			
Passer melanurus	Cape Sparrow	Near-endemic	•		
Passer diffusus	Southern Grey-headed Sparrow	P2			
Sporopipes squamifrons	Scaly-feathered Finch	Near-endemic; P2	•		•
Ploceus capensis	Cape Weaver	Endemic			
Ploceus velatus	Southern Masked-Weaver		•		
Quelea quelea	Red-billed Quelea				
Euplectes orix	Southern Red Bishop				

Scientific Name	Common Name	Conservation Status	SABAP2	2009	2012
Amadina erythrocephala	Red-headed Finch	Near-endemic; P2	•		
Pytilia melba	Green-winged Pytilia	P2			
Lagonosticta senegala	Red-billed Firefinch	P2			
Estrilda astrild	Common Waxbill	P2	•		
Vidua macroura	Pin-tailed Whydah	P2			
Serinus canicollis	Cape Canary	Endemic; P2			
Crithagra atrogularis	Black-throated Canary	P2			
Serinus alario	Black-headed Canary	Endemic; P2	•		•
Crithagra albogularis	White-throated Canary	Near-endemic; P2	•		•
Crithagra flaviventris	Yellow Canary	Near-endemic; P2	•		
Emberiza impetuani	Lark-like Bunting	Near-endemic; P2	•		
Emberiza tahapisi	Cinnamon-breasted Bunting	P2			
Emberiza capensis	Cape Bunting	Near-endemic; P2	•		•
Totals			**65**	**28**	**32**

#Conservation Status defined under various levels of importance/sensitivity, namely:

- Red Data species as defined according to the IUCN (2013) categories, ie CR (Critically Endangered), EN (Endangered), VU (Vulnerable), NT (Near Threatened) and DD (Data Deficient) (see IUCN definitions under Section 1.2.2 International Standards and Policies);
- CITES – refers Convention on International Trade of Endangered Species according to the relevant CITES appendices, CI (Appendix I), CII (Appendix II) and CIII (Appendix III) (see CITES definitions under Section 1.2.2 International Standards and Policies);
- P1 – refers to "Specially Protected" as listed under Schedule 1 of the Northern Cape Nature Conservation Act (Act 9 of 2009);
- P2 – refers to "Protected" as listed under Schedule 2 of the Northern Cape Nature Conservation Act (Act 9 of 2009); and
- RR – refers to range restricted, ie species with limited distribution ranges, restricted to part of the Northern Cape.
- Endemic refers to species with distributions confined to South Africa; and
- Near-endemic refers to species with distribution largely confined to South Africa.

APPENDIX 2.5: Regional list of mammals potentially occurring at Gamsberg, including species recorded at Gamsberg during the 1999, May 2009 and November 2012 surveys (Friedman and Daly, 2004)

Family	Scientific Name	Common Name	Conservation Status #	1999	2009	2012
Soricidae	*Crocidura cyanea*	Reddish-grey Musk Shrew	RD DD; P[2]			
Soricidae	*Crocidura hirta*	Lesser Red Musk Shrew	RD DD; P[2]			
Macroscelididae	*Elephantulus edwardii*	Cape Rock Elephant-shrew	Endemic; P[2]			
Macroscelididae	*Elephantulus rupestris*	Western Rock Elephant-shrew	P[2]	•		•
Macroscelididae	*Macroscelides proboscideus*	Round-eared Elephant-shrew	P[2]	•		
Vespertilioidae	*Neoromicia capensis*	Cape Serotine Bat	P[2]			
Vespertilioidae	*Eptesicus hottentotus*	Long-tailed Serotine Bat	P[2]			
Vespertilioidae	*Cistugo seabrai*	Angola Wing-gland Bat	RD VU; P[2]			
Vespertilioidae	*Pipistrellus rueppelli*	Rüppel's Pipistrelle	P[2]			
Miniopteridae	*Miniopterus natalensis*	Natal Long-fingered Bat	NT			
Nycteridae	*Nycteris thebaica*	Egyptian Slit-faced Bat	P[2]			
Rhinolophidae	*Rhinolophus capensis*	Cape Horseshoe Bat	RD NT; Endemic; P[2]	•		
Rhinolophidae	*Rhinolophus clivosus*	Geoffroy's Horseshoe Bat	RD NT; P[2]			
Rhinolophidae	*Rhinolophus darlingi*	Darling's Horseshoe Bat	RD NT; P[2]		•	
Rhinolophidae	*Rhinolophus denti*	Dent's Horseshoe Bat	RD NT; P[2]			
Molossidae	*Sauromys petrophilus*	Robert's Flat-headed Bat	P[2]	•		
Molossidae	*Tadarida aegyptiaca*	Egyptian Free-tailed Bat	P[2]			
Cercopithecidae	*Cercopithecus aethiops*	Vervet Monkey				
Cercopithecidae	*Papio ursinus*	Chacma Baboon		•		•
Leporidae	*Lepus capensis*	Cape Hare	P[2]			
Leporidae	*Lepus saxatilis*	Scrub Hare	P[2]	•	•	•
Leporidae	*Pronolagus rupestris*	Smith's Red Rock Rabbit	P[2]	•		•
Bathyergidae	*Cryptomys damarensis*	Damara Molerat	P[2]			
Gliridae	*Graphiurus platyops*	Rock Dormouse	RD DD; P[2]			
Gliridae	*Graphiurus ocularis*	Spectacled Dormouse	Endemic; P[2]			
Hystricidae	*Hystrix africaeaustralis*	Porcupine	P[2]	•	•	•
Pedetidae	*Pedetes capensis*	Springhare	P[2]	•		•
Petromuridae	*Petromus typicus*	Dassie Rat	RD NT; P[2]	•	•	•

Family	Scientific Name	Common Name	Conservation Status #	1999	2009	2012
Scuridae	*Xerus inauris*	Cape Ground Squirrel	P[2]	•		
Muridae	*Aethomys namaquensis*	Namaqua Rock Mouse	P[2]	•		•
Muridae	*Mus minutoides*	Pygmy Mouse	P[2]			
Muridae	*Mus musculus*	House Mouse				
Muridae	*Rhabdomys pumilio*	Striped Mouse	P[2]	•		
Muridae	*Thallomys nigricauda*	Black- tailed Tree Rat	P[2]			
Muridae	*Thallomys paedulcus*	Tree Rat	P[2]			
Cricetidae	*Desmodillus auricularis*	Short-tailed Gerbil	P[2]	•		•
Cricetidae	*Gerbillurus paeba*	Hairy-footed Gerbil	P[2]	•		
Cricetidae	*Gerbillurus vallinus*	Brush-tailed Hairy-footed Gerbil	P[2]			
Cricetidae	*Malacothrix typica*	Large-eared Mouse	P[2]			
Cricetidae	*Otomys unisulcatus*	Karoo Bush Rat	P[2]			•
Cricetidae	*Parotomys brantsii*	Brant's Whistling Rat	P[2]			
Cricetidae	*Parotomys littledalei*	Littledale's Whistling Rat	RD NT; P[2]	•		
Cricetidae	*Petromyscus collinus*	Pygmy Rock Mouse	P[2]	•		
Cricetidae	*Saccostomus campestris*	Pouched Mouse	P[2]			
Cricetidae	*Tatera brantsii*	Highveld Gerbil	P[2]			
Cricetidae	*Tatera leucogaster*	Bushveld Gerbil	RD DD; P[2]			
Manidae	*Manis temminckii*	Pangolin	RD VU			
Hyaenidae	*Hyaena brunnea*	Brown Hyaena	RD NT; P[1]			•*
Hyaenidae	*Proteles cristatus*	Aardwolf				
Felidae	*Caracal caracal*	Caracal		•		
Felidae	*Felis silvestris*	African Wild Cat	P[1]	•		•
Felidae	*Felis nigripes*	Small Spotted Cat	P[1]			
Felidae	*Panthera pardus*	Leopard				•*
Canidae	*Canis mesomelas*	Black-backed Jackal		•		
Canidae	*Otocyon megalotis*	Bat-eared Fox	P[1]	•		
Canidae	*Vulpes chama*	Cape Fox	P[1]	•		
Mustelidae	*Ictonyx striatus*	Striped Polecat	P[1]			•

Family	Scientific Name	Common Name	Conservation Status #	1999	2009	2012
Mustelidae	*Melivora capensis*	Honey Badger	RD NT; P1			
Viverridae	*Cynictis penicillata*	Yellow Mongoose	P2			
Viverridae	*Galerella pulverulenta*	Small Grey Mongoose	P2			•
Viverridae	*Galerella sanguinea*	Slender Mongoose	P2	•		
Viverridae	*Genetta genetta*	Small Spotted Genet	P2	•		•
Viverridae	*Suricata suricatta*	Suricate	P2			
Viverridae	*Atilax paludinosus*	Water Mongoose	P2	•		
Orycteropodidae	*Orycteropus afer*	Aardvark		•		•
Procaviidae	*Procavia capensis*	Rock Dassie	P2	•		•
Bovidae	*Antidorcas marsupialis*	Springbok	P2			•
Bovidae	*Oreotragus oreotragus*	Klipspringer	P2	•	•	•
Bovidae	*Oryx gazella*	Gemsbok	P2			
Bovidae	*Rhaphicerus campestris*	Steenbok	P2	•		•
Bovidae	*Sylvicapra grimmia*	Common Duiker	P2	•		
Bovidae	*Tragelaphus strepsiceros*	Kudu	P2			
Totals				**30**	**5**	**21**

* Incidental reports recorded during the 2012 survey

Conservation Status defined under various levels of importance/sensitivity, namely:

- Red Data species as defined according to the IUCN (2013) categories, ie CR (Critically Endangered), EN (Endangered), VU (Vulnerable), NT (Near Threatened) and DD (Data Deficient) (see IUCN definitions under Section 1.2.2 International Standards and Policies);
- CITES – refers Convention on International Trade of Endangered Species according to the relevant CITES appendices, CI (Appendix I), CII (Appendix II) and CIII (Appendix III) (see CITES definitions under Section 1.2.2 International Standards and Policies);
- P1 – refers to "Specially Protected" as listed under Schedule 1 of the Northern Cape Nature Conservation Act (Act 9 of 2009);
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- RR – refers to range restricted, ie species with limited distribution ranges, restricted to part of the Northern Cape.
- Endemic refers to species with distributions confined to South Africa; and
- Near-endemic refers to species with distribution largely confined to South Africa.

APPENDIX 2.6: Selection of Photographic Data obtained from the Camera Traps

Northen Plains Washout from Main Kloof

Klipspringer (*Oreotragus oreotragus*)

Small Grey Mongoose (*Galerella pulverulenta*)

Main Kloof

Porcupine (*Hystrix africaeaustralis*)

Small Grey Mongoose (*Galerella pulverulenta*)

Settling ponds on northern plain

Aardvark (*Orycteropus afer*)

Entrance to the kloof

Small Grey Mongoose (*Galerella pulverulenta*)

Washout from south-western slopes

African Wild Cat (*Felis silvestris*)

Porcupine (*Hystrix africaeaustralis*)

Washout from south-western slopes

Small Grey Mongoose (*Galerella pulverulenta*)

Central basin

Small Spotted Genet (*Genetta genetta*)

Southern slopes, near spring

Klipspringer (*Oreotragus oreotragus*)

Chacma Baboon (*Papio ursinus*)

Southern slopes, near spring

Small Grey Mongoose (*Galerella pulverulenta*)

Rock Dassie (*Procavia capensis*)

APPENDIX 3

Addendum Information Pertaining to Aquatic Ecology and Biodiversity

APPENDIX 3.1: Water quality results from the Gamsberg River (sample taken during the 2009 survey)

Site number	Description	Biodiversity component	Latitude	Longitude
AQ01	South-eastern spring	Diatoms	-29.25103	19.01094
AQ02	Southern spring	Diatoms	-29.26405	18.99593
AQ03	Gamsberg River	Water quality/SASS5/Diatoms	-29.23287	18.98084
AQ04	Gamsberg spring	Diatoms	-29.23847	18.97955

APPENDIX 3.2: Water quality results from the Gamsberg River (sample taken during the 2009 survey)

Parameter	Units	Site AQ03
Alkalinity	mg $CaCO_3$/L	<10.0
pH	pH units	6.68
Nitrate (soluble)	mg N/L	<0.5
Nitrite (soluble)	mg N/L	<0.5
Ammonia (soluble)	mg N/L	<0.5
Soluble Reactive Phosphate	µg P/L	<100
Phosphate	µg P/L	5010

APPENDIX 3.3: Full species lists of all diatom taxa recorded from the various aquatic sites assessed during May 2009 and November 2012

Taxon	2009				2012		
	Site 1	Site 2	Site 3	Site 4	Site 1	Site 3	Site 4
Achnanthidium exiguum (Grunow) Czarnecki		2	10		1		
Achnanthidium minutissimum (Kützing) Czarnecki	1	6	2	4		1	
Achnanthidium *sp.*					172		1
Amphora veneta Kützing	1		29			13	
Craticula buderi (Hustedt) Lange-Bertalot	2						
Craticula molestiformis (Hustedt) Lange-Bertalot				3			
Cyclotella meneghiniana Kützing			263				
Cymbella kolbei Hustedt			1				
Eolimna minima (Grunow) Lange-Bertalot		171	12	170	31		212
Eolimna subminuscula (Manguin) Moser, Lange-Bertalot and Metzeltin			1	1		1	2
Fistulifera saprophila (Lange-Bertalot and Bonik) Lange-Bertalot			342				
Fragilaria biceps (Kützing) Lange-Bertalot	3	8		1			
Fragilaria rumpens (Kützing) G.W.F.Carlson							
Fragilariasp.	5						
Fragilaria tenera (W.Smith) Lange-Bertalot			1				
Gomphonema parvulum (Kützing) Kützing	86	49	2		63	1	6
Gomphonema parvulum var.*parvulum* f.*saprophilum* Lange-Bert. and Reichardt	4			4			
Gomphonema pumilum (Grunow) Reichardt and Lange-Bertalot				4			
Gomphonema *sp.*			1				
Mayamaea atomus var. *permitis* (Hustedt) Lange-Bertalot				2	4	2	2
Navicula cryptocephala Kützing			26				1
Navicula lepidula Grunow		17	1				
Navicula riediana Lange-Bertalot and Rumrich			2				
Navicula schroeteri Meister				1			
Naviculasp.		1		1			
Navicula veneta Kützing			3			1	
Nitzschia acidoclinata Lange-Bertalot	1	1					
Nitzschia amphibia Grunow			3				
Nitzschia frustulum (Kützing) Grunow				4			
Nitzschia pusilla(Kützing)Grunow	4						
Nitzschiasp.	10	1	11		31	33	1
Pinnularia graciloides Hustedt		7					
Pinnulariasp.?	11						
Pinnularia subbrevistriata Krammer	17	1					
Planothidium engelbrechtii (Cholnoky) Round and Bukhtiyarova	152			190			119
Planothidium frequentissimum (Lange-Bertalot) Lange-Bertalot		1			47		
Rhopalodia gibba (Ehrenberg) O.Müller			33			4	
Sellaphora seminulum (Grunow) D.G. Mann	107	134	1	19	47		52
Tryblionella debilis Arnott		1					

APPENDIX 3.4: Summary of macro-invertebrate taxa recorded during the SASS5 sampling, May 2009 at Site AQ03 on the Gamsberg River

Order	Family	Species
Ephemeroptera	Baetidae	*Cloeon sp.*
Ephemeroptera	Caenidae	*Caenis sp.*
Odonata	Aeshnidae	*Aeshna sp.*
Odonata	Aeshnidae	*Anax sp.*
Odonata	Libellulidae	*Orthetrum sp.*
Odonata	Libellulidae	*Philomon luminans*
Odonata	Libellulidae	*Trithemis sp.*
Hemiptera	Corixidae	*Sigara sp.*
Hemiptera	Gerridae	*Gerris swakopensis*
Hemiptera	Naucoridae	*Laccocoris sp.*
Hemiptera	Notonectidae	*Anisops sp*
Coleoptera	Dytiscidae	
Coleoptera	Elmidae/Dryopidae	
Diptera	Chironomidae	Chirnomominae sp.
Diptera	Chironomidae	Orthocladiinae sp.
Diptera	Culicidae	*Uranotaenia sp.*
Diptera	Tabanidae	
Gastropoda	Planorbidae	*Bulinus tropicus*

APPENDIX 4

Addendum Information Pertaining to the Evaluation of Fauna and Faunal Habitats

APPENDIX 4.1: Evaluation of terrestrial invertebrate species recorded in the Gamsberg Study Area during the May 2009 and November 2012 surveys

Species & common name	Cons. Status #	Habitats* that will be lost			Habitats* that will be affected			Unaffected habitats*		
		H1	H2	H3	H1	H2	H3	H1	H2	H3
Camponotus AFRC-ZA-52	RD (VU/DD); RR	•	•		•	•			•	
Messor AFRC-ZA-01	RD (CR/DD); RR		•			•				

* Habitats are grouped according to those that are Irreplaceable (H1), Constrained (H2) and Flexible (H3).

Conservation Status defined under various levels of importance/sensitivity, namely:

- RD – refers to Red Data species as defined according to the IUCN (2013) categries, CR (Critically Endangered), EN (Endangered), VU (Vulnerable), NT (Near Threatened) and DD (Data Deficient) (see IUCN definitions under Section 1.2.2 International Standards and Policies); Status shown here is bracketed to emphasise that a forma assessment has not yet been carried out but that based on current data, the indicated results would be expected from such an evaluation.
- RR – refers to range restricted, ie species with limited distribution ranges, restricted to part of the Northern Cape.

APPENDIX 4.2: Evaluation of Frog Species Recorded in the Gamsberg Study Area during the May 2009 and November 2012 surveys

Species & common name	Cons. Status #	Habitats* that will be lost			Habitats* that will be affected			Unaffected habitats*		
		H1	H2	H3	H1	H2	H3	H1	H2	H3
Vandijkophrynus robinsoni Paradise Toad	RR	•	•	•	•	•	•		•	•
Phrynomantis annectens Marbled Rubber Frog		•	•		•	•			•	
Strongylopus springbokensis Namaqua Stream Frog	RR	•	•		•	•			•	
Tomopterna delalandii Cape Sand Frog		•	•	•	•	•	•		•	•
Cacosternum namaquense Namaqua Caco	RR	•	•		•	•			•	

* Habitats are grouped according to those that are Irreplaceable (H1), Constrained (H2) and Flexible (H3).

Conservation Status defined under various levels of importance/sensitivity, namely:

- RD – refers to Red Data species as defined according to the IUCN (2013) categries, CR (Critically Endangered), EN (Endangered), VU (Vulnerable), NT (Near Threatened) and DD (Data Deficient) (see IUCN definitions under Section 1.2.2 International Standards and Policies);
- E – refers to endemic, with distribution confined to South Africa;
- NE – refers to near-endemic, with distribution largely confined to South Africa;
- RR – refers to range restricted, ie species with limited distribution ranges, restricted to part of the Northern Cape.

APPENDIX 4.3: Evaluation of Reptile Species Recorded in the Gamsberg Study Area during the May 2009 and November 2012 surveys

Species & common name	Cons. Status #	Habitats* that will be lost			Habitats* that will be affected			Unaffected habitats*		
		H1	H2	H3	H1	H2	H3	H1	H2	H3
Acontia stristis Namaqua Dwarf Legless Skink	E			•			•			•
Trachylepis occidentalis Western Three-striped Skink				•			•			•
Trachylepis sulcata Western Rock Skink			•			•			•	
Trachylepis variegata Variegated Skink			•			•			•	
Agama anchietae Anchieta's Agama			•			•			•	
Chondrodactylus angulifer Giant Ground Gecko				•			•			•
Chondrodactylus bibronii Bibron's Gecko			•		•	•		•	•	
Goggia lineata Striped Dwarf Leaf-toed Gecko			•	•		•	•		•	•
Pachydactylus goodi Good's Gecko	RD VU; E; RR	•	•		•	•		•	•	
Pachydactylus haackei Haacke's Gecko	E; RR	•	•		•	•		•	•	
Pachydactylus latirostris Quartz Gecko				•			•			•
Pachydactylus montanus Namaqua Mountain Gecko	RR	•	•		•	•		•	•	
Pachydactylus rugosus Rough-skinned Gecko				•			•			•
Ptenopus garrulous maculatus Barking Gecko				•			•			•
Karusasaurus polyzonus Karoo Girdled Lizard			•		•	•		•	•	
Pedioplanis inornata Plain Sand Lizard			•	•		•	•		•	•
Pedioplanis namaquensis Namaqua Sand Lizard				•			•			•
Rhinotyphlops schinzi Schinz's Beaked Blind Snake			•	•		•	•		•	•
Psammophis notostictus Karoo Sand Snake				•			•			•
Telescopus beetzi Beetz's Tiger Snake			•	•		•	•		•	•
Aspidelaps lubricus Coral Shield Cobra		•	•	•	•	•	•	•	•	•
Naja nigricollis woodi Black Spitting Cobra		•	•		•	•		•	•	
Naja nivea Cape Cobra			•	•		•	•		•	•
Bitis xeropaga Desert Mountain Adder	RR		•			•			•	
Psammobates tentorius Tent Tortoise			•	•		•	•		•	•

* Habitats are grouped according to those that are Irreplaceable (H1), Constrained (H2) and Flexible (H3).

#Conservation Status defined under various levels of importance/sensitivity, namely:

- RD – refers to Red Data species as defined according to the IUCN (2013) categries, CR (Critically Endangered), EN (Endangered), VU (Vulnerable), NT (Near Threatened) and DD (Data Deficient) (see IUCN definitions under Section 1.2.2 International Standards and Policies);
- E – refers to endemic, with distribution confined to South Africa;
- NE – refers to near-endemic, with distribution largely confined to South Africa;
- RR – refers to range restricted, ie species with limited distribution ranges, restricted to part of the Northern Cape.

APPENDIX 4.4: Evaluation of Bird Species potentially occurring at Gamsberg, including data from the South African Bird Atlas Project 2 (SABAP2) and species recorded during the May 2009 and November 2012 surveys (Barnes, 2000)

Species & common name	Cons. Status #	Habitats* that will be lost			Habitats* that will be affected			Unaffected habitats*		
		H1	H2	H3	H1	H2	H3	H1	H2	H3
Tadorna cana South African Shelduck					•			•		
Falco biarmicus Lanner Falcon	RD NT	•	•	•	•	•	•	•	•	•
Falco rupicoloides Greater Kestrel		•	•	•	•	•	•	•	•	•
Falco rupicolus Rock Kestrel		•	•	•	•	•	•	•	•	•
Aquila verreauxii Verreaux's Eagle		•	•		•	•		•	•	
Polemaetus bellicosus Martial Eagle	RD VU		•	•		•	•		•	•
Circaetus pectoralis Black-chested Snake-Eagle				•			•			•
Buteo rufofuscus Jackal Buzzard	E	•	•		•	•		•	•	
Melierax canorus Southern Pale Chanting Goshawk	NE			•			•			•
Neotis ludwigii Ludwig's Bustard	RD VU; NE			•			•			•
Eupodotis vigorsii Karoo Korhaan	E			•			•			•
Afrotis afraoides Northern Black Korhaan	E			•			•			•
Vanellus coronatus Crowned Lapwing				•			•			•
Pterocles namaqua Namaqua Sandgrouse	NE			•			•			•
Columba guinea Speckled Pigeon		•	•		•	•		•	•	
Streptopeliacapicola Cape Turtle-Dove		•	•	•	•	•	•	•	•	•
Streptopelia senegalensis Laughing Dove		•	•	•	•	•	•	•	•	•
Oena capensis Namaqua Dove		•	•	•	•	•	•	•	•	•
Bubo capensis Cape Eagle-Owl		•	•		•	•		•	•	
Apus affinis Little Swift		•	•	•	•	•	•	•	•	•
Tachymarptis melba Alpine Swift		•	•	•	•	•	•	•	•	•
Colius colius White-backed Mousebird	E	•	•	•	•	•	•	•	•	•
Tricholae maleucomelas Acacia Pied Barbet	NE	•	•	•	•	•	•	•	•	•
Certhilauda subcoronata Karoo Long-billed Lark	E			•			•			•
Calendulauda africanoides Fawn-coloured Lark				•			•			•
Mirafra apiata	E		•	•		•	•		•	•

Species & common name	Cons. Status #	Habitats* that will be lost			Habitats* that will be affected			Unaffected habitats*		
		H1	H2	H3	H1	H2	H3	H1	H2	H3
Cape Clapper Lark										
Calendulauda sabota Sabota Lark	NE			•			•			•
Chersomanes albofasciata Spike-heeled Lark	NE		•	•		•	•		•	•
Calendulauda burra Red Lark	RD VU; E; RR						•			•
Eremopterix verticalis Grey-backed Sparrowlark	NE			•			•			•
Eremopterix australis Black-eared Sparrowlark	E			•			•			•
Spizocorys starki Stark's Lark	NE			•			•			•
Hirundo rustica Barn Swallow		•	•	•	•	•	•	•	•	•
Hirundo fuligula Rock Martin		•	•		•	•		•	•	
Parus cinerascens Ashy Tit	NE	•	•	•	•	•	•	•	•	•
Corvus albus Pied Crow		•	•	•	•	•	•	•	•	•
Corvus capensis Cape Crow				•			•			•
Parus afer Grey Tit	E	•	•	•	•	•	•	•	•	•
Anthoscopus minutus Cape Penduline-Tit	NE	•	•	•	•	•	•	•	•	•
Zosterops pallidus Orange River White-eye	E	•	•	•	•	•	•	•	•	•
Pycnonotus nigricans African Red-eyed Bulbul	NE	•	•	•	•	•	•	•	•	•
Monticola brevipes Short-toed Rock-Thrush	NE	•	•		•	•		•	•	
Oenanthe monticola Mountain Wheatear	NE	•	•		•	•		•	•	
Cercomela schlegelii Karoo Chat	NE		•	•		•	•		•	•
Oenanthe pileata Capped Wheatear				•			•			•
Cercomela familiaris Familiar Chat		•	•	•	•	•	•	•	•	•
Cercomela tractrac Tractrac Chat	NE			•			•			•
Cercomela sinuata Sickle-winged Chat	E		•	•		•	•		•	•
Myrmecocichla formicivora Anteating Chat	E			•			•			•
Saxicola torquatus African Stonechat		•	•	•	•	•	•	•	•	•
Cossypha caffra Cape Robin-Chat		•	•	•	•	•	•	•	•	•
Cercotrichas coryphoeus Karoo Scrub-Robin	E	•	•	•	•	•	•	•	•	•
Eremomela icteropygialis Yellow-bellied Eremomela		•	•	•	•	•	•	•	•	•
Euryptila subcinnamomea	E	•	•		•	•		•	•	

Species & common name	Cons. Status #	Habitats* that will be lost			Habitats* that will be affected			Unaffected habitats*		
		H1	H2	H3	H1	H2	H3	H1	H2	H3
Cinnamon-breasted Warbler										
Malcorus pectoralis Rufous-eared Warbler	E		•	•		•	•		•	•
Sylvietta rufescens Long-billed Crombec			•	•		•	•		•	•
Eremomela gregalis Karoo Eremomela	E			•			•			•
Cisticola subruficapilla Grey-backed Cisticola	NE		•	•		•	•		•	•
Prinia flavicans Black-chested Prinia	NE			•			•			•
Bradornis infuscatus Chat Flycatcher	NE		•	•		•	•		•	•
Batis pririt Pririt Batis	NE		•	•		•	•		•	•
Stenostira scita Fairy Flycatcher	E	•	•	•	•	•	•		•	•
Lanius collaris Common Fiscal		•	•	•	•	•	•		•	•
Telophorus zeylonus Bokmakierie	NE	•	•	•	•	•	•		•	•
Onychognathus nabouroup Pale-winged Starling	NE		•			•			•	
Cinnyris fuscus Dusky Sunbird	NE	•	•	•	•	•	•		•	•
Plocepasser mahali White-browed Sparrow-Weaver			•	•		•	•		•	•
Philetairus socius Sociable Weaver	E		•	•		•	•		•	•
Passer melanurus Cape Sparrow	NE	•	•		•	•		•	•	
Sporopipes squamifrons Scaly-feathered Finch	NE			•		•	•	•	•	•
Ploceus velatus Southern Masked-Weaver		•	•		•	•		•	•	
Amadina erythrocephala Red-headed Finch				•			•			•
Estrilda astrild Common Waxbill			•			•			•	
Serinus alario Black-headed Canary	E	•	•	•	•	•	•		•	•
Crithagra albogularis White-throated Canary	NE		•	•		•	•		•	•
Crithagra flaviventris Yellow Canary	NE			•			•			•
Emberiza impetuani Lark-like Bunting	NE			•			•			•
Emberiza capensis Cape Bunting	NE		•		•	•		•	•	

* Habitats are grouped according to those that are Irreplaceable (H1), Constrained (H2) and Flexible (H3).

Conservation Status defined under various levels of importance/sensitivity, namely:

- RD – refers to Red Data species as defined according to the IUCN (2013) categries, CR (Critically Endangered), EN (Endangered), VU (Vulnerable), NT (Near Threatened) and DD (Data Deficient) (see IUCN definitions under Section 1.2.2 International Standards and Policies);
- E – refers to endemic, with distribution confined to South Africa;

- NE – refers to near-endemic, with distribution largely confined to South Africa;
- RR – refers to range restricted, ie species with limited distribution ranges, restricted to part of the Northern Cape.

APPENDIX 4.5: Evaluation of Mammal Species Recorded in the Gamsberg Study Area

Species & common name	Cons. Status #	Habitats# that will be lost			Habitats that will be affected			Unaffected habitats		
		H1	H2	H3	H1	H2	H3	H1	H2	H3
Elephantulus rupestris Western Rock Elephant-shrew			•			•			•	
Macroscelides proboscideus Round-eared Elephant-shrew			•	•		•	•		•	•
Rhinolophus capensis Cape Horseshoe Bat	RD NT; E	•	•		•	•		•	•	
Rhinolophus darlingi Darling's Horseshoe Bat	RD NT	•	•		•	•		•	•	
Sauromys petrophilus Robert's Flat-headed Bat		•	•		•	•		•	•	
Papio ursinus Chacma Baboon		•	•		•	•		•	•	
Lepus saxatilis Scrub Hare			•	•		•	•		•	•
Pronolagus rupestris Smith's Red Rock Rabbit			•			•			•	
Hystrix africaeaustralis Porcupine			•	•	•	•	•	•	•	•
Pedetes capensis Springhare				•			•			•
Petromus typicus Dassie Rat	RD NT	•	•		•	•		•	•	
Xerus inauris Cape Ground Squirrel			•	•		•	•		•	•
Aethomys namaquensis Namaqua Rock Mouse		•	•	•	•	•	•	•	•	•
Rhabdomys pumilio Striped Mouse		•	•	•	•	•	•	•	•	•
Desmodillus auricularis Short-tailed Gerbil			•	•		•	•		•	•
Gerbillurus paeba Hairy-footed Gerbil			•	•		•	•		•	•
Otomys unisulcatus Karoo Bush Rat	E		•	•		•	•		•	•
Parotomys littledalei Littledale's Whistling Rat	RD NT			•			•			•
Petromyscus collinus Pygmy Rock Mouse			•			•			•	
Hyaena brunnea Brown Hyaena	RD NT			•			•			•
Caracal caracal Caracal		•	•	•	•	•	•	•	•	•
Felis silvestris African Wild Cat		•	•	•	•	•	•	•	•	•
Panthera pardus Leopard		•	•		•	•		•	•	
Canis mesomelas Black-backed Jackal			•	•		•	•		•	•
Otocyon megalotis Bat-eared Fox				•		•	•		•	•
Vulpes chama Cape Fox				•			•			•
Ictonyx striatus Striped Polecat		•	•	•	•	•	•	•	•	•

Species & common name	Cons. Status #	Habitats# that will be lost			Habitats that will be affected			Unaffected habitats		
		H1	H2	H3	H1	H2	H3	H1	H2	H3
Galerella pulverulenta Small Grey Mongoose		•	•	•	•	•	•	•	•	•
Galerella sanguinea Slender Mongoose		•	•	•	•	•	•	•	•	•
Genetta genetta Small Spotted Genet					•	•		•	•	
Atilax paludinosus Water Mongoose					•			•		
Orycteropus afer Aardvark				•			•			•
Procavia capensis Rock Dassie		•	•		•	•		•	•	
Antidorcas marsupialis Springbok				•			•			•
Oreotragus oreotragus Klipspringer		•	•	•	•	•	•	•	•	•
Rhaphicerus campestris Steenbok				•			•			•
Sylvicapra grimmia Common Duiker				•			•			•

* Habitats are grouped according to those that are Irreplaceable (H1), Constrained (H2) and Flexible (H3).

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- RD – refers to Red Data species as defined according to the IUCN (2013) categries, CR (Critically Endangered), EN (Endangered), VU (Vulnerable), NT (Near Threatened) and DD (Data Deficient) (see IUCN definitions under Section 1.2.2 International Standards and Policies);
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