FAUNA AND FLORA REPORT

FOR THE

VALENCIA URANIUM MINE

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EXECUTIVE SUMMARY

Digby Wells and Associates (DWA) was appointed by Valencia Uranium Limited as an independent environmental consultant to investigate the social and environmental aspects of the proposed Valencia Uranium Mine in Namibia for inclusion in the Environmental Impact Assessment (EIA) and Environmental Management Plan (EMP) Reports. The proposed Valencia mine site occurs in central-west Namibia, about 55 km south-south-west of the town of Usakos and about 80 km east of Swakopmund in a straight line. The uranium ore body is relatively shallow, exposed at certain localities, and therefore will be mined using open pit methods. Proposed associated activities include the processing of ore on site, the creation of a tailings dump, waste rock dumps, the temporary stockpiling of low grade ore, the construction of offices, the construction of an acid plant, the construction of a water reservoir, the construction and operation of haul roads and the development of a route through the Khan River valley. The expected life of mine is 11 years.

The area of interest falls within the semi-desert and savanna transition area contained within the Desert biome, here water scarcity and extreme temperatures are some of the major factors for plants and animals to adapt to. The area is still in a relatively natural state with pressure from livestock grazing in certain areas exacerbating the poor grass conditions resulting from the low rainfall recorded over the past year. The current prospecting activities have also had some smaller impacts on the flora and fauna in the area, as human activity in general disturbs wild animals, and unwise off-road travelling is evident in places.

Vegetation is fairly typical for the semi-desert and savanna transition area. A total of 29 species were recorded in the area during a survey from 23 -27 October 2007, which included 15 trees or shrubs, 8 grasses, 4 succulent species, a single herb and a single parasitic plant. The low number of species is attributed to the timing of the survey which was conducted during a very dry time of year after a previous year of low rainfall. All of these species were encountered on previous surveys by Strohbach, (2006), and Kolberg, (2007). Results from these previous studies have been incorporated into this report to gain a more holistic view of the area of concern, including the Exclusive Prospecting Licence (EPL) area, adjacent proposed infrastructure sites and the proposed access route through the Khan River valley. Records from these surveys, conducted during a relatively wet period, indicate a total species count of 152 plant species. A number of protected and endemic plant species were found on the site. These included species such as the quiver tree (*Aloe dichotoma*), Bushman's candle (*Sarcocaulon marlothii*), rock corkwood (*Commiphora saxicola*), slender corkwood (*Commiphora virgata*) and elephant's foot (*Adenia pechuelii*) were also recorded and these three species are near endemic. No IUCN threatened plant species were observed in the area. No alien

invasive or exotic species were recorded from the site during the survey, although alien invasive species have been recorded and removed in the past.

In accordance with Nature conservation ordinance (Ordinance 4 of 1975), the following species recorded during the site visit are protected under Namibian law. These are *Moringa ovalifolia*, all *Aloe* species and all *Hoodia* species.

A total of 21 mammals are known to occur within the EPL and surrounding areas. A single mammal, Hartman's mountain zebra (*Equus zebra*), is listed as endangered and also has a range restricted largely to Namibia. The remaining species all fall within the Lower Risk IUCN categories. Four species have been listed in the CITES database, and include Hartmann's mountain zebra, the caracal, the African wild cat and the chacma baboon.

The Atlas of Southern African Birds (Harrison et. al. 1997) lists 152 species with distribution ranges that include the proposed Project site. This does not necessarily suggest that all of these species will be present on the site as micro-habitats and food availability, for instance, might determine occurrence within that range. Although results from a short site survey should not be taken as an absolute species count, this information does provide an indication of site specific species richness and is therefore reported here. A total of 31 birds were observed within the mine area and surrounding areas. The lappet-face vulture was the only threatened bird species listed as vulnerable, however no sites of nesting were observed in the immediate area which suggests that the single specimen observed does not reside in the area. Three near-endemic bird species were observed, namely Ruppell's korhaan (*Eupodotis rueppellii*), Gray's lark (*Ammomanes grayi*) and the northern subspecies of the Karoo long-billed lark (*Certhilauda subcoronata damarensis*), all spotted in grassy plains. Near endemic species are restricted to southern Africa and therefore all these species have ranges extending beyond the area of interest. The remaining species are not threatened according to IUCN lists. Ten species have been listed in the CITES database.

According to Griffin (2005), 76 species of reptiles could occur in the region in which the proposed Valencia Project is located. During field surveys, the occurrence on site of twelve of these species was confirmed; four of which are endemic or near endemic to Namibia. A further eighteen species of reptile are expected to occur on site as these have been recorded in the near vicinity and or similar habitats elsewhere in the central Namib.

It is unlikely that any of the IUCN listed insects occur on site as all require permanent or intermittent water. Surface water availability on site is sporadic. A single endemic insect was observed on site, namely the stone grasshopper (Orthoptera: Lathiceridae). The species is a desert to semi-desert species, likely to have a preference for rocky areas where it is well camouflaged against the terrain. It

is therefore likely to have a range that extends through most of the transitional zone and the rockier areas in the desert biomes.

Several arachnids are endemic to Namibia. Those associated with the semi-desert and savanna transition zone are likely to occur in the area. Endemic species associated with the semi-desert and savanna transition zone includes one scorpion (*Opisthopthalmus intercedens*), two spiders (*Rastellus narubis* and *Theuma ababensis*) and one solifuge (*Blossia tricolor*).

No impacts on flora and fauna are expected to be of high significance and the main impacts of moderate significance are associated with vegetation removal, indirect effects of increased dust levels and emissions and the potential contamination of soils in the area through spillages of various effluents and/or chemicals and hydrocarbons. Although protected and endemic species were observed on site, many have ranges extending beyond the limited borders of the mine and for this reason impacts are not of high significance. The positioning of the tailings dam is on an undulating surface with a drainage line running through the site from south-east to north-west; this could pose a problem for water management.

No fatal flaws regarding flora and fauna have been identified for this site, but management recommendations should still be adhered to and conservation (intervention management) or preservation (isolation management) of flora and fauna should be considered during the remaining period of the exploration phase as well as for construction, operation and closure.

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1 INTRODUCTION

Digby Wells & Associates (DWA) was appointed by Valencia Uranium Limited as an independent environmental consultant to investigate the social and environmental aspects of the proposed Valencia Uranium Mine in Namibia for inclusion in the Environmental Impact Assessment (EIA) and Environmental Management Plan (EMP) Reports.

The data supplied in this study focused on flora, invertebrates, reptiles and mammals that occur in the area. A separate bird study was conducted by an external consultant (Dr. R.E. Simmons from the Fitzpatrick Institute, University of Cape Town) and findings from his study have been incorporated into this report. A separate reptile report was compiled by P. L. Cunningham from the Polytechnic of Namibia. Additional vegetation studies included a detailed botanical survey compiled by Strohbach and Christian (Eco.plan, 2006), a botanical impact assessment (Strohbach, 2006) and a survey of *Adenia pechuelii* at Valencia (Kolberg and Tholkes 2007a, 2007b). The studies by Kolberg and Tholkes have been included as appendices (Appendix G7 and G8).

These studies together will provide the baseline of the current ecological status of the area. The area currently has limited development, which is restricted to an exploration camp, a farmhouse with accompanying water reservoirs and roads, as well as a boundary and internal fences. The various activities proposed at Valencia mine include mechanised mining of the pit, processing of ore on site, stockpiling ore on site, development of a tailings dump, creation of waste rock dumps, construction of mine, administrative and ablution facilities, construction of an access road, an acid plant, water reservoirs, water and power supply lines. These activities, apart from power supply lines, have been considered when conducting impact assessments and formulating management plans to reduce risks and impacts on the flora and fauna.

The information from this report will feed into the relevant sections of the EIA/EMP reports.

2 SCOPE OF WORK

Digby Wells & Associates was appointed to conduct a fauna and flora investigation as one of the specialist studies required for inclusion in the EIA/EMP. This flora and fauna study included the following:

- A desktop vegetation study, which included:
    - Classification of the main biome and description of the dominant vegetation type;
    - Investigation of the dominant indigenous species within this region;
    - Listing the endemic species;
    - Listing the IUCN Red Data species; and
    - Determining the culturally significant species.
- A desktop invertebrate and mammal study, which included determining the:
    - Endemic species; and
    - IUCN Red Data species.
- Field surveys to:
    - Determine actual floral composition in the area;
    - Determine the likelihood of ecologically significant invertebrates and mammals occurring in the area based on status of the environment;
    - Determine presence of endemic species;
    - Determine presence of exotic and invasive species;
    - Determine presence of IUCN Red Data species; and
    - Determine presence of culturally significant species.

In addition to the surveys undertaken, the objective of the study was also to collate other specialist investigations undertaken in the area and from the available data:

- Communicate any additional relevant issues that might be of significance to the project and integrate information from other flora and fauna reports of significance to the area.

- Conduct an impact assessment and provide mitigation measures and management plans to reduce severity of impacts to the flora and fauna in the region.

- Compile a report that embraces these requirements.

3 OVERVIEW OF STUDY AREA

3.1 Locality of Valencia Uranium mine's proposed activities

The Valencia Uranium Project is located in Republic of Namibia (Namibia), situated on the Atlantic Coast of southern Africa. More specifically, the proposed development is situated in the Erongo Region named after the Erongo Mountain. Within the Erongo region, Valencia Uranium is located on the privately owned Farm Valencia (No. 122), situated on the eastern side of the Khan River and about 25 km to the north-east of the Rössing Uranium Mine, 80 km from Swakopmund and approximately 95km from Walvis Bay in a straight line. Valencia is approximately 75 km south-west of the town of Usakos in central-west Namibia. The extent of the area covered by the Exclusive Prospecting Licence (EPL) 1496 is approximately 700 hectares. Map 1 of the EIA/EMP report shows the locality of the proposed Valencia Uranium Project.

3.2 Brief Overview of Proposed Activities

According to Snowden (2007), a total mining reserve of 116.8Mt at a grade of 0.119kg/t U_3O_8 has been estimated for the Valencia deposit. Approximately 122.4Mt of waste material will be removed over the life of the mine. The final pit dimensions are estimated at 360m deep, 1 400m long and 700m wide (Snowden, 2007). As the uranium ore body is shallow and exposed at certain localities, it will be mined using open-pit methods. The run of mine (ROM) is estimated at 1 080 000t per month. The expected life of mine is 11 years.

The ore will be processed on site utilising the following processing unit operations:

- Crushing, radiometric sorting and screening
- Secondary crushing and rotary milling
- Leaching
- Counter current decantation washing
- Continuous ion exchange
- Solvent extraction and ammonium diuranate recovery
- Filtration
- Calcinations

Activities that will be associated with the mining and processing of ore will include the creation of a tailings dump and waste rock dumps, the temporary stockpiling of low grade ore, the construction of offices, the construction and operation of haul roads, the construction and operation of an acid plant, the construction of a water reservoir and the proposed development of a road and water pipeline through the Khan River. Power will be supplied by NamPower from the national grid. The routing of this transmission line has not yet been finalised and will require a separate EIA.

3.3 Location Synopsis

The proposed mine site falls within the central Namib Desert and has hot, dry days and cool to cold nights. Rainfall in the area is low (approximately 35mm/annum) and peaks in the late summer months between January and April.

Topography varies greatly from grassy plains, undulating rocky hills, steep rocky outcrops and associated drainage areas.

The soils vary from sandy, predominantly in drainage areas where they get transported and deposited, to gravely, usually along hill slopes and tops. For more detailed information on the soils of the area, refer to the soil survey report, Appendix C of the EIA.

The variety in topography and substrates leads to varied vegetation communities with certain species dominating in sandy and others in rocky areas.

4 METHODS

4.1 Desktop Studies and Previous Studies

4.1.1 Flora

During the literature study of the area of concern, previous studies conducted in the area were consulted, these included, Surveys of *Adenia pechuelli* at Valencia (Kolberg and Tholkes, 2007a, 2007b), A Detailed Botanical Survey (Strohbach, 2006) and A Botanical Impact Assessment (Strohbach, 2005). Both these studies were conducted on the same property and revealed information about species composition and habitat type.

Strohbach (2005) identifies eight prominent micro habitat types each with "a unique species composition caused primarily by the substrate in combination with the topography". These micro habitats were used as the basis for describing the habitat types surveyed and discussed in this report and cover the entire EPL area.

The description by Strohbach (2005), on the species of special interest was used to focus special attention on these species during the field surveys and subsequent analysis of these surveys. The protected status, threats, physical descriptions preferred micro habitats and ranges of these species were noted.

The Valencia EPL area was found to contain a well established and large population of *Adenia pechuelli* or elephant's foot plants. During the field surveys undertaken by Digby Wells, the sample plots where set out to ensure all surface variations were included. Any *A. pechuelii* plants observed were noted but the presence of these plants did not influence the sample site locations or sizes. The data provided in the report by Kolberg and Tholkes (2007b) was seen as adequate to determine the distribution of these plants. Recommendations regarding mitigation of the effect of mine development on the *Adenia pechuelii* population were also outlined in the report by Kolberg and Tholkes (2007a).

Strohbach (2006) conducted a detailed botanical survey in the EPL area, where he noted all plant species encountered. This study was conducted after an exceptional rainfall event. Therefore the species list provided by Strohbach is seen as comprehensive, and is included in this report. A further 27 species were noted by Kolberg (2007), and added to the 125 species initially recorded by Strohbach for Eco.plan (2006) (Appendix G3). The Eco.plan report formed the basis for the delineation of vegetation communities on and around the EPL area. The data from this survey was also incorporated in these plant communities.

4.1.2 Fauna

The desktop study included obtaining IUCN (Anon., 2007) species lists for Namibia and consulting distribution maps to determine which of these mammals (Skinner and Chimimba, 2005), frogs (Griffin, 2005) and birds (Roberts, 2003) occur in the area. A field survey conducted over a limited time period will not reveal all the species present in an area. In addition to field observations, Digby Wells therefore also makes use of a desktop determination to predict the probability of the respective species occurrence. Various aspects, such as range in which the animals occur (is the mammal restricted to National game reserves?), the food types the animal is dependent on (do termite mounds occur in the area for the aardvark?), the habitat requirements of the animal (are wetland habitats available for the ducks?) and any specific habitat requirements of the animals (is permanent water available for the common platana?) are then used to determine the probability of these animals actually occurring in the area (detailed methodology for determining the probability of occurrence is given in Appendix G1). The probability value ranged from 0.1, not very likely to occur in the area, to 0.99, very likely to occur in the area.

4.2 Field Surveys

4.2.1 Flora

The vegetation survey focussed on areas to be affected by the mining activities. Sample plots, shown on map 5, were selected in a semi-random fashion to ensure all terrain, substrate and broader vegetation types within the areas proposed for mining activities were represented at least once for each activity area. Species within each sample plot were identified and their relative abundance estimated.

Initially, aerial photographs with the site layout and infrastructure footprint were used to delineate homogenous units within the EPL area. Care was taken to ensure that the majority of the sample sites were within the infrastructure footprint areas, but with plots outside these areas also. The layout of the infrastructure footprint covered a broad spectrum of micro habitats, as described by Strohbach (2005). This meant that the majority of the sample sites (occurring within the infrastructure footprint) were seen as adequate. The size of the sample plots varied with the terrain encountered, in terms of terrain type and infrastructure footprint size. At the time of the survey, there was a tailings site option to the east of the proposed plant site (map 2) plots were therefore selected in this area and described as large aeolian sand plains (Strohbach 2005). Although this tailings option has now been discarded, results from the survey plots have been included in this report as the vegetation data is still relevant to the general area. This site was seen as relatively uniform in elevation, topography and soil type. Subsequently only six survey plots were semi evenly distributed within the footprint with one plot

outside the footprint. These sites were approximately 100m x 50m (5 000m^2) in a south-west to a north-east orientation. The site of the proposed pit was substantially more heterogeneous, and required a greater number of sample plots in order to cover all micro habitats seen. These sites were approximately 100m x 50 m (5 000m^2), in no specific orientation.

Information from the sample plots that Strohbach (2006) surveyed is also included and is used in the delineation of the vegetation communities, as the vegetation condition during that particular survey was good due to a high rainfall event during 2005/2006 rain season. Not all 69 sample plots were included as a number of them are not in the vicinity of the infrastructure footprint. The communities were delineated using Turboveg and Megatab software.

The survey undertaken by Digby Wells was from 9 October 2007 to 13 October 2007. During this time the EPL and surrounding areas were found to be very dry. Rainfall records from the on-site weather station showed a particularly dry year, with less than 10mm rain. Only 2mm rain was recorded between May 2007 and the site visit.

During the field survey, detailed digital photographs were taken of species when the identification of these species where doubted. Mr. Steve Carr, a senior agricultural researcher at the National Botanical Research Institute, in Windhoek, assisted, where necessary with identification.

4.2.2 Fauna

Specialist avian and reptilian studies were conducted by specialists from the University of Cape Townand the Polytechnic of Namibia, respectively. Information from these reports has been included and both reports are attached as Appendix G2: Ornithology Report for the Valencia Mine Area

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Mammals were identified on site either visually by actual sightings or by ecological indicators such as dung and tracks. Residents at the camp site were also consulted with regard to the animals they had seen on site.

No invertebrate trapping was conducted. Sweep-netting would not have proven valuable as the vegetation is low and sparse. Although not considered a quantitative invertebrate survey technique, the plots that were assessed for vegetation were extensively walked and rocks periodically turned over and all invertebrates observed noted.

5 RESULTS

5.1 Description of Sites

The area has mountains and plains and associated rocky outcrops and drainage areas. The drainage areas tend to be sandier with mountain sides and tops becoming increasingly rocky. Generally, trees and larger shrubs tend to be restricted to drainage areas. The area is a green-fields site and current disturbance is limited to grazing of cattle and the current prospecting-related activities. Strohbach (2005) identified eight habitat types during his survey; these descriptions corresponded with the habitat types identified during the Digby Wells survey. The habitat types were:

1. Rolling to moderately steep hills on schists.
2. Undulating hills on granite.
3. Rolling to moderately steep hills on mixed granite and schist ridges.
4. Steep marble ridges.
5. Moderately steep footslopes.
6. Calcrete plateau.
7. Rivers. (Dry riverbeds, and drainage lines)
8. Aeolian plains.

The descriptions of these eight habitat types (modified in certain instances) are used in this report to describe all areas visited. Table 5-1 shows the areas visited, accompanied by the relevant habitat type number assigned to it and listed above. Only a few of the sites sampled were completely homogenous therefore one site may contain plots located in different habitat types.

Plan 5 indicates all the vegetation sampling plots surveyed by Digby Wells.

Table 5-1: Description of the various sites sampled (Error! Reference source not found.**)**

Site name	Relevant plots	Description
Tailings Dump Option 4 (discarded)	(Plot 1 to 8 old location) Habitat type 5	This tract of land is dominated by plains on sandy soils with a rocky ridge running along its north-western boundary. Quiver trees occur within its boundaries on the southern corner. Succulents, including a *Hoodia* sp., observed in the rocky areas.
New tailings dump option	Plot 65 to 77 Habitat type 3	The new area can be described as moderately steep footslopes (Strohbach 2005), with low vegetation cover.
Tailings Dump Option 5 (discarded)	Plot 9 to 15 Habitat type 8	This area encompasses a grassy plain and the Valencia farm house with mountains on its western boundary. The substrates vary from hard gravel to sandy. The eastern half of the area is traversed by drainage lines. The area shows disturbance from grazing activity by cattle.
Plant area	Plot 16 to 21 Habitat type 8 and 4	This area is similar to that of the Tailings Dump Option 5, although less disturbed and the drainage lines are less pronounced. A rocky ridge and cliff occurs near to the north-western boundary, where many *Commiphora* spp. were observed.
Mining office area	Plot 22 to 25 Habitat type 3	The drainage lines from the plant area converge into 2 larger drainage lines within the office area. More of the area therefore has sandy substrate.
Waste rock dump south	Plot 26 to 33 Habitat type 2	The area is hilly and rocky with associated drainage paths around the hills. One of the larger drainage lines from the office area flows through the southern part of the area.
Low grade stockpile	Plot 34 to 37 Habitat type 3	The area is hilly and rocky with no predominant drainage lines through the area. The current camp site is situated in this area.
Pit area	Plot 47 to 56 Habitat type 1	The area is predominantly hilly and rocky with associated drainage paths around the hills.
Waste rock dump north	Plot 57 to 58 Habitat type 1 and 8	The area is predominantly hilly and rocky with associated drainage paths around the hills. A large drainage line follows its northern borders and shallow-sloped grassy plains dominate the south-eastern edge with mountains and cliffs beyond the south-eastern border.
Crusher area	Plot 38 to 46 Habitat type 3	The area is situated between the waste rock dump south and the low grade stockpile near the second larger drainage line flowing from the mine office area.
Khan River route	Plot 59 to 63 Habitat type 7 and 8	Harder gravel plains east of the river; sandier plains west of the river. Plots within the river bed sandy, surrounded by rocky mountains. Trees more prevalent within the river than on the plains.

5.2 Description of the Local Vegetation

The area of interest falls in the Desert biome (Lovegrove, 2003), where water is the most limiting factor for plants and animals. “As far as rainfall is concerned the Namib can be divided into three ecological zones, one near the coast where fog occurs regularly, a very dry middle zone and an elevated eastern zone that receives some rainfall” (Jensen & Hansen, 1996). The area of interest falls within the very dry middle zone, where rainfall fluctuates between 50 mm and 100 mm per annum (Eco.plan, 2006). This persistent lack of rain is caused by high pressure air masses which are carried south by the high altitude, anti-cyclonic winds from the equator and descend as dry air (Lovegrove, 2003).

The vegetation of the area of interest falls within the semi-desert and savanna transition zone (Giess, 1971). During the field surveys this was confirmed as most of the species that were found are characteristic of this zone.

Annuals (therophytes) are the dominating plant forms in the middle and driest part of the Namib Desert with *Stipagrostis* spp. occurring regularly. These therophytes persist through extended periods of drought in the form of seeds, and sprout after an effective rainfall (approximately 20mm). Many of these grasses have shallow and widely branched roots allowing them to absorb small amounts of rainfall and condensed fog from the upper few millimetres of soil. These annual grasses provide the food basis for the varied animals occurring in the Namib (Lovegrove, 2003). *Stipagrostis obtusa* or small bushman's grass was encountered periodically often in shallow sandy soil, this species is considered to be a very palatable grass, and is a good binder of sand and protects sand against wind erosion (Van Oudtshoorn 1999).

Tree species occurring here are only the few adapted to the harsh conditions. These trees grow in rock crevices or other natural depressions were rain water or fog can collect, or in dry riverbeds (Lovegrove, 2003). Specimens found during the survey confirmed this as *Commiphora virgata* and *Commiphora saxicola* were only encountered in drainage areas and rocky crevices, *Salvadora persica* was also only found near drainage lines or dry river beds. Certain rivers in the Namib have surface flow for only brief periods after being dry for many years, however many rivers contain permanent underground water, which is accessed through deep growing plant roots (Lovegrove, 2003). *Moringa ovalifolia*, one of the few tree species encountered during the survey, was found exclusively in riverbeds with no surface water flow, indicating that these trees rely almost exclusively on underground water. *Acacia erioloba* were present within the Khan River valley. The individuals found were large and well established, again signifying utilisation of underground water resources.

As the survey was undertaken during an exceptionally dry period, the species count was fairly low. Many species may not have been actively growing but were rather dormant as seed. Surveys by Strohbach (2006) and Kolberg and Tholkes (2007a, 2007b) have, however been used to supplement the species list for the area.

5.2.1 Vegetation communities

The following vegetation communities, illustrated on map 6, were derived from sample plots surveyed by Eco.plan (2006). Not all the sample plots Eco.plan (2006) sampled were included in this vegetation community delineation. Only sample plots within the EPL and proposed infrastructure areas were used.

Broad Vegetation type

Stipagrostis hirtigluma - Cleome suffruticosa desert shrubland.

The broad vegetation type represents all sample plots, and contains the two most common species encountered, *S. hirtigluma* and C. *suffruticosa.* Within this broad vegetation type, two communities were defined. Community 1 was defined as *Stipagrostis obtusa – Adenolobus pechuelli,* which consisted of the following sub-communities:

- *Commiphora virgata – Stipagrostis cilliata.*
- *Eragrostis nindensis – Zygophylum simplex.*

Community 2, defined as *Sesuvium sesuvioides - Commiphora saxicola,* occurred primarily in the central, south-eastern and south-western section of the EPL area. The northern section of the waste rock dump south, the central and eastern sections of the waste rock dump north, the entire pit area and to the west of the pit area are all included in this community. Community 2 consisted of the following sub-communities

- *Stipagrostis hirtigluma hirtigluma – Limeum aethiopicum.*
- *Petalidium setosum – Gisekia africana.*

5.2.2 Specific description of the area

Table 5-2 lists the plant species observed within each site during the October 2007 survey and the number of species associated with that site (collection of plots). The number of the sample plots varied in regards to the terrain encountered and infrastructure footprint size.

Table 5-2: Plants species recorded at each site

Site name	Relevant plots	Species observed
Tailings Dump Option 4 (discarded)	Plot 1 to 8	*Blepharis* spp. , *Acacia erioloba, Aloe dichotoma, Aristida adscensionis, Boscia foetida, Calicorema capitata, Commiphora saxicola, Commiphora virgata, Enneapogon desvauxii, Enneapogon scaber, Hoodia* spp., *Schmidtia kalihariensis, Sarcocaulon marlothii.*
New tailings dump option	Plot 65 to 77	*Aristida adscensionis, Boscia foetida, Calicorema capitata, Commiphora saxicola, Commiphora virgata, Enneapogon desvauxii, Enneapogon scaber, Schmidtia kalihariensis, Sarcocaulon marlothii, Acanthopsis disperma*
Tailings Dump Option 5 (discarded)	Plot 9 to 15	*Blepharis* spp. *Aristida adscensionis, Calicorema capitata, Commiphora saxicola, Commiphora virgata, Monechma cleomoides, Schmidtia kalihariensis, Stipagrostis obtusa, Stipagrostis uniplumis.*
Plant area	Plot 16 to 21	*Blepharis* spp., *Asparagus pearsonii, Boscia foetida, Calicorema capitata, Commiphora saxicola, Commiphora virgata, Enneapogon desvauxii, Enneapogon scaber, Schmidtia kalihariensis, Stipagrostis ciliata, Stipagrostis obtusa, Stipagrostis uniplumis, Sarcocaulon marlothii.*
Mining office area	Plot 22 to 25	*Blepharis* spp., *Aloe dichotoma, Aristida adscensionis, Boscia foetida, Calicorema capitata, Commiphora saxicola, Commiphora virgata, Enneapogon desvauxii, Eragrostis nindensis, Monechma cleomoides, Stipagrostis ciliata, Stipagrostis obtusa.*
Waste rock dump south	Plot 26 to 33	*Blepharis* spp., *Adenia pechuelii, Aloe dichotoma, Aloe* spp., *Aptosimum spinescens, Aristida adscensionis, Asparagus pearsonii, Boscia foetida, Calicorema capitata, Commiphora saxicola, Commiphora virgata, Enneapogon desvauxii, Schmidtia kalihariensis, Stipagrostis ciliata, Stipagrostis obtusa, Sarcocaulon marlothii.*
Low grade stockpile	Plot 34 to 37	*Blepharis* spp., *Adenia pechuelii, Aristida adscensionis, Asparagus pearsonii, Boscia foetida, Calicorema capitata, Commiphora saxicola, Stipagrostis ciliata, Stipagrostis obtusa.*
Pit area	Plot 47 to 56	*Blepharis* spp., *Adenia pechuelii, Adenolobus pechuelii, Aristida adscensionis, Asparagus pearsonii, Boscia foetida, Calicorema capitata, Commiphora saxicola, Commiphora virgata, Enneapogon desvauxii, Euphorbia virosa, Monechma cleomoides, Moringa ovalifolia, Salvadora persica, Stipagrostis ciliata, Stipagrostis obtusa, Sarcocaulon marlothii.*
Waste rock dump north	Plot 57 to 58	*Blepharis* spp., *Aristida adscensionis, Boscia foetida, Commiphora saxicola Commiphora virgata, Salvadora persica, Schmidtia kalihariensis, Stipagrostis ciliata, Stipagrostis obtusa.*
Crusher area	Plot 38 to 46	*Blepharis* spp., *Adenia pechuelii, Adenolobus pechuelii, Aptosimum spinescens, Aristida adscensionis, Asparagus pearsonii* *Boscia foetida, Calicorema capitata,* *Commiphora saxicola, Commiphora virgata, Geigeria ornativa, Monechma cleomoides, Moringa ovalifolia, Salvadora persica, Schmidtia kalihariensis, Stipagrostis ciliata, Stipagrostis obtusa, Stipagrostis uniplumis.*
Khan River route	Plot 59 to 63 25 x 25 625 m²	*Enneapogon desvauxii, Acacia erioloba, Adenolobus pechuelii, Salvadora persica, Schmidtia kalihariensis, Boscia foetida, Tamarix usneoides, Tapinanthus oleifolius* *Faidherbia albida, Aristida adscensionis, Commiphora virgata, Commiphora saxicola.*

5.2.2.1 Vegetation observed in the tailings dump Option 4 (now discarded)

Sample plots within this site were located either on the rocky ridge or the sandy plains, with a few plots incorporating both. Grazing in the area was evident, possibly by Hartmann's Zebra (***Equus zebra)*** and cattle, resulting in numerous short tufts of grazed grass scattered around the site. The fourth highest floral species count was observed at this site with thirteen species recorded from the area. The veld is predominantly in a sub-climax state with three pioneer species also being found.

The flat sandy plains were dominated by two grass species, including tall bushman's grass (***Stipagrostis ciliata***), and small bushman's grass (***Stipagrostis obtusa***), both being climax decreaser species that are palatable. These species are generally indicators of good veld condition, and are valuable for grazing in the arid regions of southern Africa. Furthermore, they are effective binders of sand and protect the topsoil against wind erosion (Van Oudtshoorn, 1999).

The rocky ridge area was dominated by the Rock corkwood (***Commiphora saxicola***). This is to be expected as this species is predominantly found around rocky outcrops. This species is near-endemic, and removal of any of these plants is prohibited. The sandy plains were dominated by ***Stipagrostis ciliata.***

The Star of the Namib (***Calicorema capitata***) occurred in many sample plots. This plant has very small leaves, which reduces surface area for evapo-transpiration which in turn reduces moisture loss, allowing the plant to survive extended periods of drought. This makes the plant available for periodic browsing by game, during these drought periods.

Bushman's candle ***(Sarcocaulon marlothii),*** was encountered on three of the plots within this site. ***Hoodia*** spp. was encountered on one plot along a drainage line among the rocky ridges. ***S. marlothii*** is endemic to Namibia, and all ***Hoodia spp***. are protected in Namibia. ***Commiphora saxicola*** and ***Commiphora virgata,*** both recorded from this site, are near endemic species.

No threatened IUCN Red Data species were observed at this site.

5.2.2.2 Vegetation observed in the tailings dump Option 5 (now discarded)

This site was fairly homogenous with grassy plains and drainage areas making up the main features. The area is utilised for grazing of cattle and shows signs of over-grazing, evident in the grass cover of the area, where very few tufts of grass were not grazed. The site had the second lowest floral species count with nine species observed in the area. Veld in this area was found to be predominantly in a pioneer stage, with few climax and sub-climax species found.

Schmidtia kalihariensis was found to be the most dominant grass species within the site. This is a pioneer increaser 2 species that occurs in over utilised veld. Despite its sour smell it will be utilised as a last resort by grazing animals. This grass grows fast and is therefore valuable as it can protect open sand against wind erosion (Van Oudtshoorn, 2002).

The Star of the Namib (*Calicorema capitata),* was the most dominant plant species. The plant is not utilized by livestock which would explain its dominance. Although *C. capitata* is utilised by wildlife, no signs of excessive defoliation was observed. *C. capitata* also has a soil binding role in addition to providing shelter for small animals.

No threatened IUCN Red Data species were recorded in this area.

5.2.2.3 Vegetation associated with the plant area

The plots surveyed in this area had much the same species composition as the Tailings Dump Option 5. The two areas are on the same plain with adjoining drainage lines. Disturbance at this site was not as obvious as at the Tailing Dump Option 5 site and the number of species recorded was higher, with twelve species recorded from this area. This was largely due to the incorporation of a sample plot on a low rocky ridge near its north-western boundary. This area was found to contain predominantly pioneer species of grass, with few, sub-climax species also present.

Within the rocky ridge to the north-western boundary species such as *Boscia foetida* and *Asparagus pearsonii* occurred intermittently.

Kalahari sour grass (*Schmidtia kalihariensis)* was also found to be the dominant grass at this site. Small bushman's grass (*Stipagrostis obtusa*) and Tall bushman's grass (*Stipagrostis ciliata)* also occurred in the small drainage areas.

Sarcocaulon marlothii, Commiphora saxicola and *Commiphora virgata* were also present in relatively large numbers. Of these plants only *Sarcocaulon marlothii* is endemic, with *C. saxicola* and *C. virgata* being near endemic. The endemic Bushman's candle (*Sarcocaulon marlothii*) was found on two of the sample plots within this site.

No threatened IUCN Red Data species were observed at this site.

5.2.2.4 Vegetation associated with the mine office area

Twelve species were recorded at this site. The mine office site was, however, one of the smaller areas sampled, with only four sample plots surveyed and therefore the number of species relative to the

surveyed area is higher than indicated by the figure. The majority of grass species found within this area were climax species.

The Slender corkwood (*Commiphora virgata*) was found to be the dominant species, most often found within the drainage lines. The sandy substrate within the drainage lines provided a very suitable substrate for Tall bushman's grass (*Stipagrostis ciliata*) which was also prevalent in the drainage lines.

Aloe dichotoma was associated with the drainage lines, and was the only plant of cultural significance recorded during this survey.

No threatened IUCN Red Data species were observed in this area.

5.2.2.5 Vegetation observed in the waste rock dump South site

This site had the third highest floral species count, with sixteen species recorded. *Aristida adscensionis* is a pioneer species associated with poor soils. This species, together with Small bushman's grass (*Stipagrostis obtusa*) and Tall bushman's grass (*Stipagrostis ciliata*), were the dominant grass species in this site. The drainage areas with their sandy substrates were ideal for these grasses.

Commiphora saxicola was the dominant species at this site, found mostly in the drainage areas surrounding the hills. *Calicorema capitata* was found to be the second most common species within this area.

Commiphora saxicola and *Commiphora virgata* were the near endemic species found and *Sarcocaulon marlothii* was the endemic species found.

Aloe dichotoma and *Sarcocaulon marlothii* were the only culturally significant species at this site.

No threatened IUCN Red Data species were observed at this site

5.2.2.6 Vegetation observed in the waste rock dump North site

This site had the lowest number of floral species with only nine species recorded from this vast area. The area had a large gravely plain, which was grazed by wild animals and had very few shrub species. Species recorded were predominantly pioneer species with a few sub-climax species also present. A predominant drainage line following the contours from the south-western corner to the north-eastern

corner is the area where all the non-grass species were found; this included the near endemic *Commiphora saxicola* and *Commiphora virgata* species.

Small bushman's grass (*Stipagrostis obtusa*) and Tall bushman's grass (*Stipagrostis ciliata*) were dominant within the large drainage line. Both these species are climax species.

Salvadora persica (Mustard bush) was also found within the drainage line and is a species known to occur in the vicinity of drainage lines.

Near endemic *Commiphora saxicola* and *Commiphora virgata* were both present on this site, although in very low numbers.

No culturally significant species or threatened IUCN Red Data species were observed in this area.

5.2.2.7 Vegetation observed in the low grade stockpile site

The low grade stockpile area also had the low numbers of floral species, with nine species observed in this area. The area was, however, the second smallest area sampled and therefore richness in this area may be understated.

The most dominant plant species in this area were *Aristida adscensionis* and *Calicorema capitata. A. adscensionis* is a pioneer grass species that thrives in disturbed areas and it is usually the first grass species to appear in these areas. The general activities related to prospecting and the mine camp within the area may have contributed to the increased density of *A. adscensionis* by disturbing areas and creating habitat available for *A. adscensionis* colonisation. *Commiphora saxicola* occurred in and around rocky areas.

Commiphora saxicola, was the only near endemic species present.

No culturally significant species or threatened IUCN Red Data species were recorded at this site.

5.2.2.8 Vegetation associated with the pit area

The proposed pit area had the second highest number of floral species, with seventeen species recorded in the area. The sample plots included the sandy drainage areas, which were frequently used as roads, and the mid and upper slopes of the hills.

Calicorema capitata, Aristida adscensionis, Commiphora saxicola, and *Commiphora virgata* were the dominant species found within this site.

The dwarf shrub species *Adenolobus pechuelii,* was present in this area. This shrub is regularly browsed by game, specifically Kudu. This plant was found in very low density.

Commiphora saxicola and *Commiphora virgata* were found on the rocky/gravely foot slopes and mid slopes of the hills in the area, these are near endemic species. The endemic species, *Sarcocaulon marlothii* was encountered as was the near-endemic *Adenia pechuelii*.

Sarcocaulon marlothii (Bushman's candle) was the only culturally significant species present within this site.

No threatened IUCN Red Data species were observed in this area.

5.2.2.9 Vegetation associated with the crusher

The crusher site had the highest number of floral species with 18 species recorded in the two plots sampled in the small area. This area consisted of rocky hills and drainage lines in the valley, which increased the diversity of substrates for plants and subsequently more species were found here compared to the aeolian plains.

Salvadora persica was found growing close to drainage lines, while *Moringa ovalifolia* was found on the hill slopes. *Calicorema capitata* was found to be abundant on the hill slopes.

The most commonly occurring species was *Commiphora virgata;* this species was only found on the rocky and gravely substrates associated with the upper and middle slopes of the hills. *Commiphora saxicola, Calicorema capitata* and *Aristida adscensionis* were also found to be numerous.

Commiphora virgata and *Commiphora saxicola* are near endemic species. *C. saxicola* occurs mostly in the dry drainage lines, with a few being found on the hill sides. The near-endemic *Adenia pechuelii,* also occurred here.

Aristida adscensionis and *Schmidtia kalihariensis* were the most dominant grass species, these are pioneer species. *Stipagrostis obtusa,* was also abundant but this is a climax grass species. Other grass species included *Stipagrostis uniplumis,* and *Stipagrostis ciliata.* These species were growing in the sandy drainage line and on the slope of hills.

No threatened IUCN Red Data species were observed in this area.

5.2.2.10 Vegetation observed in Khan River area

Prior to entering the Khan River area travelling from the camp site, a hard gravel plain east of the river was sampled while sandier plains were found west of the river. This plain consisted purely of the short tufted grass species *Enneapogon desvauxii*. It was evident that grazing animals frequented the area, as most of the grass tufts were grazed. This grass species is a pioneer sub climax species and is considered to have average grazing value.

Trees were more prevalent within the river bed than on the plains, probably due to the presence of underground water beneath the sandy riverbed and the shelter offered by the mountains from wind carrying sand. Dominant tree species include *Tamarix usneoides*, *Acacia erioloba* and *Faidherbia albida*.

Grass species encountered were *Schmidtia kalihariensis* and *Aristida adscensionis*, both these are pioneer species.

No threatened IUCN Red Data species were observed in this area.

5.2.3 IUCN Red Data, CITES and Endemic species

5.2.3.1 Results: Digby Wells (2007)

Table 5-3 lists the Vulnerable, Critically Endangered, Endangered and Near Threatened plant species occurring in Namibia, as listed by IUCN on the Red Data List for Namibia (Anon., 2007). None of these species were recorded during the field surveys and the probability of any of these species occurring on the site is considered low for reasons briefly outlined in the table.

5.2.3.2 Results: Eco.plan (2006), Kolberg (2007).

Listed in Appendix G3 is the plant species found by Eco.plan (2006) during a detailed botanical survey conducted on and around the Valencia uranium EPL area. This study has been augmented by further observation by Kolberg (2007) these species are indicated by # in the table.

Eco.plan (2006) recorded 22 endemic species, of which two were succulent shrubs, 15 were herbs and five were dwarf shrubs. Of these 22 endemic species only *Aloe namibiensis*, is listed on the red data list (as least concern). This species is also protected under the Nature conservation ordinance (Ordinance 4 of 1975), (Appendix G3).

During the *A. pechuelii* studies conducted by Kolberg and Tholkes (2007a, 2007b), an additional 27 species were observed in the EPL area (additional to Eco.plan 2006), these species included three endemic species, *Petalidium canescens, Tephrosia monophylla* and *Zygophyllum cylindrifolium* were the species encountered. *Blepharis grossa, Psilocaulon salicornioides, Tetragonia reduplicata, Codon royenii, Euphorbia lignosa, Phragmanthera guerichii* and *Camptoloma rotundifolium* were the seven near endemic species encountered during this survey (Appendix G3).

Table 5-3: IUCN listed plants

Family	Species	English name	IUCN status	Threats	Probability of occurrence
Compositae	*Gazania thermalis*		Critically Endangered	Declining habitat	Not likely, due to restricted habitat
Aloaceae	*Aloe pillansii*	Bastard quiver tree	Critically Endangered	Declining habitat, collection of fuelwood	Not likely, due to restricted range and small population
Aloaceae	*Aloe erinacea*		Endangered	Declining habitat	Not likely, due to isolated small populations
Leguminosae	*Elephantorrhiza rangei*		Endangered	Declining habitat	Not likely, due to restricted range and small population
Eriospermaceae	*Eriospermum halenbergense*		Vulnerable	Plant collection	Not likely, due to restricted range and small population
Campanulaceae	*Lobelia hereroensis*		Vulnerable	Declining habitat	Not likely, due to restricted range and small population
Aizoaceae	*Antimima eendornensis*		Vulnerable	Declining habitat	Not likely, due to restricted range and small population
Aizoaceae	*Conophytum halenbergense*		Vulnerable	Plant collection	Not likely, due to restricted range and small population
Aizoaceae	*Jensenobotrya lossowiana*		Vulnerable	Declining habitat	Not likely, due to restricted range and small population
Aizoaceae	*Juttadinteria kovisimontana*		Vulnerable	Plant collection	Not likely, due to restricted range and small population
Aizoaceae	*Lithops francisci*		Vulnerable	Declining habitat	Not likely, due to restricted range and small population
Aizoaceae	*Lithops hermetica*		Vulnerable	Plant collection	Not likely, due to restricted range and small population
Aizoaceae	*Lithops werneri*		Vulnerable	Plant collection	Not likely, due to restricted range and small population
Aizoaceae	*Ruschianthus falcatus*		Vulnerable	Declining habitat	Not likely, due to restricted range and small population
Aizoaceae	*Schwantesia constanceae*		Vulnerable	Declining habitat	Not likely, due to restricted range and small population
Euphorbiaceae	*Euphorbia leistneri*		Vulnerable	Declining habitat	Not likely, due to restricted range and small population
Euphorbiaceae	*Euphorbia namuskluftensis*		Vulnerable	Plant collection	Not likely, due to restricted range and small population
Euphorbiaceae	*Euphorbia otjipembana*		Vulnerable	Not Known	Not likely, due to restricted range and small population

Family	Species	English name	IUCN status	Threats	Probability of occurrence
Labiatae	*Plectranthus unguentarius*		Vulnerable	Declining habitat	Not likely, due to restricted range and small population
Orchidaceae	*Bartholina etheliae*		Vulnerable	Not Known	Not likely, due to restricted range and small population
Asphodelaceae	*Trachyandra peculiaris*		Vulnerable	Declining habitat	Not likely, due to restricted range and small population
Aloaceae	*Aloe ramosissima*	Maiden's quiver tree	Vulnerable	Declining habitat	Not Known
Scrophulariaceae	*Cromidon pusillum*		Vulnerable	Declining habitat	Not likely, due to restricted range and small population
Compositae	*Euryops mucosus*		Near Threatened	Declining habitat	Not likely, due to restricted range and small population
Crassulaceae	*Tylecodon aridimontanus*		Near Threatened	Declining habitat	Not likely, due to restricted range and small population
Crassulaceae	*Tylecodon aurusbergensis*		Near Threatened	Declining habitat	Not likely, due to restricted range and small population
Scrophulariaceae	*Dintera pterocaulis*		Near Threatened	Declining habitat	Not likely, due to restricted range and small population

Table: 5-4 contains plant species listed by CITES (the Convention on International Trade in Endangered Species of Wild Fauna and Flora).

Table: 5-4: CITES Appendix I species

Species	Threats	Occurrence likely
Pachypodium namaquanum	Habitat loss and plant collection	No, due to distribution records
Aloe pillansii	Habitat loss and plant collection	No, due to distribution records
Ansellia africana	Plant collection	No, due to distribution records
Eulophia speciosa	Incomplete data	Incomplete data
Eulophia leachii	Incomplete data	No, due to distribution records
Habenaria armatissima	Incomplete data	Incomplete data
Holothrix filicornis	Habitat loss and plant collection	No, due to distribution records
Welwitschia mirabilis	Habitat loss	No, due to distribution records

Two CITES Appendix II species were recorded from the area (***Euphorbia virosa, Aloe dichotoma).*** (Appendix II includes species not necessarily threatened with extinction, but in which trade must be controlled in order to avoid utilization incompatible with their survival).

5.2.3.3 Adenia pechuelii

Adenia pechuelii (Elephant's foot) is common over the EPL and surrounding area. As this plant was initially considered to be restricted to Namibia, Valencia Uranium commissioned a specialist study on this species. Detailed surveys (Kolbeg & Tholkes, 2007a, 2007b) of the area were undertaken to establish the occurrence and distribution of *A. pechuelii* on and around the proposed project site. A total of 1,565 specimens were recorded during the survey; of these 922 occur within the EPL and 643 in the area adjacent to the EPL. The majority of those outside the EPL were recorded to the north of the proposed pit. As there are a large number of this species occurring where the proposed mine pit will be developed, it will not be possible to avoid destroying these plants. It has therefore been recommended by Kolberg & Tholkes, (2007b) that many of these specimens be relocated to either an on site sanctuary, where they will be available for reintroduction at closure, or donated to renowned botanical gardens that specialize in plants adapted to arid regions. It is estimated that 693 individual plants will be disturbed by the proposed development and will require relocation. Recommendations on the relocation and suitable sanctuary sites have been provided by Kolberg and Tholkes (2007b). Kolberg and Tholkes (2007b) have also recommended that considering the unique status of *A. pechuelii* and its more restricted national distribution, relocation efforts should focus on this species and some of the other protected species such as the *Aloe* spp. on site be either donated or given lower priority for relocation.

A. pechuelii is, however, no longer categorized as endemic but near-endemic, as specimens were found north of Namibia, in Angola, (Kolberg & Tholkes, 2007b). Robust populations have also been

recorded in numerous other localities such as the Brandberg and the species is common in the areas adjacent to the proposed mine site. For these reasons the impact on this species by the proposed mine development is considered medium rather than high.

5.2.4 Invasive species

No alien invasive plant species were found during the vegetation survey, however the timing of the survey was after a long dry spell which may mean that alien invasive species were not actively growing and may have been dormant as seed. None of the previous surveys (Strohbach, 2006, Kolberg & Tholkes 2007a, 2007b) focused on the presence of alien invasive species, which may also have resulted in an under reporting of these plants. Alien invasive species have, however, been recorded on site but when found, were removed (Maartens, pers com, 2007). Although it is not probable that the invasive species have been eliminated, it would have contributed to the lack of exotic species evidence during the October 2007 survey. Below is an excerpt from the National review of alien invasive species compiled for the Namibian Ministry of Environment and Tourism describing the alien invasive plant species that could occur in the area after a good rain event. This study did not include a survey of alien invasives in the area surrounding the proposed Project or in the broader region. Should it be necessary to establish the locations of source populations that may infest the mine site, this survey could be included as part of the vegetation monitoring programme. The impact of mining on the distribution of alien invasive species should also be considered as an area of investigation to be included in the Strategic Environmental Assessment (SEA).

5.2.4.1 Major invasive plant species previously recorded

Bethune et al., 2004

"*Argemone ochroleuca* or the white-flowered Mexican poppy is a spiny annual found in dense stands in disturbed areas and river courses particularly, but not exclusively, close to towns. It seems to be largely restricted to the more arid western half of the country (Muller, 1985)." This will only occur in areas where sufficient water is available and could possibly occur around mine infrastructure, where water may be available due to water spills or leaks. This species thrives in disturbed soil, which is often a characteristic of areas under development. It is currently present in the Khan River valley.

Datura innoxia or the downy thorn apple is a common annual herb which invades watercourses and disturbed areas. It is widespread throughout mostly the western part of Namibia from north to south, and is particularly common around Windhoek and the westward flowing ephemeral rivers. There is a possibility of introduction this species around mine infrastructure, where water might be available due to spills or leaks. This species is currently present in the Khan River valley.

Datura ferox and *Datura stramonium*, the large and common thorn apples respectively are also widespread in Namibia and pose a similar threat to indigenous vegetation. These species will outcompete native species. These species could be present around mine infrastructure, where water could possibly be available or where water is spilt.

"*Leucaena leucocephala*, the "wonderboom" has not been officially recorded beyond towns although it has been seen in the Otavi Mountains (Piet Smit, pers. comm.). Its value for fodder, firewood, construction poles and sand binding make it a prospective agro-forestry tree in the moister north-eastern half of the country and its sale is actively promoted at plant nurseries as a "wonderboom' suited to dry conditions". As with all exotic species, this species should not be introduced on the mine, despite its attraction as a drought resistant species with perceived beneficial qualities.

Orford (2004) recently recorded an increase of prickly pear species around Windhoek and the Khomas region in general. The various *Opuntia* spp. (as well as other cactus species as yet unidentified) could be considered the most invasive terrestrial alien plant species in Namibia, along with *Prosopis* spp. Their thorny defence and ability to grow vegetatively from cladodes allow populations to grow rapidly and makes control or eradication difficult. This species could be present where sufficient water is available.

Pennisetum setaceum, fountain grass, has shown quite a dramatic increase in distribution in Namibia since the 1980s to present (from one to seven of the fourteen recognised biomes in Namibia). In the five years from 1998 to 2003, feral populations on road verges and erosion gullies outside Windhoek have shown annual growth rates (r) of between 0.1 and 0.5 respectively. This gives the populations an estimated doubling time of two to seven years, depending upon the habitats (Joubert & Cunningham, 2002; 2004). MacDonald & Nott (1987) did not record it in their 1984 survey that covered central Namibia and only Muller (1985) recorded it in townlands. This gives a good indication of its recent spread. This species could possibly invade the area, in disturbed areas or where water collects.

Nicotiana glauca or wild tobacco is widespread throughout Namibia, but more so in the more arid western half of the country (Muller 1985) particularly in river beds, disturbed areas and on old cultivated lands. Over the years there have been ongoing efforts to eradicate it from ephemeral river beds particularly from the Ugab River mouth area in the Skeleton Coast National Park. This species is capable of obtaining moisture from fog and is therefore a threat to areas where low rainfall could exclude other species (Bromilow1995). This species does occur in the Khan River valley

The Prosopis or mesquite species (*Prosopis chilensis*, *P. glandulosa* var. *torreyana* and *P. velutina*) are perhaps the most important terrestrial invasive alien species in Namibia currently, due to their extensive distribution, high densities and obvious impact on biodiversity and ecosystem functioning.

These species are tolerant of drought and high temperatures, and are therefore a threat to the area of concern. Mesquite species do occur around homesteads of farms neighbouring on the EPL area.

Henderson (2001) categorises alien invasive plant species in South Africa, in terms of their biological impact on ecosystems as either:

Transformers: plants that can replace or dominate a canopy or sub-canopy layer, altering structure and functioning of the ecosystem.

Potential transformers: plants that have the potential to dominate a canopy or sub-canopy layer but do not currently show any marked effects. They may be transformers elsewhere.

Special effects weeds: plants that can degrade the value or purpose of an ecosystem without necessarily altering its vegetation structure and functioning. They may replace indigenous plants or may be toxic or contain irritants or allergens.

Minor weeds: plants that are not particularly aggressive and do not dominate as mono-species nor seriously affect ecosystem functioning although many different minor weeds may do so through cumulative effects.

Table 5-5: Categorisation of Invasive Alien plant species that could occur in the area of interest, according to Henderson (2001).

Transformers	Potential transformers	Special effects weeds	Minor weeds
Opuntia spp.	*Pennisetum setaceum*	*Argemone ochroleuca*	
Datura spp.		*Nicotiana glauca*	
Prosopis spp.			

Of the three species regarded as transformers, two are reliant on areas where human disturbance has created an opportunity for colonisation as well as availability of water. *Prosopis* spp. is drought tolerant and can handle high temperatures, this species has the potential to colonise disturbed areas on the mine site.

The species regarded as potential transformers are also reliant on an artificially created habitat where human intervention has made water available. During the construction phase of the Project the likelihood of such favourable habitats occurring is increased, therefore the likelihood of these invader species occurring is also increased. *Datura innoxia, Nicotiana glauca, Prosopis chilensis, P. glandulosa* var. *torreyana* and *P. velutina,* are all species already present in Namibia, although these species are not yet found on the EPL or proposed infrastructure sites.

These invader species could spread by means of human assistance, i.e. Humans could carry the seeds into the EPL and infrastructure areas, here the availability of water could potentially create favourable habitat.

The most effective way of combating the spread of these species would be to prevent them from entering the EPL, area and eradicating all individual plants found.

5.2.5 Plants of cultural significance

Aloe dichotoma, referred to as the Quiver tree, received this name after the Bushmen of Namibia started making quivers from the soft wood. *Sarcocaulon marlothii*, the Bushman's candle, received its name because the flammable resin it excretes makes it useful as a candle. This dried resin was burnt by the San people as a source of light (Jensen & Hansen, 1996). Apart from grazing, there are no communities in the region of the proposed mine utilising the natural vegetation and the cultural significance of the recorded species was not investigated in great detail.

5.3 Fauna

The fauna survey included a focused reptile (Cunningham, 2007) and bird (Simmons, 2007) study as well as mammals. Due to the arid nature of the site, only a desktop amphibian investigation was undertaken. Although Namibia has a diverse population of invertebrates, the timing of the study resulted in poor invertebrate data. These studies should be conducted in April, when the may be more water available in the area, and could be included in the planned monitoring programme.

5.3.1 Mammals

Table 5-6 summarises the mammals that were observed on site at the Valencia Mine area and Khan River and indicates CITES (Convention on the International Trade in Endangered Species) listed species (*) (Anon., 2008) and the IUCN Red Data listing for mammals observed. Appendix G4 gives a list of other mammals that could occur in the area and their probability of occurrence (methodology in Appendix G1) in the area

5.3.1.1 Mammals recorded in the area

A total of 21 mammals are known to occur within the mine area and surrounding areas Table 5-6). Six of these species were actual sightings (Observed), a further 7 were identified by ecological indicators such as dung and tracks (Ecological indicators) and 3 were sighted by residents and visitors to the camp site (Sightings by visitors). Five species were identified by ecological indicators but could not be accurately identified due to close resemblance of ecological indicators to members of the same

family or due to incomplete ecological indicators such as partial footprints or desiccated or fragmented dung (Unconfirmed ecological indicators). Where identification could be completed with a level of certainty the species names have been included with a '*' in Table 5-6.Three species could not be identified with any level of certainty and have been labelled as 'Unconfirmed species' with possible species included under the 'English name" column.

Hartmann's mountain zebra is restricted mostly to Namibia, with populations extending into the extreme southwest of Angola and into the Richtersveld of South Africa in the far northwest (Skinner and Chimimba, 2005). It is listed as Endangered, an IUCN category (Anon., 2007, 1994 categories) describing species that are facing a high risk of extinction in the wild. The winter home ranges of these species range from 6 to 20 km^2, with summer ranges being smaller (Skinner and Chimimba, 2005). The animals, therefore, require large areas to feed in and can cover large distances to get to seasonal feeding grounds. The expansive areas surrounding the mining area are still mostly natural with very little disturbance from human activity and offer habitat to which the animals can retreat. It may be necessary to assess the zebra population dynamics in the region from a family group and home range perspective. This information, together with the zebra carrying capacities of the region will assist in determining if the family groups visiting the mining area can in actual fact move into surrounding regions without having a significant effect on the species.

Table 5-6: Mammals observed in the area.

Order	Species	English name	IUCN status	Record	Tailings Dump Option 4	Tailings Dump Option 5	Plant area	Mining office area	Waste rock dump south	Low grade stockpile	Pit area	Waste rock dump north	Crusher area	Khan river route
Artiodactyla	*Antidorcas marsupialis*	Springbok	LR - CD	Observed	*	*	*	*	*	*	*	*	*	*
Artiodactyla	*Oreotragus oreotragus*	Klipspringer	LR - CD	Observed			*		*		*		*	*
Artiodactyla	*Oryx gazelle*	Gemsbok	LR - CD	Ecological indicators										*
Artiodactyla	*Raphicerus campestris*	Steenbok	LR - LC	Ecological indicators	*			*	*		*		*	
Artiodactyla	*Tragelaphus strepsiceros*	Kudu	LR - CD	Ecological indicators	*		*	*	*	*	*	*	*	*
Artiodactyla	*Equus zebra*	Hartmann's Mountain Zebra	Endangered	Observed	*	*	*	*	*	*	*	*	*	*
Artiodactyla	*Sylvicapra grimmia*	Grey /Common Duiker	LR - LC	Unconfirmed ecological indicators	*									
Carnivora	*Canis mesomelas*	Black-backed Jackal	LR - LC	Ecological indicators	*									*
Carnivora	*Suricata suricatta*	Suricate	LR - LC	Ecological indicators	*							*		*
Carnivora	*Caracal caracal*	Caracal	LR - LC	Unconfirmed ecological indicators								*	*	
Carnivora	*Felis silvestris*	African Wild Cat	LR - LC	Unconfirmed ecological indicators					*					
Carnivora	*Unconfirmed species*	Bat-eared fox / Cape fox	LR - LC	Unconfirmed ecological indicators								*		
Carnivora	*Unconfirmed species*	Slender / Yellow mongoose	LR - LC	Unconfirmed ecological indicators	*									*
Hyracoidea	*Procavia capensis*	Rock Hyrax/Dassie	LR - LC	Sightings by visitors										*
Lagomorpha	*Lepus capensis*	Cape/desert Hare	LR - LC	Ecological indicators	*							*		
Primata	*Papio ursinus*	Chacma Baboon	LR - LC	Ecological indicators										*
Rodentia	*Hystrix africeaustralis*	Porcupine	LR - LC	Ecological indicators	*									
Rodentia	*Pedetes capensis*	Springhare	LR - LC	Observed			*							
Rodentia	*Petromus typicus*	Dassie Rat	LR - LC	Observed							*	*		*
Rodentia	*Xerus inauris*	South African Ground Squirrel	LR - LC	Observed	*							*		
Total number of species					11	2	5	4	6	3	6	9	6	11

LR – IUCN Lower Risk Category; CD – Conservation Dependent; LC – Least Concerned
*CITES species

The remaining species all fall within the Lower Risk IUCN Red Data category, which describes species that do not qualify for the threatened categories. Species within this category are then either in the Least Concerned or Conservation Dependent sub categories. Lower Risk – Conservation Dependent species (klipspringer, gemsbok, springbok and kudu) are species which may qualify for threatened categories if conservation efforts cease. All four species falling within this category are species commonly kept in game reserves and game farms. In this way, even if free-roaming populations come under threat, the species should be maintained due to the protection offered in game reserves and game farms. The remaining species are Lower Risk – Least Concerned species, a category describing species that are under little or no threat. Four species have been listed in the CITES database, and include Hartmann's mountain zebra, the caracal, the African wild cat and the chacma baboon. The caracal and African wild cat are threatened by persecution and should be monitored and protected on site. Gobabeb Training and Research Centre (GBB) have been approached to devise a monitoring programme appropriate to the local conditions.

5.3.1.2 Mammal richness

The Khan River route (4 sample plots) and Tailings Dump Option 4 (8 sample plots) had the highest number of mammals (11 species each), followed by the Waste Rock Dump North (10 sample plots and 9 species). This is largely due to the habitat types available within these sites; from sand drainage lines and dry river beds to gravel plains and rocky outcrops.

The lowest species count was observed on Tailings Dump Option 5 (now discarded) and the Low Grade Stockpile areas with 2 and 3 species respectively. Both these areas are more homogenous with regard to appearance of the areas and habitat types and both have human dwellings within them (farmhouse and mining campsite respectively). The human activity may keep animals from moving into these areas and thus the reduced mammal activity. The area to the east of the proposed development is also utilised for grazing of cattle and shows evidence of disturbance from grazing activities, which may reduce food available to other grazers within this area.

5.3.1.3 Mammals that could occur in the area of interest

Distribution ranges, habitat requirements, feeding habits and threats were utilised to determine their probability of occurrence in the area of interest (Appendix G4). The methodology for determining the probability of occurrence is described in (Appendix G1). The values range from 0.01 to 0.99 with higher values indicating a greater likelihood of occurrence in the area of interest. Only two other animals with IUCN listings other than Lower Risk have distributions overlapping with the area of interest. The Cheetah (Vulnerable) and Dent's horseshoe bat (Data Deficient) have a moderate to high

probability of occurrence (0.75 and 0.67 respectively) in the area of interest due to habitat requirements and their sensitivity to human activity and developments. Most of the species with distributions overlapping with the area of interest have high probabilities of occurrence in the area (>0.75). The main reason for this is the contrasting landscape, including mountains, rocky outcrops, river valleys and plains, the various soil substrates from hard clay to sandy and the habitat and microhabitat types associated with these. The animals associated with this area are able to survive desert to semi-desert biomes

5.3.2 Birds

The description of the bird populations below has been taken from the specialist bird study undertaken by Dr. R. E. Simmons (2007). The full report has been attached as Appendix G2. Table 5-7 summarises the birds that were observed on site at the Valencia Mine area and Khan River and indicates CITES listed species (*) and the IUCN Red Data listing for birds observed. Appendix G5 gives a list of other birds that could occur in the area and their probability of occurrence in the area.

5.3.2.1 Birds recorded in the area

A total of 31 bird species were observed within the proposed mine and surrounding areas (Table 5-7). One lark species could not be identified with any level of certainty and has been labelled as 'Unidentified lark'. The black eagles were not observed in the area during the survey but were reported to have been seen breeding in the Khan River area by visitors to the Valencia mine site.

A single IUCN threatened bird was observed during the three days of field work. A lappet-faced vulture was observed soaring over the Tailings Dump Option 4 area. No active nests or other activity of this species was observed during surveys. An old nest, possibly of a Lappet-faced Vulture, was observed on route to the Khan River in a 5 m high Camel thorn tree (*Acacia erioloba*). The remains of an old camping fire were observed below the tree and may explain the desertion of the nest. The remaining species all fall within the Least Concerned IUCN categories and are not threatened species.

Ten species have been listed in the CITES database, and have been indicated on Table 5-7 with an '*' next to the scientific name. These species are species of trade value and should be monitored and protected on site.

Three near-endemic species were observed in the area. Near-endemic species are species restricted to southern Africa. The three near-endemic species were all observed in grassy plains and include Ruppell's korhaan (*Eupodotis rueppellii*), Gray's lark (*Ammomanes grayi*) and the northern subspecies of the Karoo long-billed lark (*Certhilauda subcoronata damarensis*). The Karoo long-

billed lark is a subspecies of the common lark found in southern parts of Namibia and South Africa's northern Karoo region. Nevertheless, this subspecies occurs only in central-south Namibia (Dean & Ryan, 2005).

Table 5-7: Birds observed in the Valencia mine area

English name	Scientific	Residency	IUCN Status	Tailings Dump Option 4	Tailings Dump Option 5 & Plant area	Waste rock dump south	Pit area	Waste rock dump north	Khan river route	Haul road to Bloemhof
Speckled pigeon / rock pigeon	*Columba guinea**	Resident	LC				*			
Namaqua sandgrouse	*Pterocles namaqua*	Resident	LC	*			*			
Laughing dove	*Stigmatopelia senegalensis*	Resident	LC			*				
Cape turtle dove	*Streptopelia capicola*	Resident	LC				*		*	
Rock kestrel	*Falco rupicolus / Falco tinnunculus**	Resident	LC	*		*	*			
Pale chanting goshawk	*Melierax canorus**	Resident	LC				*			
Gabar goshawk	*Melierax gabar**	Resident	LC		*					
Secretarybird	*Sagittarius serpentarius**	Resident	LC							*
Lappet-faced vulture	*Torgos tracheliotos**	Resident	V	*						
Black Eagle	*Aquila verreauxii**	Resident	LC						*	
Ruppell's korhaan	*Eupodotis rueppellii**	Near Endemic	LC	*						
Gray's lark	*Ammomanes grayi / Ammomanopsis grayi*	Near Endemic	LC	*						
Unidentified lark	*Unidentified*		LC	*						
Familiar chat	*Cercomela familiaris*	Resident	LC				*	*	*	
Tractrac chat	*Cercomela tractrac*	Resident	LC	*	*					*
Karoo Long-billed Lark	*Certhilauda subcoronata*	Near Endemic	LC	*			*		*	
Cape bunting	*Emberiza capensis*	Resident	LC			*			*	
Stark's lark	*Eremalauda starki / Spizocorys starki*	Resident	LC	*	*					*
Karoo eremomela	*Eremomela gregalis*	Resident	LC	*					*	
Grey Backed sparrowlark / Grey Backed Finchlark	*Eremopterix verticalis*	Resident	LC		*					
Rock martin	*Hirundo fuligula*	Resident	LC	*			*			
Dusky sunbird	*Nectarinia fusca / Cinnyris fuscus*	Resident	LC			*			*	
Mountain chat	*Oenanthe monticola*	Resident	LC	*		*	*		*	*
Pale-winged starling	*Onychognathus nabouroup*	Resident	LC						*	
Layard's tit-babbler	*Parisoma layardi*	Resident	LC			*				
Cape sparrow	*Passer melanurus*	Resident	LC			*	*		*	
Sociable weaver	*Philetairus socius*	Resident	LC		*					
Red-eyed bulbul	*Pycnonotus nigricans*	Resident	LC						*	
White-thoated Canary	*Serinus albogularis / Crithagra albogularis*	Resident	LC				*			
Bokmakierie	*Telophorus zeylonus*	Resident	LC	*						*
Spotted eagle owl	*Bubo africanu*s*	Resident	LC		*					
Ostrich	*Struthio camelus**	Resident	LC		*				*	
White-browed fiscal shrike		Resident	LC	*		*	*		*	
Species richness				14	7	8	12	1	13	5

LC – Least Concerned; V – Vulnerable
*CITES species

5.3.2.2 Birds Numbers

The Tailings Dump Option 4 (now discarded) had the highest number of bird species, with a total of 14 species observed in the area, including the vulnerable lappet-faced vulture and all the near-endemic species. The mixture of grassy plains, rocky outcrops and tall quiver trees in this area contribute to the higher bird count, observed in the area. The Khan River valley and the proposed pit areas had the second and third highest number of species, with 13 and 12 species recorded at each site respectively, with one near-endemic species, the Karoo long-billed lark, recorded in the Khan River area. It was expected that the richness in the Khan River valley should be higher, but birds in the area may have been disturbed due to the increased traffic through the area and may have moved into quieter, unused tributaries. The number of species present in the Khan River valley may also increase with rainfall to the area.

The lowest species count was observed in the proposed Waste Rock Dump North and along the Road to Bloemhof, with 1 and 5 bird species respectively recorded in these areas.

The rocky areas, with lower plant cover tended to have lower number of bird species than the grassy plains with greater plant cover.

5.3.2.3 Birds that could occur in the area of interest

Appendix G5 summarises other birds that have distributions overlapping with the area of interest, together with their probability of occurrence. Birds exclusively requiring wetland habitats or permanent water were excluded.

None of the species that could occur are truly endemic species. Many of those that have distributions falling almost exclusively in Namibia still occur in the northern regions of South Africa or extend into southern Angola. A further 49 near-endemic species could occur in the area with 38 of these having high to very high probabilities of occurring (>0.75) in the area of interest.

Most of the birds with distributions falling over the area that are not dependent on permanent water or wetlands have a moderate to high probability of occurring in the area of interest. The main reason for this is the contrasting landscapes, the various soil substrates and the associated variable habitat and microhabitat types, which results in many habitat requirements of birds being met in the area. It should be mentioned here that birds are transient in nature and bird sightings in the area may include species that have not been included in the list. Vagrants and migrants may result in species not typical

to the area being observed on site. These species are unlikely though to remain in the area and therefore are not likely to be impacted on by activities in the area.

5.3.3 Amphibians

No Amphibians were observed in the area. Table 5-8 lists the frogs with distributions intersecting the area of interest, their probability of occurring in the area and the main threats affecting species. Methodology for calculating probability has been included in Appendix G1.

None of the species which could occur in the area are endangered and all fall within the Least Concern IUCN Red Data category. The marbled rubber frog and the Dombe frog have the highest probability (0.99) of occurring in the area of interest. The marbled rubber frog is specifically a desert and semi desert species breeding in temporary pools that develop in rocky areas. The Dombe frog is more generalist in its habitat preferences but does occur in deserts, and semi-desert and rocky areas, breeding in temporary streams and pools. The tremolo sand frog, although a savanna and grassland species also occurs in deserts and semi deserts, associated with highly seasonal river beds. It is therefore likely (0.88) this species may be found in the tributaries of the Khan River. Griffin (2005) cites the marbled rubber frog, bushveld rain frog, mottled toad, Damara dwarf toad, cryptic sand frog and Tanby's sand frog as species likely to occur on or around the proposed Valencia Project.

Table 5-8: Frogs that could occur in the area of interest and their probability of occurring in the area.

Family	Species	English name	Probability of occurrence	Threats as listed with IUCN
Microhylidae	*Phrynomantis annectens*	Marbled Rubber Frog	0.99	Habitat loss/degradation - extraction – mining. Pollution - commercial/industrial water pollution.
Bufonidae	*Bufo dombensis*	Dombe toad	0.99	
Ranidae	*Tomopterna cryptotis*	Tremolo Sand Frog	0.88	
Bufonidae	*Bufo hoeschi*		0.75	Habitat loss/degradation - agriculture – livestock.
Microhylidae	*Breviceps adspersus*	Bushveld Rain Frog	0.75	
Bufonidae	*Bufo poweri*	Western olive toad	0.63	Habitat loss/degradation - agriculture - crops & livestock Habitat loss/degradation - extraction of wood Habitat loss/degradation - infrastructure development - human settlement.

5.3.4 Reptiles

According to Griffin (2005) at least 76 species of reptiles are known, reported and/or expected to occur in the general Valencia Uranium Mine area. Of these, 31 species are viewed as being endemic to Namibia – i.e. 41% endemic. These endemics include 12 snakes (38.8% of the endemics & 15.8% of all species), 11 geckos (35.5% of the endemics & 14.5% of all species) and 8 skinks (2 species) and lizards (6 species) (25.7% of the endemics & 10.5% of all species).

During the fieldwork conducted by Peter Cunningham from the Polytechnic of Namibian during early November 2007, 12 species of reptiles were confirmed at various development sites at the Valencia Uranium Mine area. Of these, 4 species are classified as endemic to Namibia (Griffin 2005). The full reptile report has been attached as Appendix G7.

The endemic species recorded on site are:

- Bradfield's Namib day gecko - *Rhoptropus bradfieldi* (100% endemic);
- Western rock skink - *Mabuya [Trachylepis] hoeschi* (near endemic);
- Husab sand lizard - *Pedioplanis husabensis* (100% endemic); and
- Western sand snake - *Psammophis trigrammus* (near endemic).

As *Rhoptropus bradfieldi* and *Pedioplanis husabensis* are 100% endemic, these are considered the two most sensitive species recorded on site. According to Cunningham (2008) both are, however relatively common in their preferred habitat, rocky boulders and gravel plains respectively. In addition to the species recorded on site, other sensitive species known from the area include a number of

Pachydactylus species (geckos), which are also 100% endemic (Griffin, 2005). The Damara tiger snake (*Telescopus sp. nov.*) has also been recorded in the vicinity of the Valencia Project site. Very little information exists for this species and it has not yet been properly classified (Cunningham, 2008). It is, however, considered 100% endemic and as snakes are often targeted for extermination, the species should be afforded additional protection on site.

5.3.5 Invertebrates

The timing of the fauna filed survey did not allow for effective invertebrate trapping and this should be included as a component of the fauna and flora monitoring programme that will be implemented during the construction phase of the project.

5.3.5.1 Insects

The invertebrate diversity in Namibia is vast, with around 35,000 insect species occurring in the country, with around three quarters not yet identified and around 1,541 endemic species (Anon., 2008b). Seven Odonata (dragonflies and damselflies) are listed on the IUCN list for Namibia with one listed as Near Threatened and the other six as Data Deficient (Anon., 2007). It is unlikely that any of these occur on site as all require permanent or intermittent water and surface water availability on site is sporadic. The conservation status of invertebrates will require more detailed investigation as most Namibian invertebrates have not been evaluated in terms of the IUCN status (Pallet pers. com. 2008). A single endemic insect was observed on site, namely the stone grasshopper (Orthoptera: Lathiceridae). The species is a desert to semi-desert species, likely to have a preference for rocky areas where it is well camouflaged against the terrain. It is therefore likely to have a range that extends through most of the transitional zone and the rockier areas in the desert biomes.

5.3.5.2 Arachnids

5,700 arachnids are estimated to occur in Namibia, with around three quarters not yet identified. Approximately 1,541 endemic insect species, 68 endemic spiders, 57 endemic scorpions and 71 endemic solifuge species occur in the country (Anon., 2008b). The area of interest lies in a region of moderate to high endemism with regard to all species and in a region of very high endemism for scorpions particularly.

Table 5-9 below lists the endemic arachnids associated with the Semi-desert and Savanna Transition zones, within which the area occurs (National Museum of Namibia, 1998). It should be mentioned that the Semi-desert and Savanna Transition zone species are very likely to occur in the area of

interest. The Central Namib Desert species occurring in adjacent drier areas, such as west of the Khan River, should not be impacted on by the proposed activities.

Table 5-9: Endemic arachnids which could occur in the area of interest

Family	Species	Eco-region
Endemic Scorpions		
Scorpionidae	*Opisthopthalmus intercedens*	Semi-desert & Savanna Transition
Buthidae	*Parabuthus namibensis*	Central Namib Desert
Scorpionidae	*Opisthopthalmus penrithorum*	Central Namib Desert
Endemic Spiders		
Ammoxenidae	*Rastellus narubis*	Semi-desert & Savanna Transition
Gnaphosidae	*Theuma ababensis*	Semi-desert & Savanna Transition
Migidae	*Moggridgea eremicola*	Central Namib Desert
Eresidae	*Seothyra annettae*	Central Namib Desert
Zodariidae	*Cyrioctea hirsuta*	Central Namib Desert
Zodariidae	*Cyrioctea namibensis*	Central Namib Desert
Zodariidae	*Cyrioctea whartoni*	Central Namib Desert
Zodariidae	*Palfuria panner*	Central Namib Desert
Endemic solifuge species		
Daesiidae	*Blossia tricolor*	Semi-desert & Savanna transition
Solpugidae	*Solpugista namibica*	Semi-desert & Savanna transition
Daesiidae	*Blossia planicursor*	Central Namib Desert
Daesiidae	*Blossia purpurea*	Central Namib Desert
Daesiidae	*Namibesia pallida*	Central Namib Desert
Gylippidae	*Trichotoma michaelseni*	Central Namib Desert
Hexispodidae	*Hexisopus infuscatus*	Central Namib Desert
Hexispodidae	*Hexisopus moiseli*	Central Namib Desert
Hexispodidae	*Hexisopus pusillus*	Central Namib Desert
Melanoblossidae	*Lawrencega longitarsus*	Central Namib Desert
Melanoblossidae	*Lawrencega procera*	Central Namib Desert

No scorpions or solifuges were recorded from the area, it is however highly likely that they occur here. Only a single endemic trapdoor spider occurs in the area of interest, namely *Moggridgea eremicola*. Recent work at Rössing concluded this species was critically endangered (Pallet pers. com. 2008) and future monitoring should focus on establishing whether this species occurs on the site.

Environmental Impact Assessment

The impact assessment for the construction phase, operation phase, decommissioning phase and closure and post closure phase have been assessed for flora and fauna. The detailed impact assessment matrices can be found in Appendix G6. The methodology is briefly described below.

Severity of the impact is scored as:

1 Minor/insignificant effects on the biophysical environment

2 Moderate effects not affecting ecosystem functioning

3 Moderate alteration of ecosystem functioning

4 Serious impairment of ecosystem function

5 Very significant impact/total destruction of a highly valued species, habitat or ecosystem

The spatial scale is scored as follows:

1 Site (does not extend beyond site boundary)

2 Local (beyond site boundary and affects neighbours)

3 Regional (substantially beyond site boundary)

4 Provincial/Regional

5 National/International

The duration is scored as follows:

1 Short term (Less than a year)

2 Medium-Short Term (1-5 years)

3 Medium Term (6-25 years)

4 Long Term (26 to 50 years or beyond closure)

5 Permanent/Irreversible (more than 51 years)

The consequence is the sum of severity, spatial scale and duration scores.

The probability is assessed as:

1 Conceivable, but only in a set of very specific and extreme circumstances

2 Has not happened yet, but could

3 Could happen and has happened here or elsewhere

4 Will more than likely happen

5 Certain/ normally happens in cases of this nature

The significance is the product of consequence and probability which has been converted to a percentage.

Significance is rated as follows:

Rating	Score out of 100
High	**67-100**
Medium	**34-66**
Low	**1-33**

The impacts are rated in comparison to the baseline situation. Decommissioning, closure and post-closure phases will have impacts that are positive in terms of rehabilitating disturbed areas but may still be rated as negative or, at best neutral, when considered against baseline conditions.

Due to the heterogeneity of the area with regard to grassy plains and rocky hills, certain impacts have been discussed in detail for various areas which incorporated a number of sites. The waste rock dumps and mine area incorporated waste rock dumps, the pit, the crusher and the low grade stockpile. The Tailings Dump Option 5 and Plant area incorporated the tailings dump, the plant and the mine offices. The Tailings Dump Option 4 and the Khan River Route areas remained as separate areas.

5.4 Pre-construction and Construction Phase

A detailed Impact Assessment Matrix has been included in Appendix G6. Construction phase activities include activities to prepare the area for operation. Activities include the stripping of vegetation, levelling off of areas, construction of offices, plant, crusher, roads and dams and the preparation of the pit for mining. In general, the activities that take place during construction will result in the same impacts to flora and fauna; however, significance of impacts will alter from site to site and have been discussed as such.

5.4.1 Hydrocarbon Spills

Cause and comment:

The increased activity of construction vehicles, machinery and equipment will increase the potential of hydrocarbon contamination to soils which will directly impact on flora and soil-dwelling fauna by polluting the habitat the species rely on. Herbivores will also be indirectly impacted as their food plants may be affected.

Significance:

The impact is of low significance (28% and 24% respectively).

Impact	Type	Nature	Duration	Scale	Likelihood	Severity	Significance
Increased risk of hydrocarbon spills.	Direct	Negative	Short term	Local	Possible	Moderate	Low (28% for flora) Low (24% for fauna)

5.4.2 Poor Waste Management

Cause and comment:

Poor waste management could result in litter as well as more hazardous waste polluting the surrounding area. Whilst this could result in poisoning of animals or plants, it most likely impact will be on aesthetics and landowners.

Significance:

An increase in human activity will result in an increase in waste generation. This impact could be compounded by the large, open, wind swept site. The significance of the impact on fauna and flora is considered low (13%), although it could be higher from an aesthetics perspective.

Impact	Type	Nature	Duration	Scale	Likelihood	Severity	Significance
Incorrect waste management	Direct	Negative	Short term	Local	Possible	Moderate	Low (13%)

5.4.3 Noise

Cause and comment:

The increased activity of construction vehicles, machinery and equipment will contribute to elevated noise levels in the area which will impact on fauna and may result in temporary movement of certain animals out of the area.

Significance:

The impact is of low significance (33%).

Impact	Type	Nature	Duration	Scale	Likelihood	Severity	Significance
Elevated noise levels.	Direct	Negative	Short term	Local	Definite	Moderate	Low (33%)

5.4.4 Alien Invasive Introduction

Cause and comment:

With increased activity of vehicles and trucks which will be entering the area from various other parts of Namibia and South Africa and the increased activity of people in the area, there exists the potential of alien invasive species introduction.

Significance:

The significance of the impact is considered moderate (36%) as the introduction of alien invasive species could potentially alter the ecological status and functioning of the area.

Impact	Type	Nature	Duration	Scale	Likelihood	Severity	Significance
Alien invasive species introduction.	Direct	Negative	Short term	Local	Definite	Moderate	Medium (36%)

5.4.5 Off-Road Driving

Cause and comment:

Should vehicles and trucks not remain on roads or in areas designated as areas of construction activities then flora will be damaged. This is often one of the more significant impacts during the construction phase of a project.

Significance:

The significance of the impact varies from low to medium depending on the area. In the waste rock dump, pit area and the Khan River route are the more sensitive areas with regard to supporting protected and endemic plant species and the integrity of the natural habitat. The significance of damaging flora in this area indiscriminately by driving off-road in these areas is medium (43%). Where there is an impact on soil from off-road driving, this will result in a further impact on the ability of seed to germinate and plants to establish. Where there is no control and indiscriminate off-road driving, the impact will be higher than the 43% rating given above.

Impact	Type	Nature	Duration	Scale	Likelihood	Severity	Significance
Off road driving.	Direct	Negative	Medium term	Local	Possible	Moderate	Medium (43%)

5.4.6 Animal Road Deaths

Cause and comment:

Increased traffic and speeding will also increase risk of animal related deaths.

Significance:

The impact significance will also vary from area to area, but in all cases the significance is low as animals are able to move and fewer protected animals were observed on site. In the proposed tailings dump site and the Khan River route areas the significance is 32% as animal activity appeared to be high in these areas, judging by ecological indicators and species richness. In the waste rock dump and mine area the significance is 27% as animal activity was still relatively high but animals had more areas to retreat to away from the dirt roads. In the plant area significance of the impact is low (16%) as animal activity in these areas was low.

Impact	Type	Nature	Duration	Scale	Likelihood	Severity	Significance
Animal related deaths, due to increased traffic and speeding.	Direct	Negative	Short term	Local	Possible	Moderate	Low (32% in Khan River) Low (27% in waste rock dump and mine area) Low (16% in plant area)

5.4.7 Vegetation Removal

Cause and comment:

The removal of trees, shrubs, grasses and succulents will result in the complete loss of vegetation in areas of construction. This is the single biggest impact to flora during construction and alters the ecological status and functioning of those sites.

Significance:

The impact is of moderate significance (53%). With removal of vegetation in areas of construction, one will lose protected and endemic species in the process. The significance of this impact is moderate (53%) in the waste rock dump and mine area, the proposed tailings dump site and the Khan River route area, which support more protected and endemic plant species and are more pristine habitats. Significance is not considered higher as the protected and endemic species have ranges that extend beyond the proposed area of activity. The removal of shrubs and trees grasses and succulents could expose areas for introduction of weeds, exotics or alien invasive species. The impact is of low significance (21%) as the probability is low. Wind erosion of topsoil would also increase, resulting in less soil available for plant growth.

Impact	Type	Nature	Duration	Scale	Likelihood	Severity	Significance
Removal of trees, shrubs, grasses and succulents. Expose areas for weed introduction	Direct	Negative	Medium term	Local	Definite	Moderate	Medium (53% in all areas) Low (21% in all areas)

Cause and comment:

The removal of shrubs and trees, grasses and succulents will directly impact on fauna living in association with these plants and indirectly on animals requiring the plants for food, shelter or nesting.

Significance:

The impact is of moderate significance (37%). There also exists the potential for death or harm to protected and endemic species when trees and shrubs grasses and succulents are removed from the area. The impact is of low significance (24%).

Impact	Type	Nature	Duration	Scale	Likelihood	Severity	Significance
Removal of trees, shrubs, grasses and succulents, will directly impact on fauna species.	Direct	Negative	Short term	Local	Definite	Moderate	Medium(37% in all areas)

5.4.8 Loss of Topsoil

Cause and comment:

There is minimal topsoil available on site; however, in areas where topsoil does occur, it may be lost due to mining activities. The highest impact would be on the sandier Aeolian plains to the east of the proposed plant site.

Significance:

The impacts on flora include the loss of herbaceous vegetation which may have an effect on the ecological functioning of the area. The significance is medium (37%). The loss of the seed bank associated with the soils will result in loss of floral species' potential to sprout after rain events. The impact is of low significance (23%)

Impact	Type	Nature	Duration	Scale	Likelihood	Severity	Significance
Disturbance to vegetation and seed bank.	Direct Indirect	Negative	Long term	Local	Definite	Moderate	medium (37% in all areas)

5.4.9 Impairment of Flow in Drainage Channels

Cause and comment:

Infrastructure and roads built in or across drainage lines will impair occasional stream flow, which could affect any plant species present within these drainage lines.

Significance:

The impact is moderate (37%).

Impact	Type	Nature	Duration	Scale	Likelihood	Severity	Significance
Impairment of stream flow.	Direct	Negative	Long term	Local	Possible	Moderate	Medium (37% in all areas)

5.5 Operation phase

During the operation of the mine most additional impacts on flora and fauna will not be as severe as during the construction phase. The reason for this is that no more vegetation will be removed and most sensitive animal species that would have initially been disturbed and moved away from the area should become accustomed to the disturbance and may re-colonise the proposed mine vicinity.

5.5.1 Vehicle Activity

Cause and comment:

Truck activity and general vehicle traffic will continue to negatively impact on flora and fauna in the area during operation of the mine. The continuous movement of trucks in and out of the EPL area will increase the potential of alien invasive species introduction.

Significance:

The significance of the impact is considered moderate (36%).

Impact	Type	Nature	Duration	Scale	Likelihood	Severity	Significance
Alien invasive species introduction.	Direct	Negative	Long term	Local	Possible	Moderate	Medium (36% in all areas)

5.5.2 Off-Road Driving

Cause and comment:

Vehicles and trucks driving off-road will impact on flora in the area and could result in the loss of protected and endemic species.

The significance of the impact is low (32%).

Impact	Type	Nature	Duration	Scale	Likelihood	Severity	Significance
Loss of protected and endemic species.	Direct	Negative	Long term	Local	Definite	Moderate	Medium (36% in all areas)

5.5.3 Elevated Dust Levels

Cause and comment:

Blasting activities in the mine pit, the mining of ore and the crushing of ore at the crusher will elevate the dust levels in the area.

Significance:

Dust may impact on flora by interfering with photosynthesis. The impact is of low significance (28%). These activities will also elevate noise levels and increase vibrations in the area and this may result in any sensitive animals moving away from the area. The impact is of low significance (32%) as most of the animals once accustomed to the noise will move back into the area.

Impact	Type	Nature	Duration	Scale	Likelihood	Severity	Significance
Increased dust levels.	Direct	Negative	Medium term	Local	Possible	Low	Low (28% in all areas)
Increased noise levels	Direct	Negative	Short term	Local	Definite	Low	Low (26%)

5.5.4 Hydrocarbon Spills

Cause and comment:

The operation of vehicles, trucks, heavy machinery and equipment on site increases the risk for hydrocarbon spills and leaks in the area.

Significance:

Hydrocarbon spills will contaminate soils in the area which will directly impact on flora and soil-dwelling organisms and indirectly on herbivores reliant on affected plants. The significance of the impact on flora (32%) and fauna (28%) is low.

Impact	Type	Nature	Duration	Scale	Likelihood	Severity	Significance
Hydrocarbon spills	Direct	Negative	Long term	Local	Possible	Moderate	Low (32% Fauna) (28% Flora)

5.5.5 Surface water contamination

Cause and comment:

Should contaminated water not be contained then contaminants from the plant will pollute the soils in surrounding areas which will directly impact flora and soil-dwelling fauna.

Significance:

The impacts are of moderate (37%) and low (28%) significance for flora and fauna respectively. If contaminated water reaches the Khan River aquifer, the contaminants may be concentrated at springs which animals utilise. Should this be the case, the significance would be higher.

Impact	Type	Nature	Duration	Scale	Likelihood	Severity	Significance
Contaminated water	Direct	Negative	Long term	Local	Possible	Moderate	Medium (37% Flora) Low (28% Fauna)

5.5.6 Noise and Light Disturbance

Cause and comment:

The continual activity of the processing plant will produce continuous noise and require lights which will impact negatively on nocturnal animals.

Significance:

The impacts are of low significance (28% and 32% respectively) as it is expected that the animals will become accustomed to the activities.

Impact	Type	Nature	Duration	Scale	Likelihood	Severity	Significance
Noise contamination	Direct	Negative	Medium term	Local	High	Moderate	Low (28% Flora) (32% Fauna)
Light contamination	Direct	Negative	Medium term	Local	High	Moderate	Low (28% Flora) (32% Fauna)

5.5.7 Tailings Dump

Cause and comment:

Operation of the tailings facilities will also decrease the ecological potential of the affected area, which will impact negatively on flora (47%) and fauna (28%). These impacts will include the actual surface area that will be lost due to the tailings dump footprint. As the tailings will be placed dry, leachates and spills are not considered a major risk, however, the dry tailings could result in a higher wind blown dust impact. In the event of a severe storm, erosion of the tailings material could also occur should the dump not be adequately covered with coarse material.

Significance:

These impacts are of moderate to low significance respectively.

Impact	Type	Nature	Duration	Scale	Likelihood	Severity	Significance
Decreased ecological functioning	Direct	Negative	Long term	Local	High	Moderate	Medium (47% Flora) Low (28% Fauna)

5.5.8 Radiation

Cause and comment:

Radiation has been considered although impacts on flora and fauna can only be accurately assessed once the operational radiation values are known. Current natural radiation levels on site are low and predicted long term levels are also not anticipated to increase substantially.

Significance:

It is assumed that due to the low grade of the ore body, impacts will be of low (20%) significance.

Impact	Type	Nature	Duration	Scale	Likelihood	Severity	Significance
Increased radiation levels	Direct	Negative	Long term	Local	High	Moderate	Low (20% Flora) Low (20% Fauna)

5.5.9 Poor Waste Management

Cause and comment:

Should sewage spills occur, it will contaminate the surrounding area and impact on flora and fauna, as will illegal dumping of domestic waste and littering. The breakdown of domestic waste could result in contamination to soil which will have an impact on flora and soil-dwelling organisms, but the actual waste, particularly plastic waste, could be directly harmful to animals in the area. The impacts of poor waste management will therefore negatively impact on flora and fauna.

Significance:

The impacts are of low significance (28% and 24% respectively) due to the unlikely presence of protected species and the low density of species expected in the immediate vicinity of the waste sites. Should littering occur in more natural, undisturbed areas then the impacts will be more significant. Littering along the access road through the Khan River may have more of an impact than on site due to the difficulty in controlling personnel and activities over a broader, linear area.

Impact	Type	Nature	Duration	Scale	Likelihood	Severity	Significance
Poor waste management	Direct	Negative	Medium term	Local	Possible	Moderate	Low (28% Flora) Low (24% Fauna)

The opportunity for obtaining research data from the completed investigations and planned monitoring programmes can be seen as a positive impact. The effects of this impact may not immediately be seen but will aid in the better understanding of the mining impact on the ecology of the region.

5.6 Decommissioning and Closure Phases

During decommissioning certain general negative impacts will affect flora and fauna throughout the area.

5.6.1 Vehicle and machinery Activity

Cause and comment:

Vehicles and heavy machinery used for the various decommissioning activities will result in increased dust levels and fume emissions to the air which may have an impact on photosynthesis.

Significance:

This impact is of low significance (33%).

Impact	Type	Nature	Duration	Scale	Likelihood	Severity	Significance
Increased dust and emissions	Direct	Negative	Short term	Local	High	Moderate	Low (33 %)

5.6.2 Hydrocarbon Spills

Cause and comment:

The increased activity of vehicles, machinery and equipment, operating to remove redundant infrastructure, will increase the potential of hydrocarbon contamination to soils which will directly impact on flora and soil-dwelling fauna by polluting the habitat the species rely on.

Significance:

The impact is of low significance (20%).

Impact	Type	Nature	Duration	Scale	Likelihood	Severity	Significance
Potential of hydrocarbon contamination	Direct	Negative	Medium term	Site specific	Possible	Moderate	Low (20 %)

5.6.3 Off-Road Driving

Cause and comment:

Vehicles and trucks driving off-road will impact on flora in the area and could result in the loss of protected and endemic species, the compaction of soil by off road travelling will reduce the growth potential for plant species.

Significance:

The significance of the impact is medium (28%).

Impact	Type	Nature	Duration	Scale	Likelihood	Severity	Significance
Off road driving	Direct	Negative	Long term	Local	Possible	Moderate	Medium (47 %)

5.6.4 Traffic

Cause and comment:

Traffic and speeding will increase risk of road kills.

Significance:

The significance of the impact is low (16%).

Impact	Type	Nature	Duration	Scale	Likelihood	Severity	Significance
Animal deaths related to speeding	Direct	Negative	Short term	Local	Possible	Moderate	Low (16%)

5.6.5 Rehabilitation

Cause and comment:

During rehabilitation, indigenous vegetation should be introduced where possible, improving the biodiversity of these sites. As the vegetation richness improves and natural succession occurs in areas, animals will begin to move into the area as their habitat recovers.

Significance:

The impact is neutral in relation to baseline conditions.

Impact	Type	Nature	Duration	Scale	Likelihood	Severity	Significance
Rehabilitation of vegetation	Direct	Neutral	Long term	Local	High	N/A	N/A

6 Flora and Fauna Management Plan

6.1 Construction phase

See Appendix G6 for details regarding specific mitigation for specific impacts and for significance of impacts post mitigation measures.

6.1.1 Aims and objectives

- Prevent needless loss of or damage to flora particularly with regard to protected, endemic, near-endemic and rare species.
- Prevent death, injury or hindrance to fauna particularly with regard to protected species.
- Control the introduction of alien invasive species to the area.

6.1.2 Mitigation and management measures

- Remove vegetation only where required by planning carefully the areas that will be disturbed.
- Preserve the integrity of the soils with regard to organic matter, seed bank, soil structure and chemistry.
- Relocate plants, particularly protected and endemic species, with specialist advice.
- Avoid rocky outcrops and drainage lines as far as possible as these are generally associated with higher species richness.
- Ensure as much herbaceous matter is stockpiled with the soil to retain organic matter in soil and allow establishment of vegetation on stockpiles, specialist input required.
- Ensure awareness amongst all staff, contractors and visitors to site to not needlessly harm or hinder animals or damage flora.
- Allow animals to escape areas of activity freely and do not hinder their movement.
- Have a policy in place to prohibit hunting (rifles, snares, dogs). These conditions should be written into contractors agreements, with strict penalty clauses. Employees engaging in any of these activities should be faced with disciplinary action.
- Have a policy in place preventing domesticated animals from being kept on site.

- Have a policy and management plan to eradicate alien invasive plants.
- Ensure trucks and vehicles remain on roads and areas designated as construction sites to limit disturbance to areas unaffected by construction.
- Prohibit off-road driving and include penalty clauses in contractor agreements that result in fines or expulsion from site should there be a contravention of the agreement. Off-road driving by employees should result in disciplinary action.
- Ensure speed limits are set on all roads and enforce speed limits. Ensure all drivers at the site are informed about speed limits.
- Have communication channels set up to report hydrocarbon spills and leaks. Ensure such leaks are remediated in a reputable manner.
- Have dust suppression mechanisms in place.
- Regularly maintain equipment to reduce unnecessary emissions.
- Consider enclosing point sources of noise to reduce noise levels.
- Consider use of silencers and other noise muffling devices on equipment and vehicles.
- Policy and awareness in place to prevent littering.

The following are additional recommendations made by Kolberg and Tholkes (2007a):

- Establish a sanctuary for *Adenia pechuelii* plants in near vicinity and translocate individuals to this area, bearing in mind a permit is needed for relocation of these plants.
- Donate some individuals of *A. pechuelii* to interested and competent botanic gardens.
- Translocate plants such as *Aloe dichotoma* and *A. namibensis*, and other endemics and near-endemics that do occur in the area.
- Although most of the species recorded on site are common in the areas surrounding the EPL and other parts of Namibia, it may still be useful to translocate some of these specimens for use in rehabilitation.

- Give the National Botanic Garden of the NBRI the opportunity to remove any specimens of species such as *Euphorbia lignosa* and *Commiphora saxicola* that have value as ornamental plants.

6.1.3 Monitoring

- Monthly visual assessments of areas to determine if vegetation in undisturbed areas is being impacted.

- A biodiversity baseline assessment should be conducted. Once this data in available, annual biodiversity monitoring of areas both affected and unaffected by activities should be initiated to determine annual fluctuation in species numbers and if necessary relate this to activities on site.

- Establish a monitoring programme for early detection of alien invasive species and establish an alien invasive eradication and control programme.

6.2 Operation phase

6.2.1 Aims and objectives

- Prevent needless loss of or damage to flora particularly with regard to protected and endemic species.

- Prevent death, injury or hindrance to fauna particularly with regard to protected species.

- Prevent significant alteration to the ecosystems in the area.

- Control alien invasive species establishment in the area.

6.2.2 Mitigation and management measures

- Protect and preserve all surrounding areas unaffected by mining activities.

- Ensure awareness for the fauna and flora amongst all staff, contractors and visitors to site.

- Ensure linear structures, like roads and pipelines, are well managed to reduce the degradation of vegetation due to edge effects. This will be facilitated by ensuring vehicles remain on roads and alien invasive species introduction is controlled along road verges.

- Avoid rocky outcrops and riverbeds as far as possible as these are generally associated with higher species richness.

- Establish an alien invasive awareness, eradication and control programme.

- Ensure trucks and vehicles remain on roads and areas designated as construction sites to limit disturbance to areas unaffected by construction.

- Ensure drivers are informed that off-road travelling is prohibited.

- Ensure speed limits are set on all roads and enforce speed limits. Ensure all drivers at the site are informed about speed limits.

- Regularly maintain equipment to reduce risk of hydrocarbon leaks, and have communication channels set up to report incidences and action plans in place to address issues immediately.

- Inspect sewage system regularly, report all incidences immediately and have action plans in place to deal with any issues arising immediately.

- Have dust suppression mechanisms in place.

- Consider enclosing point sources of noise to reduce noise levels.

- Consider use of silencers and other noise muffling devices on equipment and vehicles.

- Consider screening areas of high noise off from sensitive areas.

- Ensure adequate domestic waste bins are supplied and that domestic waste is removed by a reputable contractor. Adhere to the waste management plan (Appendix N of the EIA)

- Erect posters to educate staff about the dangers of littering and dangers of damaging sensitive and endemic plant species they may encounter.

6.2.3 Monitoring

- Monthly visual assessments of areas to determine if vegetation in undisturbed areas is being impacted.

- Continue with annual biodiversity monitoring of areas both affected and unaffected by activities to determine annual fluctuation in species numbers and if necessary relate this to activities on site.

- Establish a monitoring programme for early detection of alien invasive species and establish an alien invasive awareness, eradication and control programme.

6.3 Decommissioning and Closure Phase

6.3.1 Aims and objectives

- Prevent needless loss of or damage to flora particularly with regard to protected and endemic species.

- Prevent death, injury or hindrance to fauna particularly with regard to protected species.

- Prevent alien invasive species introduction.

6.3.2 Mitigation and management measures

- Protect and preserve all surrounding areas unaffected directly by mining activities.

- Ensure awareness amongst all staff, contractors and visitors to site to not needlessly harm or hinder animals or damage flora.

- Rehabilitate area with natural, indigenous vegetation as much as possible, consulting with specialists as to the most appropriate methods.

- Ensure trucks and vehicles remain on roads and areas designated as construction sites to limit disturbance to areas unaffected by construction.

- Ensure drivers are informed that off-road travelling is prohibited.

- Ensure speed limits are set on all roads and enforce speed limits. Ensure all drivers at the site are informed about speed limits.

- Regularly maintain equipment to reduce risk of hydrocarbon leaks, and have communication channels set up to report incidences and action plans in place to address issues immediately.

- Have dust suppression mechanisms in place.

6.3.3 Monitoring

- Continue with annual biodiversity monitoring. Include biodiversity monitoring sites in rehabilitated areas to determine if these are improving with regard to habitat.

- Continue with alien invasive monitoring, eradication and control programme.

7 Conclusions

No impacts on flora and fauna are expected to be of high significance and the main impacts of moderate significance are associated with vegetation removal, indirect effects of increased dust levels and emissions and the potential contamination of soils in the area through spillages of various effluents and / or chemicals and hydrocarbons. Although protected and endemic species were observed on site, many have ranges extending beyond the limited borders of the mine and for this reason impacts are not of high significance.

One of the main impacts from the tailings dam position is that it will be situated across drainage lines where a relative concentration of vegetation was found, this vegetation will be removed. Moreover in the event of a rainfall episode the drainage lines will be blocked by the tailings dam and this may prevent runoff from reaching the downstream areas.

No fatal flaws regarding flora and fauna have been identified for this site, but management recommendations should still be adhered to and conservation (intervention management) and preservation (isolation management) of all flora and fauna should be considered with every action taken on site.

Proposed Infrastructure and Vegetation sample plots

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Appendix G1

Animal Probability of Occurrence Methodology

1. INTRODUCTION

Utilising distribution maps to determine if animals occur in the area or not may be misleading as various other aspects will play an important role as to whether the animal actually occurs in the area. The range in which the animal occurs is particularly important with some of the bigger mammals, which may be restricted to game reserves or game farms. One is unlikely these days to find animals like elephant and lion roaming in unprotected areas. Habitat preferences and microhabitat or niche requirements are also important aspects with all animals, as they are likely to occur only in areas where their preferred habitats occur and niche preferences are available. Generalist species are less affected by such requirements, but specialist animals will only occur in their specialist habitats and microhabitats, and are unlikely to occur in areas that do not have these habitats. Feeding habits and prey (utilised generally to include plant and animal prey) availability will also be important with regard to animals occurring in an area. Generalist species are again relatively unaffected, but specialist species will not occur in an area if their particular food item is not available to them, even if the habitat and microhabitat is ideal. Many animals may also not occur in an area because they have been driven out of the area or are locally extinct due to a variety of adverse activities or threats. These threats have been listed extensively for most Red Data species and are important aspects to consider when determining the probability of occurrence of an animal in an area.

2. METHODOLOGY

During desktop and literary research on occurrence of animals in an area, distribution maps are utilised to determine the animals that are likely to occur in the area. Initial site visits are then conducted to determine what habitats and microhabitats are likely to be present in the area. The various aspects discussed below are then utilised to determine the probability of occurrence of the animal in that particular area.

2.1 Aspects

The aspects utilised to determine probability of occurrence are described below. Not all aspects are used for all groups of organisms as they may not be limiting factors in probability of occurrence. For mammals, range, habitat, feeding habits and threats area utilised, with any specific habitat requirements included into habitat assessments. For birds, habitat is utilised, with any specific habitat

requirements included in the habitat assessments. Due to the transient nature of birds, utilising other aspects is problematic. Habitats, feeding habits and threats have been used for reptiles. For frogs, habitat, specific breeding requirements and threats have been utilised. Frogs are generally insectivores and food is generally abundant in the habitats they occupy, and therefore, habitat is more likely to be a limiting factor than feeding habits in their probability of occurring in a particular area.

2.1.1. Range

Range is utilised for mammals only. Mammals are the only group of animals that are restricted by fences and may be restricted to areas such as game reserves and game farms (Friedman and Daly, 2004; Skinner and Chimimba, 2005). The following categories have been included for range: national game reserves, nature reserves, botanical gardens (including parks), private game farms, stock farms, crop farms, mining land, industrial areas, suburban areas and unprotected land. Animals occurring only in fenced-off, protected areas are unlikely to occur on other lands and their probability of occurrence in such areas will be zero. All animals scoring zero for this aspect will automatically get an overall score of 0.01 probability of occurrence, regardless of habitat type and food availability.

The actual score an animal gets will depend on the ranges available to them in the area and the number that the animals have actually been recorded in. For example, in an agricultural field bordered by gardens and a few grazing fields, animals that occur in crop farms, suburban gardens and stock farms will score full points, animals that just occur in crop farms will score fewer points. If the crop farms dominate in the area, followed by grazing fields and suburban areas, then animals that have been recorded only in crop farms will score slightly higher than animals occurring only in grazing fields and suburban areas. More generalist animals, or those highly adaptable to human settlements or developments will score higher under more circumstances than animals occurring strictly within certain ranges.

2.1.2 Habitat

Habitat type has been used for all animals (Branch, 1988; Henning and Henning, 1989; Passmore and Curruthers, 1995; Newman, 1997; Branch, 1998; Barnes, 2000; Sinclair *et al.*, 2002, Roberts 2003; Friedman and Daly, 2004; Skinner and Chimimba, 2005; Woodhall, 2005), and is generally the main determining factor of whether an animal will occur in a particular area or not. Examples of habitat types include grasslands, savanna, wetland, woodland and forest. The scoring is determined in much the same way as for range, where the score will depend on the habitat types available to them in the area of interest and the number that the animals occur in. This will result in generalist animals occurring in a wide variety of habitats to score higher in most circumstances and specialists only scoring high if their particular habitat is available.

Microhabitat requirements for specialist animals have been considered when scoring for habitat. For example, many birds occur in wetland habitats, but some require densely vegetated areas, some require wooded wetlands only, some require large expanses of water, and a general wetland habitat evaluation is not sufficient and will result in poorer assessments of probability of occurrence.

2.1.3 Feeding habits

Feeding habits takes into account the type of feeder the animal is and specifics on the animal's diet. It has been used for mammals, reptiles and butterfly larvae (Branch, 1988; Henning and Henning, 1989; Branch, 1998; Friedman and Daly, 2004; Skinner and Chimimba, 2005; Woodhall, 2005). Frogs and birds are mostly feeders of general food types like invertebrates, seeds or fruits, which are readily available in the habitats they occur in. This results in feeding habits not being a limiting factor in their probability of occurrence in a particular area. Feeding behaviours are again rated the same as above with generalist feeders scoring higher under more circumstances than specialist feeder, and specialist feeders scoring high if their particular needs are met.

2.1.4 Specific requirements

Frogs (and birds) have specific breeding requirements ad these have been included in the probability of occurrence assessments for frogs. Whether a frog breeds in an area should probably not be weighed as much as habitat type, as a frog could still occur in the area regardless of whether breeding niches are available. However, should breeding sites not be available, then population numbers are likely to decrease and so will probability of occurrence, and therefore it is relevant. The fact that breeding sites and habitat types are often related eliminates the concern for weighing them equally.

Specific requirements, such as specific breeding sites, are scored in the same way as the other aspects, with animals requiring specific breeding sites scoring low, unless these sites are available to them in a particular area.

2.1.5 Threats

The various threats utilised for scoring purposes are those listed in Red Data books for mammals (Friedman and Daly, 2004), birds (Barnes, 2000); reptiles and frogs (Branch 1988); and butterflies (Henning and Henning, 1989). The Red Data mammal book has evaluated all mammals, whereas other Red Data books have only evaluated the listed species. Threats are considered in light of the activities occurring in an area, and the more activities occurring in the particular area that are listed as threats to that animal the higher the score. The scoring is therefore very similar to the above aspects; however, in this instance the scores are given negative values. If no threats to the animal exist in the

area, then the animal scores zero, if most of the threats occur in the area the animal scores full negative points.

2.2 Scoring

The aspects for each animal are scored individually according to the following:

- 4 – The animal is highly likely to occur in the area; the specific aspect is abundant.
- 3 – The animal is probably likely to occur in the area; the specific aspect is available but not abundant.
- 2 – The animal could possibly occur in the area; the specific aspect is scarce.
- 1 – The animal is probably unlikely to occur in the area; the specific aspect could, but is unlikely to, occur in the area.
- 0 – The animal is highly unlikely to occur in the area; the specific aspect is not available to the animal.

Once all the scores have been decided for all animals and their relevant aspects, a simple formula is applied to determine the probability of occurrence, which is as follows:

$$Likelihood\_of\_Occurence = \frac{T + (A_1 + A_2 + A_3 + \mathbf{K} + A_n)}{4n}$$

Where:

T is the score for the threats aspect

A is the score for other aspects, and

n is the number of aspects other than T

The probability of occurrence will vary between 0 and 1, with 0.00 indicating a high probability of not occurring in the area and a value of 1.00 indicating a high probability of occurring in the area. All zero scores and potential negative scores (when scores for threat outweigh other scores) are indicated as 0.01 probability of occurrence, as one cannot be 100% sure that the animal doesn't occur in the area and all scores of 1.00 are indicated as 0.99 as one can only be 100% sure that an animal occurs in the area if actually sighted in the area.

3 DISCUSSION

It should be mentioned that the methodology of scoring summarised above will reduce subjectivity of scoring, but the actual scoring will still be subjective, as individuals may weigh details within the aspects differently. However, the same subjectivity will be applied to each species within a group (for example the mammals), and, therefore, when the animals are listed in decreasing orders of probability of occurrence for example, these orders should be very similar when done by different individuals. Therefore, the ultimate relevance of this system is not the actual score the animal gets but its probability of occurrence in relation too other species in its group.

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Appendix G2: Ornithology Report for the Valencia Mine Area

Ornithology Report for Valencia Mine area

EIA Specialist Study Report on: The impact of uranium mining on the avifauna of the Valencia farm (No. 122) by Valencia Uranium (Pty) Limited

Final Report - 8 October 2007

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Background

The Valencia farm is situated about 75 km south-west of the town of Usakos in central-west Namibia and is the site of an ore body of uranium which will be exploited by Valencia Uranium (Pty) Limited using open–pit mining. This is similar to the nearby and well-known Rössing Uranium Mine across the Khan River. The uranium is expected to be mined for 10-15 years and this may cause short- and long-term impacts on the biodiversity of the area to be mined, through the mine tailings dumps, the rock dumps, the haul roads and a possible route through the Khan River.

The preliminary, desktop avifaunal study of the Valencia farm has suggested several priorities for an in-depth look at bird species that may be affected by the mining activity and road construction (Brown 2006). This was based on the Red data book of Namibian birds and atlas records for the quarter degree squares 2215AC and 2215AD (Simmons & Brown 2007, Harrison *et al*. 1997).

Brown (2006) in particular recommended that:

(a) the two endemic species Herero Chat *Namibornis herero* and Rockrunner *Achaetops pycnopygius* that may occur in this area be assessed for (i) population status in areas to be impacted; (ii) possible impacts on the populations; and (iii) mitigation of the impacts;

(b) breeding by Lappet-faced Vultures *Aegypius tracheliotus* in the area to be mined be determined to reduce any disturbance within 1 km of potential nests;

(c) other species were deemed less important because of their transient status in such an arid area.

Additionally, the Terms of Reference calls for confirmation of the presence of the endemic and Red-listed species, with particular emphasis on threatened species and ways to mitigate impacts where necessary.

Field work methods

I spent three full days in field work at Valencia (3-5 September 2007), including a morning of orientation with Trevor Stafford, the Camp Manager. Waypoints of all the proposed tailings dams, rock and ore dump sites and the plant and mine site itself were uploaded onto my GPS (Garmin E-trex) by Ron Joly from Westport Resources Namibia (Pty) Ltd to facilitate location and access (see Figure 1). Most of the field time was used to undertake walking surveys to record all species seen and recording perpendicular distances to them to determine densities if necessary. Two surveys of the Khan River access roads were under-taken by me and H Thomas, one by vehicle and later a walking survey, covering 2 km. We paid particular attention to the two resident endemics – the Herero Chat and the Rockrunner (Boix–Hinzen & Simmons 2005, Simmons 2005) as suggested by the

preliminary, desktop study. We looked carefully for signs of Lappet-faced Vultures breeding on the farm.

All bird species seen were recorded as were signs (e.g. droppings and sightings) of large and small mammals for which no other specific surveys have apparently been undertaken to date by specialists. We assumed that the density of ungulate faeces correlated loosely with the numbers found but rarely seen in the transects (many large ungulates are secretive or nocturnal but occur commonly, so fresh dung can act as a guide to their numbers).

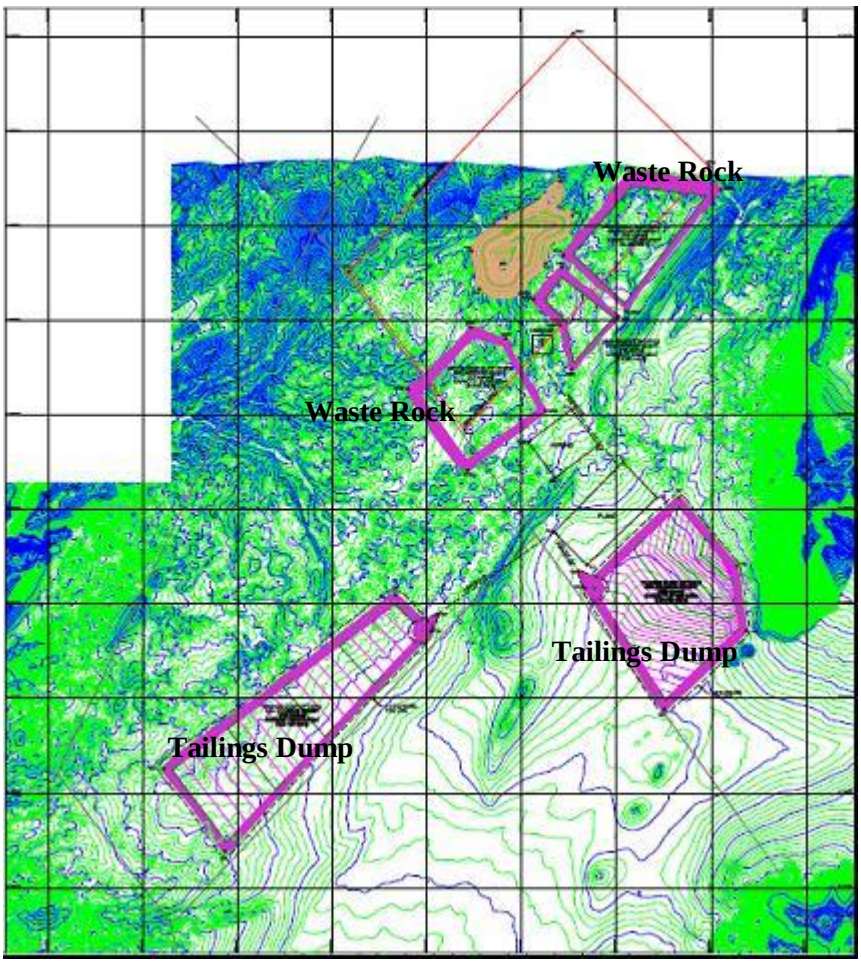

Figure 1: Valencia waste rock and tailings dumps; general layout and additional options (Source: Epoch Resources (Pty) Ltd.).

Results of field work

Red-listed species

Only one red-listed bird species was observed during the three days of field work – a single flying Lappet-faced Vulture heading towards the proposed Valencia Mine headquarters over the Tailings Dump Option 4. No active nests or other activity of this species were observed in the driven survey (5 km in the tributary, ~2 km in Khan Main River), or the 2 km of walking surveys in the tributary. An old nest, presumed to be of a Lappet-faced Vulture, in a 5 m high Camel thorn tree (*Acacia erioloba)* was discovered in the approach to the Khan tributary (S22^{o} 26.755', E 15^{o} 09.301'). Old fire remains below the nest indicate overnight camping and one of the probable reasons for the nest's demise.

Near-endemic species

Despite extensive searching and calling of Herero Chats none were seen or heard. The same was true of the endemic Rockrunner. The habitat appeared inappropriate for these species, particularly the Herero Chat which prefers south-facing hillsides with *Commiphora* or *Acacia* trees (Boix-Hinzen & Simmons 2005). Much of the terrain was devoid of trees or was grassland supporting open-country species such as larks, mountain chats and korhaans.

Three near-endemic species were present on the grassy plains: Ruppell's Korhaan *Eupodotis rueppellii*, Gray's Lark *Ammomanes grayi* and the northern subspecies of the Karoo Long-billed Lark *Certhilauda subcoronata damarensis* (Figures 2 to 3).

Figure 2: Karoo Long-billed Lark – northern form (*damarensis*).

Figure 3: Ruppell's Korhaan, a relatively common near-endemic on the grasslands around Valencia.

The latter is not a full species but a subspecies of a common lark found in southern parts of Namibia and South Africa's Karoo region. Nevertheless, this subspecies occurs only in central-south Namibia (Dean & Ryan 2005). Larger populations of the korhaans and the larks were found on Tailings Dump Option 4 than on any other Site (Table 1), with eight korhaans, 13 Gray's Larks and three Karoo Long-billed Larks found in just over 3 km of transect. These endemics were also found on the Pit area and in the Khan River tributary, but nowhere else.

None of the other endemics expected from the Atlas results (in Brown 2006), were found or heard or suspected. These may occur following rainfall later in the season or in higher rainfall years, but always at low densities.

Table 1: Species of birds found during field work (3-5 September 2007) in different sites that may be impacted by the proposed uranium mining at the Valencia farm. Birds in red are Red-listed species and those in yellow are near-endemics. Distances walked during surveys are given in brackets.

Bird species recorded	**Pit (2.15)**	**Waste Rock Site South (>1.0)**	**Waste Rock Site North (1.34)**	**Plant + Tailings Dump Option 5 (1.45 + 1.66)**	**Tailings Dump Option 4 (3.06)**	**Haul road to Bloemhof (>1.0)**	**Khan River (5.0 +2.0)**
GPS coordinates	PT1-PT7	WRS1-WRS5	WRN1-WRN4	PL1-PL4 TD1-TD6	TD7 – TD11		Khan In Khan Main
Ostrich	0	0	0	1	0	0	9
Ruppell's Korhaan	**0**	**0**	**0**	**0**	**8**	**0**	**0**
Lappet-faced Vulture	**0**	**0**	**0**	**0**	**1**	**0**	**0**
Secretary Bird	0	0	0	0	0	2	0
Rock Kestrel	1	2	0	0	2	0	0
Pale Chanting Goshawk	1	0	0	0	0	0	0
Gabar Goshawk	0	0	0	1	0	0	0
Spotted Eagle Owl	0	0	0	1	0	0	0
Speckled Pigeon	1	0	0	0	0	0	0
Cape turtle	1	0	0	0	0	0	2

Dove							
Laughing Dove	0	2	0	0	0	0	0
Pale-winged Starling	0	0	0	0	0	0	3
Rock Martin	1	0	0	0	1	0	0
Karoo Eremomela	0	0	0	0	4	0	3
Layard's Titbabbler	0	1	0	0	0	0	0
Namaqua Sandgrouse	1	0	0	0	53	0	0
Gray's Lark	**0**	**0**	**0**	**0**	**13**	**0**	**0**
Karoo Long-billed Lark	**2**	**0**	**0**	**0**	**3**	**0**	**2**
Stark's Lark	0	0	0	5	1	flocks	0
Unid Lark species	0	0	0	0	3	0	0
White-browed Fiscal Shrike	1	1	0	0	1	0	2
Bokmakierie	0	0	0	0	1	1	0
Mountain Chat	4	1	0	0	3	1	1
Trac-trac Chat	0	0	0	1	3	1	0
Familiar Chat	1	0	1	0	0	0	1
Red-eyed Bulbul	0	0	0	0	0	0	2
Dusky Sunbird	0	1	0	0	0	0	1

White-throated Canary	1	0	0	0	0	0	0
Cape Sparrow	4	4	0	0	0	0	1
Sociable Weaver	0	0	0	1	0	0	0
Cape Bunting	0	2	0	0	0	0	5
Grey-backed Sparrow-Lark	0	0	0	3	0	0	0
Species richness	**13**	**8**	**1**	**7**	**14**	**5**	**12**
	Pit (2.15)	**Waste Rock Site South (> 1.0)**	**Waste Rock Site North (1.34)**	**Plant + Tailings Dump Option 5 (1.45 + 1.66)**	**Tailings Dump Option 4 (3.06)**	**Haul road to Bloemhof (> 1.0)**	**Khan River (5.0 +2.0)**

Species richness by site

I assessed the avian species richness of each area by walking slowly through all potentially impacted areas. While the lengths of the transects differed slightly, this method will give a first rough assessment of the species richness, because surveys represent equal effort.

In general, as expected for the dry pro-Namib, the Valencia farm was rather species-poor overall (31 species) and only one site supported any red-data species (Table 1).

All individual sites were relatively poor in birds with the Tailings Dump Option 4 exhibiting the highest species richness (14 species), followed by the Pit itself (13 species) and the Khan River tributary (12 species). All sites represent low numbers of birds, with the remainder (Table 1) showing very low species levels. This is fairly typical of the dry desert, especially in the winter.

The likely reason for the higher avian richness on the Tailings Dump Option 4 was: (i) the larger size of this site; (ii) the good grass cover on the south-east side; and (iii) the change to open rocky habitat – with quiver trees (*Aloe dichotoma*) on the western and southern borders. Large numbers of Namaqua Sandgrouse (53) were seen moving over this area and heading to the Khan River where I presume there was open water for drinking.

The avian species richness in the Khan River (12) was unexpectedly low for a large ephemeral river and compared unfavourably with species counts (26) made in riverine habitat on the Rooiklip property (below the Gamsberg escarpment) just prior to this assessment (Simmons & Thomas unpublished data). The reasons are unknown, but judging by vehicle tracks through the Khan River bed, disturbance is likely to be one of the main reasons.

It was reported to me by geological engineers visiting the Valencia Site that a pair of Black (Verreaux's) Eagles *Aquila verreauxi* was raising a nestling in the main Khan River bed on a cliff site above an area of phragmites reeds near a spring. We did not get to this area and we have thus not included it in our survey results.

The site with the lowest richness was the Waste Rock Site North where only one species of bird was seen in 1.3 km of surveying; two species of mammals were apparent (kudu droppings and Elephant Shrew).

My conclusion from these first surveys is that those areas to be impacted and that support grassland were more diverse in terms of birds (but still very low in avian species richness) than the rocky areas supporting a few trees or even the river washes. The three near-endemic species were found in these

grassland areas and in the Pit area. The only Red-listed species was seen flying over the Tailings Dump Option 4 Site.

Other biodiversity

In each area I looked for signs of mammals (droppings and live animals) and the unusual Elephants-foot *Adenia pechuelii* plant (Figure 4).

Figure 4: Elephants- foot plant – commonly encountered in the surveys of the rocky areas around Valencia, and a Hoodia seen in the Tailings Dump Option 4.

As expected more mammals (seven species) were seen in the Khan River tributary than elsewhere. Again the Tailings Dump Option 4 held at least five species of mammals (Table 2). The most common mammals in the river were kudu and oryx, while endemic klipspringer was seen in the Khan and the Tailings Dump Option 4 (Tables 2-3). Live Elephant Shrews (probably Smith's Rock Elephant Shrew *Elephantulus rupestris)* were seen in rocky river wash terrain in the Pit area and the Waste Rock North (Tables 4-5). This species is endemic to southern Africa (Smithers 1983).

Elephants-foot plants were seen in Waste Rock Site South and Tailings Dump Option 4 and I understand a full survey of these unusual plants has been undertaken.

Table 2: Mammal signs, or sightings in Tailings Dump Option 4, 4 September 2007.

Tailings Dump Option 4	Open grassland	Zebra - droppings	4
Tailings Dump Option 4	Open grassland	Kudu/Oryx - droppings	3
Tailings Dump Option 4	Open grassland	Scrub Hare – live and droppings	4
Tailings Dump Option 4	Rocky	Klipspringer - live	1

Tailings Dump Option 4	Rocky	Dassie Rat - live	1

Table 3: Mammal signs, or sightings in 5 km of driven transect and 2 km of walking survey in the Khan River, 3 and 5 September 2007.

Khan River Tributary	River banks	Baboon - troop	10+
Khan River Tributary	Riverbed	Kudu - droppings	6
Khan River Tributary	Riverbed	Oryx - droppings	6
Khan River Tributary	Riverbanks	Dassie -heard	1
Khan River Main	Slopes	Klipspringer -live	2
Khan River Tributary	Riverbed	Jackal – live	1
Khan River Tributary	Slopes	Dassie Rat	1

Table 4 : Mammal signs or sightings in the Pit area, 5 September 2007.

Pit Area	Open rocky	Kudu - droppings	7
Pit Area	Riverbed	Elephant Shrew - live	1

Table 5: Mammal signs or sightings in the Waste Rock Site North, 5 September 2007

Waste Rock Site North	River wash	Kudu -droppings	7
Waste Rock Site North	Rocky river wash	Elephant Shrew -live	1

The two possible roads out of the proposed Valencia Mine contrast greatly in terms of biodiversity richness. The farm road through to the Bloemhof farm was very low in birds, relative to the alternate routes through the Khan River sections, which were high. The only Lappet-faced Vulture was seen flying from this area, but no nests were seen in the Khan. The number of vehicle tracks and the passage of a 4-wheel drive during one of my surveys suggest that any likelihood of vultures breeding in the Khan is remote. This species tends to avoid disturbance close to their nests and have deserted some riverline breeding sites as a result (P Bridgeford unpublished data).

Data quality and uncertainty

Three days of sampling in winter can only give a snap-shot of the avifauna of an area. In total, 31 species were recorded from all habitats, whereas the Atlas of southern African birds gives a total of 152 species possible in a (much larger) area surrounding Valencia (Brown 2006). Of these, 67 species were classed as rare or vagrant – arriving only when good rains occur – leaving 85 that might be classed as regular (Brown 2006). Thus, this three-day survey sampled about one third of the resident species one can expect to see in habitats similar to this (but over a much broader area covering about 1,800 km^2). Given that this survey followed a lower-than-average rain year (in 2006) bird species numbers are expected to be low.

Many of the lark species are difficult to distinguish and at least one species could not be identified (a possible Pink-billed Lark *Spizocorys conirostris*); the Karoo Long-billed Lark is very similar in appearance to the Benguela Long-billed Lark *Certhilauda benguelensis* (a full endemic) and for which the species (Figure 2) was at first mistaken. The photos have been sent to experts for further identification.

Nocturnal species were under-sampled as only those birds around the present Exploration Camp's Accommodation Complex were sampled on an *ad hoc* basis.

The farm road alternative to the Khan River – that goes to the Bloemhof farm - was sampled for birds because it was originally described on site as an alternative route to the haul road through the Khan. I surveyed it and discovered only later that it was not considered an alternative. I have included the results in here because it might be considered as such in light of the problems that the Khan route may pose. One species that occurred there and was seen nowhere else was the Secretary Bird. It is expected that other birds found in the grassy habitats of sites such as Tailings Dump Option 4 will occur on the grasslands either side of this road. So this area too is of low biodiversity richness, but requires a better assessment.

IMPACTS: POTENTIAL and CUMULATIVE

Dump sites

The mining of rock from the ore body itself will destroy habitat there and the dump sites will be covered by rocks and semi-processed material to a depth of 30 – 56 m. All species recorded there will be forced to move away, but these numbers are low, and in relation to total Namibian populations of the least common species found (the endemic larks and korhaan) this will be a tiny fraction of their population.

The dump sites are also likely to create habitat – for some birds (kestrels, owls) as well as reptiles. This will not however, compensate for any loss in species richness.

Dust will presumably blow from these dumps with strong prevailing winds, coating vegetation and habitats down wind with fine sand and sediment. The effects on birds are unknown but fine dust tends to smother plant leaves, filling the stomata and eventually killing the plant (K Schachtshneider pers comm.). This will reduce avian habitat (cover and possible seeds) downwind.

Vehicle traffic

Disturbance due to vehicle traffic along haul roads is known to affect larger species. For example Lappet-faced Vulture breeding in the Tsondabvlei and Sossusvlei area were disrupted by vehicle traffic and low-flying aircraft to the extent that there is little or no breeding taking place present day (P Bridgeford unpublished data). There are no breeding vultures in the Valencia area – most breed in the Namib-Naukluft Park, just south of Valencia – so the only birds will be those foraging in the vicinity.

While larks often use the roads for perching in the mornings, vehicle traffic will push these birds away from permanent use of the roads. Both Ostrich and Secretary Birds tend to move away from vehicles.

Water abstraction

The uranium mining process requires fresh water as does the maintenance of the Exploration Camp itself (Trevor Stafford pers. comm.). The local aquifer (Khan) water is brackish and requires a reverse-osmosis (desalination) process to make it drinkable. If water is mined from the Khan River, it will reduce the underground flow with possible riverine ecology effects dependent on the degree of abstraction. Given this, we might expect less flowering, less fruiting and lower leaf mass of Acacia and Zizyphus trees and Salvadora bushes present in the river. This will have the effect of reducing the number of trees available for food, shade and roost sites for birds and mammals alike. Namibia's riverine trees are often hundreds of years old and have experienced many drought and flood situations. However, "sustained drought" which is what water abstraction represents is less likely to be tolerated by these trees and it is likely that these Khan River trees, like those of the Swakop River, will eventually die, impoverishing the river (K Schachtschneider pers comm.)

Thus, the water abstraction as both an immediate and cumulative impact, particularly in light of longer droughts expected under climate change (IPCC 2001) for western Namibia, must be considered when water use for the proposed Uranium Mine is considered.

MITIGATION of IDENTIFIED IMPACTS

The least biodiversity-rich Dumping Site of the two proposed is the **Waste Rock Dump North**. This was so for birds since almost none were recorded, and similarly for mammals since only two species were recorded. Thus of the two Waste Rock Sites the North site would result in less loss in biodiversity than the South Site.

Of the two **Tailings Dump** Options, the least species rich site was Tailings Dump Option 5 (seven bird species, no mammals) relative to Tailings Dump Option 4 (14 bird species and seven mammals). Thus the better Tailings Dump Option to reduce impacts would be the Tailings Dump Option 5.

The **Plant Site** itself held a low richness of birds but large numbers of zebra tracks occurred across it and it appears to be something of a highway for Hartmann's Mountain Zebra. The erection of a plant on this site holds little biodiversity loss for birds, and zebra can move around the area as long as it not fenced to stop daily or weekly migrations.

The proposed road through the **Khan River** had a reasonably high avian diversity (12 species of birds) and had the highest number of mammals (seven species). Relative to the farm road out to the Bloemhof farm, the Khan River was higher in both bird and mammal richness. Thus the existing road through to the Bloemhof farm would cause less biodiversity loss than the Khan River option.

There is no maintained road in the Khan River and if one were constructed it is unlikely to survive floods that occur through the river on an irregular basis. The 1985 flood for example, was large and filled the river from wall to wall (Jacobsohn *et al.* 1995). At present the loose sandy bed is difficult to traverse, even for a 4-wheel drive, so a truck laden with rocks will struggle through such an area.

If a road were constructed through the Khan the vehicle traffic will reduce bird richness through dust and noise pollution. This is especially likely with larger more sensitive species such as vultures and raptors (as explained above) which require pristine environments.

Water abstraction from the Khan River for the mining process and the water consumption for the mine personnel will almost certainly influence the ecology of the Khan River. The "sustained" drought this results in is different to the occasional one that most Namibian biota is adapted to. Thus water should be imported into the site rather than any more abstracted from the Khan River aquifer.

Recommendations

- Waste Rock Dump North is recommended as it would result in less biodiversity loss than Waste Rock Dump South;
- Tailings Dump Option 5 is recommended as it would result in less biodiversity loss relative to the alternative Tailings Dump Option 4;
- An alternative to the Khan River access route is recommended given the higher biodiversity therein and the flooding that occurs irregularly but frequently enough to destroy any road built therein;
- The farm road via the Bloemhof Farm is recommended rather than any alternate through the Khan River, to reduce biodiversity loss;
- Water is best piped into the mine rather than mined locally from the Khan River to avoid short- and long-term ecological impacts on the river.

I also recommend that a second bird (and mammal) survey be undertaken when the rains have brought other nomadic or migratory species into the area. Breeding will also be uncovered and it is likely that other avian species of importance may be picked up. Since rains generally occur by March in this area this would be the best month to undertake a study.

General Conclusions

On present evidence the proposed Uranium Mine centred on the Valencia farm is in an area of low avian diversity and very few birds were encountered in any of the sites surveyed. Only one Red-listed species (Lappet-faced Vulture) was seen in three days and three near-endemic species (and subspecies) were recorded at low density. The impacts therefore on the avian diversity would be very low. Water abstraction from the Khan River may however have both short- and long-term detrimental effects and should be avoided. I recommend that Waste Rock Dump North be used in preference to Waste Rock Dump South and Tailings Dump Option 5 be used in preference to Option 4 to reduce impacts on avian diversity loss. A breeding season survey following the rains (~March) is required to verify these results.

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Appendix G3

Plants observed in the area of interest

Table 8-1: Species list Digby Wells 2007

Species name	Common name	Ecological status	Growth form	Biogeographic status	Conservation and Legal	Abundance
Acanthopsis disperma			Dwarfshrub			
Aristida adscensionis	Annual three awn	Pioneer increaser 2	Grass			
Enneapogon desvauxii	Eight day grass	Pioneer subclimax, increaser 2	Grass			
Enneapogon scaber	Rock nine awned grass	Climax	Grass			
Eragrostis nindensis	Wether Love Grass	Sub climax increaser 2	Grass			
Schmidtia kalihariensis	Kalahari sour grass	Pioneer, Increaser 2	Grass			
Stipagrostis ciliata	Tall bushmans grass	Climax decreaser	Grass			
Stipagrostis obtusa	Small bushman's grass	Climax decreaser	Grass			
Stipagrostis uniplumis	Silky Bushman's grass	Sub climax increaser 2	Grass			
Geigeria ornativa	Dune vermeer bush		Herb			
Tapinanthus oleifolius		Parasite	Parasitic			
Adenia pechuelii	Elephants foot		Shrub	Near endemic		
Aptosimum spinescens			Shrub			
Asparagus pearsonii			Shrub			
Boscia foetida	Stinkbush		Shrub			
Calicorema capitata	Star of the Namib		Shrub			
Monechma cleomoides			Shrub			
Euphorbia virosa	Candelabra Euphorbia	.	Succulent shrub		CITES App.2	
Hoodia			Succulent shrub	Endemic	Nat. Cons. Ordance	Rare
Aloe	Sand aloe		Succulent shrub		Nat. Cons. Ordance	
Acacia erioloba	Camel thorn		Tree			
Aloe dichotoma	Quiver tree		Tree		CITES App.2 Nat. Cons. Ordance	
Faidherbia albida	Ana tree		Tree			
Moringa ovalifolia			Tree		Nat. Cons.	

					Ordance	
Tamarix usneoides	Wild tamarisk		Tree			
Adenolobus pechuelii			Shrub			
Commiphora saxicola	Rock corkwood		Shrub	Near-endemic		
Commiphora virgata	Slender corkwood		Shrub	Near-endemic		
Salvadora persica	Mustard bush		Tree, shrub			
Sarcocaulon marlothii	Bushman's Candle		Shrub	Endemic		

Table 8-2: Species list Eco.plan 2006 and Kolberg 2007.

Species	Biogeographic status	Growth form	RDL Status	Legal status	Abundance
Abutilon pycnodon #					occasional
Acacia erioloba.		tree		FA	rare
Acacia senegal var. rostrata #					rare
Adenia pechuelii	endemic	succulent shrub			common
Adenolobus pechuelii		dwarfshrub			abundant
Aizoanthemum dinteri	endemic	herb			rare
Aloe dichotoma		Tree		NC,C2	occasional
Aloe hereroensis		succulent shrub		NC,C2	rare
Aloe namibensis	endemic	succulent shrub	LC	NC,C2	occasional
Amphiasma divaricatum	endemic	dwarfshrub			occasional
Anticharis imbricata	endemic	herb			common
Anticharis inflata	endemic	herb			occasional
Aptosimum arenarium	endemic	herb			common
Aptosimum lineare		herb			common
Aptosimum		herb			common
Aristida adscensionis		Grass annual			occasional

Aristida parvula		Grass annual			occasional
Asparagus pearsonii		dwarfshrub			common
Barleria lancifolia		herb			occasional
Barleria merxmuelleri	endemic	herb			rare
Blepharis gigantea	endemic	dwarfshrub			occasional
Blepharis grossa #	near-endemic				common
Blepharis obmitrata		herb			occasional
Boscia albitrunca		tree/shrub		FA	rare
Boscia foetida		shrub			common
Calicorema capitata		dwarfshrub			abundant
Calostephane divaricata		herb			occasional
Camptoloma rotundifolium #	near-endemic				common
Carallocarpus dissectus		climber			rare
Cardiospermum pechuelli		climber			rare
Chamaesyce glandurigera		herb			abundant
Chascanum garipense		herb			occasional
Chascanum pinnatifidum		herb			rare
Chascanum pumilum		herb			occasional
Cleome suffruticosa	endemic	herb			abundant
Codon royenii #	near-endemic				common
Commicarpus squarrosus.		herb			rare
Commiphora glaucescens		tree/shrub			common
Commiphora saxicola.	endemic	shrub			abundant
Commiphora tenuipetiolata.		tree/shrub			common

Commiphora virgata.	endemic	shrub			abundant
Corbichonia decumbens		herb			common
Cordia sinensis		tree			rare
Crotalaria podocarpa		herb			occasional
Cucumella aspera #					common
Cryptolepis decidua		dwarfshrub			abundant
Danthoniopsis ramosa		Grass perennial			rare
Dauresia alliariifolia #					common
Dicoma capensis		herb			rare
Ornithogalum crispum		geotype			rare
Ornithogalum magnum		geotype			occasional
Dyerophytum africanum		dwarfshrub			occasional
Ehretia alba #					rare
Emilia marlothiana		herb			common
Enneapogon desvauxii		Grass annual			wide-spread
Enneapogon scaber.		Grass perennial			common
Enneapogon scoparius #					occasional
Eragrostis nindensis		Grass perennial			wide-spread
Eriocephalus pinnatus	endemic	dwarfshrub			rare
Euphorbia guerichiana		tree/shrub		C2	rare
Euphorbia lignosa #	near-endemic				occasional
Euphorbia phylloclada.		herb			common
Euphorbia virosa		succulent shrub		C2	common
Fagonia isotricha		herb			common

Felicia anthemidodes		dwarfshrub			rare
Forskaolea hereroensis		herb			occasional
Geigeria alata #					abundant
Geigeria ornativa		herb			common
Geigeria pectidea		herb			common
Gisekia africana		herb			common
Helichrysum tomentosulum		dwarfshrub			occasional
Helichrysum tomentosulum subsp. *tomentosulum #*					common
Heliotropium tubulosum		herb			rare
Helychrysum roseo-niveum		herb			occasional
Hermannia amabilis.	endemic	herb			rare
Hermannia helianthemum		herb			common
Hermannia solaniflora	endemic	herb			rare
Hermbstaedtia spathulifolia	endemic	herb			rare
Hoodia sp. #					
Indigofera adenocarpa		herb			rare
Indigofera auricoma		herb			common
Indigofera teixeirae		herb			wide-spread
Jamesbrittenia hereroensis	endemic	herb			rare
Kissenia capensis		herb			occasional
Kohautia caespitosa .ssp.*brachyloba*		herb			occasional
Kohautia		herb			occasional

cynanchica					
Limeum aethiopicum.		herb			common
Lotononis platycarpa.		herb			rare
Lycium oxycarpum		shrub			rare
Maerua schinzii		tree/shrub		FA	occasional
Gymnosporia senegalensis		shrub			rare
Mesembryanthemum guerichianum #					occasional
Mollugo cerviana		herb			occasional
Monechma cleomoides		dwarfshrub			common
Monechma genistifolium ssp.*genistifolium*		dwarfshrub			occasional
Monsonia umbellata		herb			common
Moringa ovalifolia		tree		NC	occasional
Orepetium capense		Grass annual			occasional
Orthanthera albida		dwarfshrub			rare
Parkinsonia africana		shrub		FA	rare
Pavonia rehmannii	endemic	herb			rare
Pechuel-Loeschea leubnitziae #					rare
Pegolettia senegalensis		herb			occasional
Pelargonium otaviense	endemic	dwarfshrub			rare
Pergularia daemia #					rare
Petalidium canescens #	endemic				common
Petalidium pilosi – bracteolatum	endemic	dwarfshrub			rare
Petalidium setosum		herb			common
Petalidium variabile		dwarfshrub			common

Phaeoptilum spinosum #					occasional
Phragmanthera guerichii #	near-endemic				rare
Phyllanthus pentandrus.	endemic	herb			occasional
Polygala guerichiana		herb			occasional
Psilocaulon salicornioides #	near-endemic				occasional
Ptycholobium biflorum ssp. *biflorum*		herb			common
Rhus marlothii #					occasional
Ruellia diversifolia #					common
Salsola aphyll		dwarfshrub			occasional
Salvadora persica L.		shrub			rare
Sarcocaulohn marlothii	endemic	dwarfshrub			occasional
Sarcostemma viminale #					rare
Schmidtia kalihariensis		Grass annual			rare
Seddera schizantha		dwarfshrub			occasional
Sericocoma heterochiton		herb			rare
Sesamum marlothii.	endemic	herb			common
Sesamum tryphyllum		herb			occasional
Sesbania pachycarpa		herb			rare
Sesuvium sesuvioides.		herb			abundant
Sida ovata Forssk.		herb			rare
Solanum	endemic	herb			occasional

rigescentoides					
Sterculia africana		tree		FA	occasional
Stipagrosis ciliata		Grass perennial			abundant
Stipagrosis damarensis	near endemic	Grass perennial			rare
Stipagrosis hirtigluma		Grass annual			wide-spread
Stipagrosis hochstetteriana		Grass perennial			occasional
Stipagrosis obtusa		Grass perennial			common
Stipagrosis uniplumis		Grass perennial			common
Talinum caffrum.		geophyte			occasional
Tamarix usneoides #					occasional
Tephrosia dregeana		herb			common
Tephrosia monophylla #	endemic				occasional
Tetragonia reduplicata #	near-endemic				occasional
Thamnosma africana		herb			rare
Trianthema triquetra		herb			common
Tribulus zeyheri		herb			common
Trichodesma africanum (L.)		herb			occasional
Tripteris microcarpa		herb			occasional
Triraphis pumilio R.		Grass annual			occasional
Triraphis ramosissima		Grass perennial			rare
Zygophyllum cylindrifolium #	endemic				common
Zygophylum simplex		herb			abundant
Zygophylum stapffii		Succulent shrub			rare

 # - Observations by Kolberg (2007)

Appendix G4:

Mammals that could occur in the Valencia Mine area and their probability of occurrence.

Species	English name	IUCN status	Probability of occurrence
ORDER: Carnivora			
Galerella sanguinea	Slender Mongoose	LR - least concern	0.99
Otocyon megalotis	Bat-eared Fox	LR - least concern	0.92
Vulpes chama	Cape Fox	LR - least concern	0.92
*Panthera pardus**	Leopard	LR - least concern	0.92
Crocuta crocuta	Spotted Hyaena	LR - conservation dependent	0.82
*Ictonyx striatus**	Striped Polecat	LR - least concern	0.92
*Mellivora capensis**	Honey Badger	LR - least concern	0.92
Genetta genetta	Small-spotted Genet	LR - least concern	0.92
Cynictis penicillata	Yellow Mongoose	LR - least concern	0.92
*Proteles cristatus**	Aardwolf	LR - least concern	0.83
*Acinonyx jubatus**	Cheetah	Vulnerable	0.75
ORDER: Chiroptera			
Cistugo seabrai	Angolan hairy bat	LR - near threatened	0.99
Rhinolophus clivosus	Geoffroy's Horseshoe Bat	LR - least concern	0.92
Tadarida aegyptiaca	Egyptian Free-tailed Bat	LR - least concern	0.83
Nycteris thebaica	Egyptian Slit-faced Bat	LR - least concern	0.83
Eptesicus hottentotus	Long-tailed Serotine Bat	LR - least Concerned	0.83
Rhinolophus darlingi	Darling's Horseshoe Bat	LR - least concern	0.75
Neoromicia capensis	Cape Serotine Bat	LR - least concern	0.75
Miniopterus natalensis	natal long-fingered bat	LR - near threatened	0.75
Scotophilus dinganii	Yellow House Bat	LR - least concern	0.75
Neoromicia somalicus	Somali serotine	LR - least concern	0.75
Neoromicia zuluensis	Aloe Bat	LR - least concern	0.75
Rhinolophus denti	Dent's Horseshoe Bat	Data Defecient	0.67
Scotophilus leucogaster	White-bellied yellow bat	LR - least concern	0.67
Rhinolophus fumigatus	Rüppell's horseshoe bat	LR - least concern	0.58
Hipposideros caffer	Sundevall's Leaf-nosed Bat	LR - least concern	0.58
Hipposideros commersoni	Commerson's roundleaf bat	LR - near threatened	0.58
Hipposideros marungensis		LR - near threatened	0.58
Sauromys petrophilus	Flat-headed Free-tail Bat	LR - least concern	0.58
Eidolon helvum	Straw-coloured fruit bat	LR - least concern	0.50
ORDER: Rodentia			
Desmodillus auricularis	Short-tailed Gerbil	LR - least concern	0.99
Gerbillurus paeba	Hairy-footed Gerbil	LR - least concern	0.99
Mastomys coucha	Multimammate Mouse	LR - least concern	0.99
Micaelamys namaquensis	Namaqua Rock Mouse	LR - least concern	0.92
Saccostomus campestris	Pouched mouse	LR - least concern	0.92
Thallomys paedulcus	Acacia Rat	LR - least concern	0.92
Aethomys chrysophilus	Red Veld Rat	LR - least concern	0.83
Rhabdomys pumilio	Striped Mouse	LR - least concern	0.83
Thallomys nigricauda	Black-tailed Tree Rat	LR - least concern	0.83
Mastomys natalensis	Natal Multimammate Mouse	LR - least concern	0.83
Gerbillurus setzeri	Setzer's Hairy footed Gerbil	LR - least concern	0.83
Graphiurus microtis	Small eared Doormouse	LR - least concern	0.83
Graphiurus rupicola	Stone Doormouse	LR - least concern	0.83
Petromyscus collinus	Pygmy Rock Mouse	LR - least concern	0.83
Tatera leucogaster	Bushveld Gerbil	LR - least concern	0.83
Parotomys littledalei	Littledale's Whistling Rat	LR - least concern	0.75

Species	English name	IUCN status	Probability of occurrence
Malacothrix typica	Gerbil Mouse	LR - least concern	0.75
Mus indutus	Desert Pygmy Mouse	LR - least concern	0.75
Xerus princeps	Damara Ground Squirrel	LR - least concern	0.75
Dasymys nudipes	Angolan marsh rat	LR - near threatened	0.67
Cryptomys damarensis	Damaraland Mole-rat	LR - least concern	0.67
OTHER MAMMALS			
Crocidura cyanea	Reddish-grey Musk Shrew	LR - least concern	0.99
Lepus microtis	African savanna hare	LR - least concern	0.99
Elephantulus intufi	Bushveld Elephant-shrew	LR - least concern	0.99
Macroscelides proboscideus	Round-eared Elephant-shrew	LR - least concern	0.99
Atelerixs frontalis*	South African Hedgehog	LR - least concern	0.92
Lepus saxatilis	Scrub/Savannah Hare	LR - least concern	0.92
Pronolagus randensis	Jameson's Red Rock Rabbit	LR - least concern	0.92
Elephantulus rupestris	Smith's Rock Elephant-shrew	LR - least concern	0.92
Madoqua damarensis	Damara Dikdik	LR - least concern	0.75
Orycteropus afer	Aardvark/Ant bear	LR - least concern	0.83
Phacochoerus africanus	Warthog	LR - least concern	0.75
Galago moholi*	Southern Lesser Galago	LR - least concern	0.67
Manis temminckii*	Pangolin	LR - near threatened	0.58
Crocidura fuscomurina	Tiny Musk Shrew	LR - least concern	0.50
Eremitalpa granti	Grant's golden Mole rat	LR - near threatened	0.42
LR – IUCN Lower Risk Category; CD – Conservation Dependent; LC – Least Concerned; NT – Near Threatene *CITES species			

Appendix G5:

Birds that could occur in the Valencia Mine area and their probability of occurrence.

Scientific	English Name	Endemism	IUCN Status	Probability of occurrence
Apus apus	Eurasian Swift		LC	0.99
Apus bradfieldi	Bradfield's Swift	Near endemic	LC	0.99
Burhinus capensis	Spotted Dikkop		LC	0.99
Caprimulgus tristigma	Freckled Nightjar		LC	0.99
*Falco biarmicus**	Lanner Falcon		LC	0.99
*Oena capensis**	Namaqua Dove		LC	0.99
Rhinoptilus africanus	Double-banded Courser		LC	0.99
Tachymarptis melba	Alpine Swift		LC	0.99
Amadina erythrocephala	Redheaded Finch	Near Endemic	LC	0.99
*Ardeotis kori**	Kori Bustard		LC	0.99
Calendulauda sabota / Mirafra sabota	Sabota Lark	Near Endemic	LC	0.99
Chersomanes albofasciata	Spikeheeled Lark	Near Endemic	LC	0.99
Cisticola subruficapilla		Near Endemic	LC	0.99
Emberiza impetuani	Larklike Bunting		LC	0.99
Emberiza tahapisi	Rock Bunting		LC	0.99
Eremomela icteropygialis	Yellow-bellied Eremomela		LC	0.99
Hirundo rustica	Eurasian Swallow		LC	0.99
Malcorus pectoralis	Rufous-eared Warbler	Near Endemic	LC	0.99
Monticola brevipes	Short-toed Rock-Thrush	Near Endemic	LC	0.99
Myrmecocichla formicivora	Anteating Chat	Near Endemic	LC	0.99
*Neotis ludwigii**	Ludwigs Bustard	Near Endemic	LC	0.99
Numida meleagris	Helmeted Guineafowl		LC	0.99
Prinia flavicans	Blackchested Prinia		LC	0.99
*Buteo augur**	Augur Buzzard		LC	0.94
*Circaetus pectoralis**	Blackbreasted Snake Eagle		LC	0.94
Cursorius rufus	Burchell's courser	Breeding near endemic	LC	0.94
*Falco peregrinus**	Peregrine Falcon		LC	0.94
*Hieraaetus pennatus**	Booted Eagle		LC	0.94
Achaetops pycnopygius	Rockrunner	Near Endemic	LC	0.94
Anthus similis	Longbilled Pipit		LC	0.94
*Bubo capensis**	Cape Eagle Owl		LC	0.94
Cercomela schlegelii	Karoo Chat	Near Endemic	LC	0.94
Cisticola aridulus	Desert Cisticola		LC	0.94
Eupodotis/Afrotis afraoides	Whitewinged/Northern-Black Korhaan	Near Endemic	LC	0.94
Francolinus hartlaubi / Pternistis hartlaubi	Hartlaubs Spurfowl	Near Endemic	LC	0.94
Mirafra passerina	Monotonous Lark	Near Endemic	LC	0.94
Oenanthe pileata	Capped Wheatear	Near Endemic	LC	0.94
Quelea quelea	Redbilled Quelea		LC	0.94
Serinus alario	Black-headed Canary	Near Endemic	LC	0.94
Serinus flaviventris / Crithagra flaviventris	Yellow Canary	Near Endemic	LC	0.94
Sylvietta rufescens	Longbilled Crombec		LC	0.94

Scientific	English Name	Endemism	IUCN Status	Probability of occurrence
*Tyto alba**	Barn Owl		LC	0.94
Apus affinis	Little Swift		LC	0.88
Apus caffer	Whiterumped Swift		LC	0.88
Caprimulgus rufigena	Rufous-cheeked Nightjar		LC	0.88
Cursorius temminckii	Temminck's Courser		LC	0.88
*Falco rupicoloides**	Greater Kestrel		LC	0.88
*Milvus migrans**	Black Kite		LC	0.88
*Polemaetus bellicosus**	Martial Eagle		LC	0.88
Vanellus coronatus	Crowned Plover		LC	0.88
Anthoscopus minutus	Cape Penduline-tit	Near Endemic	LC	0.88
Bradornis infuscatus	Chat Flycatcher	Near Endemic	LC	0.88
Calandrella cinerea	Redcapped Lark		LC	0.88
Corvus capensis	Black Crow		LC	0.88
Francolinus levaillantoides / Scleroptila levaillantoides	Orange River Francolin		LC	0.88
Lanius collurio	Redbacked Shrike		LC	0.88
Lanius minor	Lesser Grey Shrike		LC	0.88
Mirafra africanoides	Fawn-coloured Lark	Near Endemic	LC	0.88
Muscicapa striata	Spotted Flycatcher		LC	0.88
*Otus leucotis/Ptilopsis granti**	WHITE-FACED SCOPS-OWL		LC	0.88
Parus cinerascens	Ashy Tit	Near Endemic	LC	0.88
Passer motitensis	Great Sparrow	Near Endemic	LC	0.88
Ploceus velatus	Masked Weaver	Near Endemic	LC	0.88
Zosterops pallidus	Orange River White-eyed	Near Endemic	LC	0.88
*Aquila rapax**	Tawny Eagle		LC	0.81
Ciconia ciconia	White Stork		LC	0.81
Colius colius	White-backed mousebird	Near Endemic	LC	0.81
*Elanus caeruleus**	Blackshouldered Kite		LC	0.81
Pterocles bicinctus	Double-banded snadgrouse	Near Endemic	LC	0.81
Rhinoptilus chalcopterus	BRONZE-WINGED COURSER		LC	0.81
Tockus monteiri	Monteiro's honrbill	Near Endemic	LC	0.81
*Agapornis roseicollis**	Rosy-faced Lovebird	Near Endemic	LC	0.81
Batis pririt	Pririt Batis	Near Endemic	LC	0.81
Corvus albus	Pied Crow		LC	0.81
Coturnix coturnix	Common Quail		LC	0.81
Creatophora cinerea	Wattled Starling		LC	0.81
Erythropygia paena / Cercotrichus paena	Kalahari Scrub-robin	Near Endemic	LC	0.81
Francolinus adspersus / Pternistis adspersus	Red-billed Spurfowl	Near Endemic	LC	0.81
Hirundo spilodera	South African Cliff Swallow		LC	0.81
Lamprotornis australis	Burchells starling		LC	0.81
Lanioturdus torquatus	White-tailed shrike	Near Endemic	LC	0.81
Lanius collaris	Fiscal Shrike		LC	0.81
Passer diffusus	Southern Greyheaded Sparrow		LC	0.81
Phylloscopus trochilus	Willow Warbler		LC	0.81
Serinus atrogularis/Crithagra atrogularis	Blackthroated Canary		LC	0.81
Sporopipes squamifrons	Scaly-feathered finch	Near Endemic	LC	0.81
Charadrius asiaticus	Caspian Plover		LC	0.75
Ciconia abdimii	Abdim's Stork		LC	0.75
*Falco subbuteo**	Northern Hobby Falcon		LC	0.75
*Polihierax semitorquatus**	Pygmy Falcon		LC	0.75
Tockus leucomelas	Southern Yellow-billed Hornbill	Near Endemic	LC	0.75
Urocolius indicus	Redfaced Mousebird		LC	0.75
Anthus vaalensis	Buffy Pipit		LC	0.75

Scientific	English Name	Endemism	IUCN Status	Probability of occurrence
Dicrurus adsimilis	Forktailed Drongo		LC	0.75
Estrilda erythronotos	Blackcheeked Waxbill		LC	0.75
*Eupodotis ruficrista / Lophotis ruficrista**	Red-crested Korhaan	Near Endemic	LC	0.75
Granatina granatina / Uraeginthus granatinus	Violeteared Waxbill	Near Endemic		0.75
Hippolais icterina	Icterine Warbler		LC	0.75
Hirundo dimidiata	Pearlbreasted Swallow		LC	0.75
Lamprotornis nitens	Glossy Starling		LC	0.75
Laniarius atrococcineus	Crimsonbreasted Shrike		LC	0.75
Namibornis herero	Herero Chat	Near Endemic	LC	0.75
Nectarinia senegalensis/Chalcomitra senegalensis	SCARLET-CHESTED SUNBIRD		LC	0.75
Oriolus oriolus	EURASIAN GOLDEN-ORIOLE		LC	0.75
Plocepasser mahali	Whitebrowed Sparrowweaver		LC	0.75
Ploceus rubiginosus	Chestnut Weaver		LC	0.75
Riparia paludicola	Brownthroated Martin		LC	0.75
Vidua paradisaea	Paradise Whydah		LC	0.75
Vidua regia	Shaft-tailed Whydah	Near Endemic	LC	0.75
*Gyps coprotheres**	Cape Vulture	Near Endemic	V	0.69
*Bubulcus ibis**	Cattle Egret		LC	0.69
*Buteo vulpinus / Buteo buteo**	Bruinjakkalsvoël		LC	0.69
Coracias naevius	Purple Roller		LC	0.69
*Gyps africanus**	White-backed vulture		LC	0.69
Merops hirundineus	SWALLOW-TAILED BEE-EATER		LC	0.69
Tockus nasutus	Grey Hornbill		LC	0.69
Bradornis mariquensis	Marico Flycatcher	Near Endemic	LC	0.69
Bubalornis niger	Red-billed Buffalo-Weaver		LC	0.69
Camaroptera fasciolata / Calamonastes fasciolata	Barred Wren-Warbler	Near Endemic	LC	0.69
Cinnyricinclus leucogaster	Plumcoloured Starling		LC	0.69
Emberiza flaviventris	Goldenbreasted Bunting		LC	0.69
*Estrilda astrild**	Common Waxbill		LC	0.69
Eurocephalus anguitimens	White-crowned shrike	Near Endemic	LC	0.69
Francolinus sephaena / Dendroperdix sephaena	Crested Francolin		LC	0.69
Francolinus swainsonii / Pternistis swainsonii	Crested francolin	Near Endemic	LC	0.69
Hirundo cucullata	Greater Striped Swallow		LC	0.69
Psophocichla litsipsirupa	Groundscraper Thrush		LC	0.69
Pytilia melba	Melba Finch		LC	0.69
Tchagra australis	Threestreaked Tchagra		LC	0.69
*Terathopius ecaudatus**	BATELEUR		LC	0.69
Tockus damarensis	Damara hornbill	Near Endemic	LC	0.69
Ardea melanocephala	Blackheaded Heron		LC	0.63
Chrysococcyx caprius	Diederik Cuckoo		LC	0.63
Corythaixoides concolor	Grey Lourie		LC	0.63
*Hieraaetus spilogaster/Aquila spilogaster**	AFRICAN HAWK-EAGLE		LC	0.63
Merops apiaster	Eurasian Bee-eater		LC	0.63
Cinnyris mariquensis / Nectarinia mariquensis	Marico Sunbird		LC	0.63
*Glaucidium perlatum**	Pearlspotted Owl		LC	0.63
Nilaus afer	Brubru		LC	0.63

Scientific	English Name	Endemism	IUCN Status	Probability of occurrence
*Poicephalus rueppellii**	Ruppells Parrot	Near Endemic	LC	0.63
Tricholaema leucomelas	Pied Barbet	Near Endemic	LC	0.63
Turdoides bicolor	Pied Babbler	Near Endemic	LC	0.63
Turnix sylvatica	Kurrichane Buttonquail		LC	0.63
*Accipiter badius**	Little banded Goshawk		LC	0.56
*Aquila nipalensis**			LC	0.56
Chrysococcyx klaas	Klaas's Cuckoo		LC	0.56
Cuculus gularis	AFRICAN CUCKOO		LC	0.56
Dendropicos fuscescens	Cardinal Woodpecker		LC	0.56
Phoeniculus purpureus	Redbilled Woodhoopoe		LC	0.56
Rhinopomastus cyanomelas	Common Scimitarbill		LC	0.56
Upupa africana / Upapa epops	African Hoopoe		LC	0.56
*Anas capensis**	Cape Teal		LC	0.50
Coracias caudatus	Lilac-breasted Roller		LC	0.50
Tadorna cana	South African Shelduck	Near Endemic	LC	0.50
*Bubo lacteus**	Giant Eagle Owl		LC	0.50
Campethera abingoni	Golden-tailed woodpecker		LC	0.50
Dendropicos namaquus / Thripias namaquus	Bearded Woodpecker			0.50
Indicator minor	Lesser Honeyguide		LC	0.50
Terpsiphone viridis	Paradise Flycatcher		LC	0.50
Cypsiurus parvus	Palm Swift		LC	0.44
Vanellus armatus	Blacksmith Plover		LC	0.44
Halcyon leucocephala	GREY-HEADED KINGFISHER		LC	0.38
Amaurornis flavirostris	Black Crake		LC	0.31
Phoeniculus damarensis	Violet Wood-Hoopoe	Near Endemic	LC	0.31

LR – IUCN Lower Risk Category; CD – Conservation Dependent; LC – Least Concerned; NT – Near Threatene
*CITES species

Appendix G6

Detailed Impact assessment matrices

PRE-CONSTRUCTION AND CONSTRUCTION PHASE

Activity	Area	Impacted Environment	Impact	Positive / Negative / Neutral	Significance / 100	Management/Mitigation Measure	Significance / 100
General construction activities	Entire area	Flora	Increased air pollution which interferes with respiration and photosynthesis.	-ve	32	Have dust suppression mechanisms in place. Regularly maintain equipment to reduce emissions.	16
General construction activities	Entire area	Flora	Increased risk for soil contamination which pollutes the substrates plants rely on for growth.	-ve	28	Regularly maintain equipment to reduce risk of hydrocarbon leaks. Have communication channels set up to report incidences and action plans in place to address issues immediately.	13
General construction activities	Entire area	Fauna	Increased noise levels which will result in emigration of animals.	-ve	33	Consider enclosing point sources of noise to reduce noise levels. Consider use of silencers and other noise muffling devices on equipment and vehicles. Consider screening areas of high noise off from sensitive areas.	21
General construction activities	Entire area	Fauna	Increased air pollution which interferes with respiration and if severe visibility.	-ve	32	Have dust suppression mechanisms in place. Regularly maintain equipment to reduce emissions.	16
General construction activities	Entire area	Fauna	Increased risk for soil contamination which pollutes the habitat of soil-dwelling organisms and affects food plants for other animals.	-ve	24	Regularly maintain equipment to reduce risk of hydrocarbon leaks. Have communication channels set up to report incidences and action plans in place to address issues immediately.	13
Truck and vehicle activity	Entire area	Flora	Increased risk of introduction of alien invasive species if trucks are coming in from other areas.	-ve	36	Establish an alien invasive monitoring and eradication and control programme.	21
Truck and vehicle activity	Waste rock dump & mine area	Flora	Damage to protected and endemic.	-ve	37	Ensure trucks and vehicles remain on roads and areas designated as construction sites to limit disturbance to areas unaffected by construction. Ensure drivers are informed that off-road traveling is prohibited.	16
Truck and vehicle activity	Tailings dump & plant area	Flora	Damage to protected and endemic	-ve	11	Ensure trucks and vehicles remain on roads and areas designated as construction sites to limit disturbance to areas unaffected by construction. Ensure drivers are informed that off-road traveling is prohibited.	11
Truck and vehicle activity	Tailings dump option 4 area	Flora	Damage to protected and endemic.	-ve	37	Ensure trucks and vehicles remain on roads and areas designated as construction sites to limit disturbance to areas unaffected by construction. Ensure drivers are informed that off-road traveling is prohibited.	16
Truck and vehicle activity	Khan River route area	Flora	Damage to protected and endemic.	-ve	37	Ensure trucks and vehicles remain on roads and areas designated as construction sites to limit disturbance to areas unaffected by construction. Ensure drivers are informed that off-road traveling is prohibited.	16
Truck and vehicle activity	Waste rock dump & mine area	Fauna	Increase risk of road-related deaths.	-ve	27	Ensure speed limits are set on all roads and enforce speed limits. Ensure all drivers at the site are informed about speed limits.	11
Truck and vehicle activity	Tailings dump & plant area	Fauna	Increase risk of road-related deaths.	-ve	16	Ensure speed limits are set on all roads and enforce speed limits. Ensure all drivers at the site are informed about speed limits.	11
Truck and vehicle activity	Tailings dump option 4 area	Fauna	Increase risk of road-related deaths.	-ve	32	Ensure speed limits are set on all roads and enforce speed limits. Ensure all drivers at the site are informed about speed limits.	13
Truck and vehicle activity	Khan River route area	Fauna	Increase risk of road-related deaths.	-ve	32	Ensure speed limits are set on all roads and enforce speed limits. Ensure all drivers at the site are informed about speed limits.	13
Removal of perennial vegetation	Entire area	Flora	Loss of natural vegetation.	-ve	43	Remove only vegetation where it is required by planning carefully the areas that will be disturbed. Relocate plants if possible. step-wise process over time	37
Removal of perennial vegetation	Waste rock dump & mine area	Flora	Damage to protected and endemic	-ve	43	Relocate as much vegetation as possible, particularly IUCN and protected and endemic Get specialist input on this.	24
Removal of perennial vegetation	Tailings dump & plant area	Flora	Damage to protected and endemic	-ve	32	Relocate as much vegetation as possible, particularly IUCN and protected and endemic Get specialist input on this.	16
Removal of perennial vegetation	Tailings dump option 4 area	Flora	Damage to protected and endemic	-ve	43	Relocate as much vegetation as possible, particularly IUCN and protected and endemic Get specialist input on this.	24
Removal of perennial vegetation	Khan River route area	Flora	Damage to protected and endemic	-ve	43	Relocate as much vegetation as possible, particularly IUCN and protected and endemic Get specialist input on this.	24
Removal of perennial vegetation	Entire area	Fauna	Harm and death to animals associated with these areas and with the vegetation.	-ve	37	Ensure awareness amongst all staff, contractors and visitors to site to not needlessly harm or hinder animals. Allow animals to escape areas of activity freely.	27

Activity	Area	Impacted Environment	Impact	Positive / Negative / Neutral	Significance / 100	Management/Mitigation Measure	Significance / 100
Removal of perennial vegetation	Entire area	Fauna	Loss of protected / threatened species.	-ve	24	Allow animals to escape areas of activity freely and do not needlessly hinder animals' movement. If possible plan activities in areas during non-breeding seasons of protected or threatened species.	20
Removal of perennial vegetation	Entire area	Flora	Increased risk of establishment of alien invasive species in disturbed areas.	-ve	21	Establish an alien invasive monitoring and eradication and control programme.	16
Stripping & stockpiling of surface soils	Entire area	Flora	Loss of natural vegetation.	-ve	37	Ensure as much herbaceous matter is stockpiled with the soil to retain organic matter in soil and allow establishment of vegetation on stockpiles. Remove only vegetation where and when it is required.	27
Stripping & stockpiling of surface soils	Entire area	Flora	Disturbance to seed bank.	-ve	33	Stockpile soil as recommended by specialist to preserve seed bank in soil as much as possible.	27
Stripping & stockpiling of surface soils	Waste rock dump & mine area	Flora	Loss of protected / threatened species.	-ve	43	Relocate as much vegetation as possible, particularly IUCN and protected species. Get specialist input on this.	13
Stripping & stockpiling of surface soils	Tailings dump & plant area	Flora	Loss of protected / threatened species.	-ve	32	Relocate as much vegetation as possible, particularly IUCN and protected species. Get specialist input on this.	5
Stripping & stockpiling of surface soils	Tailings dump option 4 area	Flora	Loss of protected / threatened species.	-ve	43	Relocate as much vegetation as possible, particularly IUCN and protected species. Get specialist input on this.	13
Stripping & stockpiling of surface soils	Khan River route area	Flora	Loss of protected / threatened species.	-ve	43	Relocate as much vegetation as possible, particularly IUCN and protected species. Get specialist input on this.	13
Stripping & stockpiling of surface soils	Entire area	Fauna	Loss of soil-dwelling organisms.	-ve	33	No mitigation measures.	33
Stripping & stockpiling of surface soils	Entire area	Fauna	Loss of protected / threatened species.	-ve	16	Allow animals to escape areas of activity freely and do not needlessly hinder animals' movement. If possible plan activities in areas during non-breeding seasons of protected or threatened species.	11
General decommissioning activities	Entire area	Fauna and Flora	With removal of infrastructure littering of useless equipment and general littering could negatively affect Fauna and Flora.	-ve	13	Ensure permanent staff and sub-contractors are aware of the restriction on littering.	13

OPERATION PHASE

Activity	Area	Impacted Environment	Impact	Positive / Negative / Neutral	Significance / 100	Management/Mitigation Measure	Significance / 100
Truck and vehicle activity	Entire area	Flora	Increased risk of introduction of alien invasive species if trucks are coming in from other areas.	-ve	36	Establish an alien invasive monitoring and eradication and control programme. awareness creation	32
Truck and vehicle activity	Entire area	Flora	Damage to protected / threatened species.	-ve	32	Ensure trucks and vehicles remain on roads and areas designated as construction sites to limit disturbance to areas unaffected by construction. Ensure drivers are informed that off-road traveling is prohibited.	19
Truck and vehicle activity	Entire area	Fauna	Increased risk of road-related deaths.	-ve	32	Ensure speed limits are set on all roads and enforce speed limits. Ensure all drivers at the site are informed about speed limits.	19
Open pit blasting & mining	Waste rock dump & mine area	Flora	Increased air pollution which interferes with respiration and photosynthesis.	-ve	47	Have dust suppression mechanisms in place.	33
Open pit blasting & mining	Waste rock dump & mine area	Fauna	Increased air pollution which interferes with respiration and if severe visibility.	-ve	47	Have dust suppression mechanisms in place.	33
Open pit blasting & mining	Waste rock dump & mine area	Fauna	Increased noise levels which will result in emigration of animals.	-ve	32	Consider use of silencers and other noise muffling devices on equipment and vehicles. Consider screening areas of high noise off from sensitive areas.	32
Open pit blasting & mining	Waste rock dump & mine area	Fauna	Vibrations from basting may result in animals moving away from the area.	-ve	32	No mitigation measures.	32
Crushing of ore-bearing rock	Waste rock dump & mine area	Flora	Increased air pollution (dust and emissions) which interferes with respiration and photosynthesis.	-ve	47	Have dust suppression mechanisms in place.	24
Crushing of ore-bearing rock	Waste rock dump & mine area	Fauna	Increased noise levels which will result in emigration of animals.	-ve	32	Consider use of silencers and other noise muffling devices on equipment and vehicles. Consider screening areas of high noise off from sensitive areas.	32
Crushing of ore-bearing rock	Waste rock dump & mine area	Fauna	Increased air pollution (dust and emissions) which interferes with respiration and if severe visibility.	-ve	47	Have dust suppression mechanisms in place.	32
Operation of vehicles, heavy machinery and other equipment	Entire area	Flora	Increased risk for soil contamination which pollutes the substrates plants rely on for growth.	-ve	32	Regularly maintain equipment to reduce risk of hydrocarbon leaks. Have communication channels set up to report incidences and action plans in place to address issues immediately.	21
Operation of vehicles, heavy machinery and other equipment	Entire area	Fauna	Increased risk for soil contamination which pollutes the habitat of soil-dwelling organisms and affects food plants for other animals.	-ve	28	Regularly maintain equipment to reduce risk of hydrocarbon leaks. Have communication channels set up to report incidences and action plans in place to address issues immediately.	19
Processing ore	Entire area	Flora	Increased air pollution (dust and emissions) which interferes with respiration and photosynthesis.	-ve	47	Have dust suppression mechanisms in place. Regularly maintain equipment to reduce emissions, constantly monitor emissions	32
Processing ore	Entire area	Flora	Increased risk for soil contamination which pollutes the substrates plants rely on for growth.	-ve	37	Ensure dust suppression mechanisms are in place to reduce risk of dust contaminating soils. Ensure water berms and channels are in place to keep dirty water contained on site and prevent contamination to other areas.	24
Processing ore	Entire area	Fauna	Increased noise levels which will result in emigration of animals.	-ve	24	Consider use of silencers and other noise muffling devices on equipment and vehicles. Consider screening areas of high noise off from sensitive areas.	13
Processing ore	Entire area	Fauna	Increased air pollution (dust and emissions) which interferes with respiration and if severe visibility.	-ve	37	Have dust suppression mechanisms in place. Regularly maintain equipment to reduce emissions.	28
Processing ore	Entire area	Fauna	Increased risk for soil contamination which pollutes the habitat of soil-dwelling organisms and affects food plants for other animals.	-ve	28	Ensure dust suppression mechanisms are in place to reduce risk of dust contaminating soils. Ensure water berms and channels are in place to keep dirty water contained on site and prevent contamination to other areas.	16
Processing ore	Entire area	Fauna	Increased light pollution will impact on nocturnal animals.	-ve	32	Consider directional lighting to limit illumination to areas requiring it.	27
Waste rock disposal on waste rock sites	Waste rock dumps	Flora	Increased air pollution (dust and emissions) which interferes with respiration and photosynthesis.	-ve	28	Have dust suppression mechanisms in place.	20
Waste rock disposal on waste rock sites	Waste rock dumps	Flora	Increased risk for soil contamination which pollutes the substrates plants rely on for growth.	-ve	28	Ensure dust suppression mechanisms are in place to reduce risk of dust contaminating soils. Ensure water berms and channels are in place to keep dirty water contained on site and prevent contamination to other areas.	24

Activity	Area	Impacted Environment	Impact	Positive / Negative / Neutral	Significance / 100	Management/Mitigation Measure	Significance / 100
Waste rock disposal on waste rock sites	Waste rock dumps	Fauna	Death or injury to animals living between the rocks.	-ve	16	Consider relocating any protected fauna species which may have settled in the area. Do not deliberately hinder animal movement or harm or injure animals.	16
Waste rock disposal on waste rock sites	Waste rock dumps	Fauna	Increased noise levels which will result in emigration of animals.	-ve	24	Consider use of silencers and other noise muffling devices on equipment and vehicles. Consider screening areas of high noise off from sensitive areas.	20
Waste rock disposal on waste rock sites	Waste rock dumps	Fauna	Increased air pollution (dust and emissions) which interferes with respiration and if severe visibility.	-ve	28	Have dust suppression mechanisms in place.	20
Waste rock disposal on waste rock sites	Waste rock dumps	Fauna	Increased risk for soil contamination which pollutes the habitat of soil-dwelling organisms and affects food plants for other animals.	-ve	28	Ensure dust suppression mechanisms are in place to reduce risk of dust contaminating soils. Ensure water berms and channels are in place to keep dirty water contained on site and prevent contamination to other areas.	16
Increased radiation levels on site	Entire area	Flora	Increased radiation levels may affect genetic make up of flora and produce hybrids / mutants. High enough radiation levels will kill plants.	-ve	20	No mitigation measures.	0
Increased radiation levels on site	Entire area	Fauna	Increased radiation levels may affect genetic make up of fauna and produce hybrids / mutants. High enough radiation will kill animals.	-ve	20	No mitigation measures.	0
Operation of tailings facility	Tailings dump operation	Flora	Increased air pollution (dust and emissions) which interferes with respiration and photosynthesis.	-ve	47	Have dust suppression mechanisms in place.	0
Operation of tailings facility	Tailings dump operation	Flora	Increased risk for soil contamination which pollutes the substrates plants rely on for growth.	-ve	43	Ensure dust suppression mechanisms are in place to reduce risk of dust contaminating soils. Ensure water berms and channels are in place to keep dirty water contained on site and prevent contamination to other areas.	28
Operation of tailings facility	Tailings dump operation	Fauna	Increased air pollution (dust and emissions) which interferes with respiration and photosynthesis.	-ve	28	Have dust suppression mechanisms in place.	16
Operation of tailings facility	Tailings dump operation	Fauna	Increased noise levels which will result in emigration of animals.	-ve	20	Consider enclosing point sources of noise to reduce noise levels. Consider use of silencers and other noise muffling devices on equipment and vehicles. Consider screening areas of high noise off from sensitive areas.	13
Operation of tailings facility	Tailings dump operation	Fauna	Increased risk for soil contamination which pollutes the habitat of soil-dwelling organisms and affects food plants for other animals.	-ve	43	Ensure dust suppression mechanisms are in place to reduce risk of dust contaminating soils. Ensure water berms and channels are in place to keep dirty water contained on site and prevent contamination to other areas. decontaminate water and tailings as far as possible in contained site before release onto open dumps	28
Activity on routes and roads	Entire area	Flora	Increased air pollution (dust and emissions) which interferes with respiration and photosynthesis.	-ve	28	Have dust suppression mechanisms in place.	16
Activity on routes and roads	Entire area	Fauna	Increased air pollution (dust and emissions) which interferes with respiration and photosynthesis.	-ve	24	Have dust suppression mechanisms in place.	16
Activity on routes and roads	Entire area	Fauna	Increased noise levels which will result in emigration of animals.	-ve	27	Consider use of silencers and other noise muffling devices on equipment and vehicles. Consider screening areas of high noise off from sensitive areas.	20
Activity on routes and roads	Entire area	Flora	Fragmentation of habitat and edge effects due to linear structures may alter vegetation composition.	-ve	37	Ensure areas adjacent to roads are vegetated with natural indigenous flora and are alien invasive free.	28
Activity on routes and roads	Entire area	Fauna	Linear structures may hamper movement of smaller animals and may potentially separate, isolated breeding groups, reducing genetic flow and increasing the risk of inbreeding.	-ve	21	Ensure speed limits are set and enforced and create awareness amongst all drivers to drive responsibly and not needlessly injury or harm animals on the road.	28
General office operation	Mine offices	Fauna	Dispersal of animals due to increased noise levels	-ve	13	Ensure noise levels are kept to a minimum. Create awareness amongst staff to not exceed noise levels beyond what is necessary at the offices.	13

Activity	Area	Impacted Environment	Impact	Positive / Negative / Neutral	Significance / 100	Management/Mitigation Measure	Significance / 100
General office operation	Mine offices	Flora	Increased risk for soil contamination from litter and sewage spills which pollutes the substrates plants rely on for growth.	-ve	28	Monitor sewage tanks and have sewage removed within sufficient time to reduce risk of sewage overflow. Inspect sewage pipes regularly and report all incidences immediately and have action plans in place to deal with any issues arising immediately. Ensure adequate domestic waste bins are supplied and that domestic waste is removed by a reputable contractor. Erect posters to educate staff about the dangers of littering. Create recycling initiatives. Report incidences of littering and clear areas immediately. Follow waste management plans.	16
General office operation	Mine offices	Fauna	Increased risk for soil contamination from litter and sewage spills which pollutes the habitat of soil-dwelling organisms and affects food plants for other animals.	-ve	24	Monitor sewage tanks and have sewage removed within sufficient time to reduce risk of sewage overflow. Inspect sewage pipes regularly and report all incidences immediately and have action plans in place to deal with any issues arising immediately. Ensure adequate domestic waste bins are supplied and that domestic waste is removed by a reputable contractor. Erect posters to educate staff about the dangers of littering. Create recycling initiatives. Report incidences of littering and clear areas immediately. Follow waste management plans.	16
Academic research	Entire area, and beyond site boundaries.	Fauna and Flora	Academic studies conducted in the general area will have a positive impact on the fauna and flora in the area.	+ve	16		
Infrastructure expansion	Drainage lines	Flora and occasional streamflow	Infrastructure expansion in drainage areas will have a negative effect on occasional stream flow and flora	-ve	37	Further infrastructutr expansion projects must attempt to divert occasional streamflow, and plant species within these drainage lines must be transplanted	28

DECOMMISSIONING AND CLOSURE PHASE

Activity	Area	Impacted Environment	Impact	Positive / Negative / Neutral	Significance / 100	Management/Mitigation Measure	Significance / 100
General decommissioning activities	Entire area	Flora	Increased air pollution which interferes with respiration and photosynthesis.	-ve	33	Have dust suppression mechanisms in place. Regularly maintain equipment to reduce emissions.	21
General decommissioning activities	Entire area	Flora	Increased risk for soil contamination which pollutes the substrates plants rely on for growth.	-ve	20	Regularly maintain equipment to reduce risk of hydrocarbon leaks. Have communication channels set up to report incidences and action plans in place to address issues immediately.	16
General decommissioning activities	Entire area	Fauna	Increased noise levels which will result in emigration of animals.	-ve	27	Consider enclosing point sources of noise to reduce noise levels. Consider use of silencers and other noise muffling devices on equipment and vehicles. Consider screening areas of high noise off from sensitive areas.	16
General decommissioning activities	Entire area	Fauna	Increased air pollution which interferes with respiration and if severe visibility.	-ve	33	Have dust suppression mechanisms in place. Regularly maintain equipment to reduce emissions.	21
General decommissioning activities	Entire area	Fauna	Increased risk for soil contamination which pollutes the habitat of soil-dwelling organisms and affects food plants for other animals.	-ve	20	Regularly maintain equipment to reduce risk of hydrocarbon leaks. Have communication channels set up to report incidences and action plans in place to address issues immediately.	16
Truck and vehicle activity	Entire area	Flora	Increased risk of spreading alien invasive species.	-ve	24	Establish an alien invasive monitoring and eradication and control programme.	13
Truck and vehicle activity	Entire area	Flora	Damage to protected / threatened species.	-ve	28	Ensure trucks and vehicles remain on roads and areas designated as construction sites to limit disturbance to areas unaffected by construction. Ensure drivers are informed that off-road traveling is prohibited.	16
Truck and vehicle activity	Entire area	Fauna	Increased risk of road-related deaths.	-ve	16	Ensure speed limits are set on all roads and enforce speed limits. Ensure all drivers at the site are informed about speed limits.	16
Operation of vehicles, heavy machinery and other equipment	Entire area	Flora	Increased risk for soil contamination which pollutes the substrates plants rely on for growth.	-ve	24	Regularly maintain equipment to reduce risk of hydrocarbon leaks. Have communication channels set up to report incidences and action plans in place to address issues immediately.	13
Operation of vehicles, heavy machinery and other equipment	Entire area	Fauna	Increased risk for soil contamination which pollutes the habitat of soil-dwelling organisms and affects food plants for other animals.	-ve	20	Regularly maintain equipment to reduce risk of hydrocarbon leaks. Have communication channels set up to report incidences and action plans in place to address issues immediately.	13
Cessation of various mining-related activities	Entire area	Flora	Decreased dust levels will alleviate respiration and photosynthesis of plants in the vicinity of the pit.	+ve	37	No mitigation measures	
Cessation of various mining-related activities	Entire area	Fauna	Decreased dust levels will alleviate respiration of organisms in the area and visibility should return to normal.	+ve	37	No mitigation measures	
Cessation of various mining-related activities	Entire area	Fauna	Cessation of vibrations and noise at the pit will no longer impact on fauna and animals may slowly start returning to the area.	+ve	24	No mitigation measures	
Revegetation of disturbed areas	Entire area	Flora	Flora returned to area and biodiversity improved	+ve	36	Revegetate with natural indigenous species as far as possible. Reintroduce protected and threatened species when soil quality is sufficient. Re-introduction of stored topsoil .	
Revegetation of disturbed areas	Entire area	Fauna	Fauna slowly returns to area as habitat is replaced	+ve	36	Reduce activity as much as possible in rehabilitated areas.	

Appendix A7

Reptile Report

SPECIALIST CONTRIBUTION:

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CONTENTS

1. **Reptile fauna expected in the Valencia Uranium Mine area**

1.1 ntroduction

A desktop study (i.e. literature review) was conducted for reptiles potentially occurring in the general Valencia area by Mike Griffin of the Ministry of Environment & Tourism in October 2005. According to Griffin (2005) at least 76 species of reptiles are known, reported and/or expected to occur in the Valencia Uranium Mine area. Of these, 31 are snakes (including worm, blind & pythons) and 43 are lizards (17 Gecko's, 11 old world lizards, 7 skinks, 3 plated lizards, 2 agama's and 1 each for chameleon, monitor & worm lizard) while 1 tortoise and 1 terrapin are also expected from the general area.

Approximately 261 species of reptiles are known or expected to occur in Namibia thus supporting approximately 30% of the continents species diversity (Griffin 1998). At least 22% or 55 species of Namibian lizards are classified as endemic. Namibia with approximately 129 species of lizards (Lacertilia) has one of the continents richest lizard fauna and the occurrence of reptiles of "conservation concern" includes about 67% of Namibian reptiles (Griffin 1998). Emergency grazing and large scale mineral extraction in critical habitats are some of the biggest problems facing reptiles in Namibia (Griffin 1998).

The overall reptile diversity and endemism in the general Valencia area is estimated at between 51-60 species and 21-28 species, respectively (Mendelsohn *et al.* 2002). Griffin (1998) presents figures of between 31-40 and 9-10 for endemic lizards and snakes, respectively, from the general western central part of Namibia. Species absent from this area are the burrowing worm lizards, usually associated with more mesic and sandy habitats of eastern Namibia, and tortoises and terrapins (Griffin 1998). Furthermore, Griffin (1998) states that at least 28 reptile species of conservation concern occur in the general area.

The following table indicates the reptile diversity known, reported and/or expected to occur in the general Valencia Uranium Mine area as presented by Griffin (2005):

SPECIES: SCIENTIFIC NAME	**COMMON NAME**
TURTLES & TORTOISES & TERRAPINS	
Geochelone pardalis	Leopard tortoise
Pelomedusa subrufa	Marsh/Helmeted Terrapin
SNAKES	

Worm Snakes	
Leptotyphlops occidentalis	Western Thread/Worm Snake
Leptotyphlops labialis	Damara Thread/Worm Snake
Leptotyphlops scutifrons	Peter's Thread/Worm Snake
Blind Snakes	
Rhinotyphlops lalandei	Delalande's Blind Snake
Rhinotyphlops schinzi	Beaked Blind Snake
Boas & Pythons	
Python anchietae	Namibian Dwarf Python
Typical Snakes	
Lamprophis fuliginosus	Brown House Snake
Pseudaspis cana	Mole Snake
Psammophylax rhombeatus	Spotted Skaapsteker
Dipsina multimaculata	Dwarf Beaked Snake
Psammophis trigrammus	Western Sand Snake
Psammophis notostictus	Karoo Sand Snake
Psammophis leightoni namibensis	Namib Sand Snake
Psammophis subtaeniatus	Western Striped-bellied Sand Snake
Psammophis leopardinus	Leopard Whip Snake
Dasypeltis scabra	Common/Rhombic Egg Eater
Philothamnus semivariegatus	Spotted Bush Snake

Telescopus beetzii	Namaqua Tiger Snake
Telescopus semiannulatus	Southern Tiger Snake
Telescopus sp. nov.	Damara Tiger Snake
Pythonodipsas carinata	Western keeled Snake
Prosymna frontalis	Shouthwestern Shovel-snout
Aspidelaps lubricus infuscatus	Coral Snake
Aspidelaps scutatus scutatus	Shield-nose Snake
Naja anchietae	Angolan Cobra
Naja nigricollis nigricincta	Black-necked Spitting Cobra
Naja woodi	Black Spitting Cobra
Naja nivea	Cape Cobra
Dendroaspis polylepis	Black Mamba
Bitis arietans	Puff Adder
Bitis caudalis	Horned Adder
LIZARDS	
Worm Lizards	
Zygaspis quadrifrons	Kalahari Round-headed Worm Lizard
Skinks	
Mabuya [*Trachylepis*] *acutilabris*	Wedge-snouted Skink
Mabuya [*Trachylepis*] *occidentalis*	Western Three-striped Skink
Mabuya [*Trachylepis*] *hoeschi*	Western Rock Skink

Mabuya [*Trachylepis*] *spilogaster*	Namibian Tree Skink
Mabuya [*Trachylepis*] *sulcata*	Western Rock Skink
Mabuya [*Trachylepis*] *variegata variegata*	Variegated Skink
Mabuya [*Trachylepis*] *wahlbergii*	Wahlberg's Striped Skink
Old World Lizards	
Nucras intertexta	Spotted Sandveld Lizard
Heliobolus lugubris	Bushveld Lizard
Meroles knoxii	Round-snouted Sand Lizard
Meroles cuneirostris	Wedge-snouted Desert Lizard
Meroles suborbitalis	Spotted Desert Lizard
Pedioplanis breviceps	Short-headed Sand Lizard
Pedioplanis lineoocellata	Ocellated Sand Lizard
Pedioplanis namaquensis	Namaqua Sand Lizard
Pedioplanis gaerdesi	Damara Sand Lizard
Pedioplanis undata	Western Sand Lizard
Pedioplanis inornata	Plain Sand Lizard
Pedioplanis hasabensis	Husab Sand Lizard
Plated Lizards	
Cordylosaurus subtessellatus	Dwarf Plated Lizard
Gerrhosaurus nigrolineatus	Black-lined Plated Lizard
Gerrhosaurus validus	Giant Plated Lizard

Monitors	
Varanus albigularis	Rock Monitor
Agamas	
Agama anchietae	Western Rock Agama
Agama planiceps	Namibian Rock Agama
Chameleons	
Chamaeleo namaquensis	Namaqua Chameleon
Geckos	
Afroedura africana africana	African Flat Gecko
Chondrodactylus angulifer namibensis	Giant Ground Gecko
Narudasia festiva	Festive Gecko
Pachydactylus bicolour	Velvety Thick-toed Gecko
Pachydactylus capensis	Cape Thick-toed Gecko
Pachydactylus fasciatus	Damaraland Banded Thick-toed Gecko
Pachydactylus kockii	Koch's Thick-toed Gecko
Pachydactylus punctatus	Speckled Thick-toed Gecko
Pachydactylus turneri	Turner's Thick-toed Gecko
Pachydactylus scherzi	Schertz's Thick-toed Gecko
Pachydactylus rugosus rugosus	Rough Thick-toed Gecko
Pachydactylus weberi	Weber's Thick-toed Gecko

Lygodactylus bradfieldi	Namibian Dwarf Gecko
Ptenopus garrulus maculatus	Common Barking Gecko
Rhoptropus afer	Common Namib Day Gecko
Rhoptropus barnardi	Lesser Namib Day Gecko
Rhoptropus bradfieldi	Bradfield's Namib Day Gecko

Source: Griffin (2005)

According to Henschel *et al* (2000) at least 20 species of lizards (12 geckos, 5 lizards & 3 skinks) have been recorded on the gravel plains at Gobabeb (Desert Research site approximately 150km southwest of Valencia). These lizards are indicated in the following table:

Family & Scientific name	**Common name**
Gekkonidae	
Chondrodactylus angulifer	Giant Ground Gecko
Pachydactylus kockii	Koch's Thick-toed Gecko
Pachydactylus turneri	Turner's Thick-toed Gecko
Pachydactylus scherzi	Schertz's Thick-toed Gecko
Pachydactylus rugosus	Rough Thick-toed Gecko
Palmatogecko rangei	Palmatogecko
Ptenopus carpi	Banded Barking Gecko
Ptenopus garrulus	Common Barking Gecko
Rhoptropus afer	Common Namib Day Gecko
Rhoptropus barnardi	Lesser Namib Day Gecko
Rhoptropus bradfieldi	Bradfield's Namib Day Gecko
Narudasia festiva	Festive Gecko
Lacertidae	
Meroles suborbitalis	Spotted Desert Lizard

Pedioplanis breviceps	Short-headed Sand Lizard
Pedioplanis lineoocellata	Ocellated Sand Lizard
Pedioplanis namaquensis	Namaqua Sand Lizard
Pedioplanis undata	Western Sand Lizard
Scincidae	
Mabuya [*Trachylepis*] *acutilabris*	Wedge-snouted Skink
Mabuya [*Trachylepis*] *occidentalis*	Western Three-striped Skink
Mabuya [*Trachylepis*] *spilogaster*	Namibian Tree Skink

Source: Henschel *et al* (2000)

A pilot study conducted by Kavari (2007) on the reptile diversity associated with the future expansion of the Rössing Uranium Mine (approximately 30km west of Valencia) indicated the presence of 6 reptile species (3 geckos, 1 lizard, 1 chameleon & 1 snake). These are indicated in the following table:

Family & Scientific name	**Common name**
Geckkonidae	
Mabuya [*Trachylepis*] *variegata variegata*	Variegated Skink
Mabuya [*Trachylepis*] *hoeschi*	Western Rock Skink
Ptenopus garrulus	Common Barking Gecko
Lacertidae	
Pedioplanis hasabensis	Husab Sand Lizard
Chameleons	
Chamaeleo namaquensis	Namaqua Chameleon
Typical snakes	
Psammophis notostictus	Karoo Sand Snake

Source: Kavari (2007)

A survey of the reptiles associated with the Trekkopje Uranium Mining area (approximately 40km northwest of Valencia) conducted by Cunningham (2006a) indicated the presence of 22 reptiles species (8 snakes, 1 skink, 2 lizards, 2 agamas, 1 chameleon & 8 geckos).
These are indicated in the following table:

Species: Scientific name	**Species: Common name**
Typical Snakes	
Lamprophis fuliginosus	Brown House Snake
Lycophidion namibianum	Namibian Wolf Snake
Dipsina multimaculata	Dwarf Beaked Snake
Psammophis leightoni namibensis	Namib Sand Snake
Dasypeltis scabra	Common Egg Eater
Aspidelaps lubricus infuscatus	Coral Snake
Naya nigricollis nigricincta	Black-necked Spitting Cobra
Bitis caudalis	Horned Adder
LIZARDS	
Skinks	
Mabuya [Trachylepis] *acutilabris*	Wedge-snouted Skink
Old World Lizards	
Pedioplanis namaquensis	Namaqua Sand Lizard
Pedioplanis husabensis	Husab Sand Lizard
Agamas	
Agama aculeata	Ground Agama

Agama anchietae	Anchieta's Agama
Chameleons	
Chamaeleo namaquensis	Namaqua Chameleon
Geckos	
Chondrodactylus angulifer namibensis	Giant Ground Gecko
Lygodactylus bradfieldi	Bradfield's Dwarf Gecko
Pachydactylus bicolor	Velvety Thick-toed Gecko
Pachydactylus serval serval	Western Spotted Thick-toed Gecko
Ptenopus carpi	Carp's Barking Gecko
Rhoptropus afer	Common Namib Day Gecko
Rhoptropus boultoni	Boulton's Namib Day Gecko
Rhoptropus bradfieldi	Bradfield's Namib Day Gecko

Source: Cunningham (2006a)

This Valencia Uranium Mine falls within the general area commonly referred to as the Dwarf Shrub Savannah (Giess 1971, Mendelsohn *et al.* 2002, Van der Merwe 1983) although include the escarpment area classified as the Western Central Escarpment & Inselbergs (Mendelsohn *et al.* 2002) or the Semi-desert and Savannah Transition Zone (Giess 1971). Reptiles, especially desert adapted species, are habitat specific with species occurring in the Valencia area thus consequently adapted to the above mentioned vegetation types. Only 7% of the Savannah biome are formally protected with the Dwarf Shrub Savannah region in Namibia being badly underrepresented with only 0-2% of the land area being protected (Barnard 1998). The #Gaingu (Spitzkoppe Mountain) communal conservancy is located in the general area, which includes the Rössing Mine, (NACSO 2006) with no freehold conservancies occurring in the general area (Mendelsohn *et al.* 2002).

10 2. Reptile fauna observed in the Valencia Uranium Mine area

2.1 Introduction

A physical survey to determine the actual reptile diversity was conducted in the Valencia Mine Area between 31 October and 3 November 2007. The focus of the fieldwork was at the following sites: Waste Rock Dump North, Waste Rock Dump South, Low-grade Stockpile, Tailings Dump Option 4 and Tailings Dump Option 5. Additional areas – i.e. Pit, Plant, Mining Area and Crusher area – were also surveyed.

2.2 Methods

The literature review (i.e. desktop study) regarding the reptiles known, reported & expected to occur in the general/immediate Valencia Uranium Mine area as determined by Griffin (2005a) was using as basis for the fieldwork. Other supporting reptile surveys in the general area – e.g. Cunningham (2006a), Henschel *et al* (2000) & Kavari (2007) – were also consulted.

Diurnal and nocturnal surveys were conducted in the various focus areas (e.g. Waste Rock dumps, Tailings dumps, etc.).

The surveys consisted of transects (by foot) of various lengths determined by the terrain through the focus areas with reptiles encountered immediately identified or caught using an extendable rod and noose and identified *in situ* and thereafter released.

Potential hiding places – e.g. rocky outcrops, loose standing boulders, shrubs, trees, desert litter (natural litter [dead trees, bark, etc.] & human litter [scrap metal, building wood, etc.] – were all investigated for reptile presence.

A binocular was also used to scour potential reptile basking sites and to facilitate identification without disturbing the reptiles at a distance.

Nocturnal surveys were conducted in a similar way as the diurnal surveys, but using a gas lantern.

All reptiles encountered were plotted using a GPS and photographed.

2.3 Results

The following table indicates the reptile species expected to occur in the Valencia Uranium Mine area (Griffin 2005), species actually encountered during surveys (diurnal & nocturnal) in the area and species reported (i.e. confirmed) from the area:

Species expected: Scientific name	**Species expected: Common name**	**Species observed: (confirmed – this study)**	**Species reported: (confirmed – Valencia staff)**	**Species marginal (†) Status unknown (‡) Should occur but not observed (•)**
TURTLES & TORTOISES & TERRAPINS				
Geochelone pardalis	Leopard tortoise			†
Pelomedusa subrufa	Marsh/Helmeted Terrapin			†
SNAKES				
Worm Snakes				
Leptotyphlops occidentalis	Western Thread/Worm Snake			‡
Leptotyphlops labialis	Damara Thread/Worm Snake			‡
Leptotyphlops scutifrons	Peter's Thread/Worm Snake			‡
Blind Snakes				

Rhinotyphlops lalandei	Delalande's Blind Snake			‡
Rhinotyphlops schinzi	Beaked Blind Snake			‡
Boas & Pythons				
Python anchietae	Namibian Dwarf Python			‡
Typical Snakes				
Lamprophis fuliginosus	Brown House Snake		√	
Pseudaspis cana	Mole Snake			†
Psammophylax rhombeatus	Spotted Skaapsteker			†
Dipsina multimaculata	Dwarf Beaked Snake			•
Psammophis trigrammus	Western Sand Snake	√		
Psammophis notostictus	Karoo Sand Snake			•
Psammophis leightoni namibensis	Namib Sand Snake	√		
Psammophis subtaeniatus	Western Striped-bellied Sand Snake			•
Psammophis leopardinus	Leopard Whip Snake			†
Dasypeltis scabra	Common/Rhombic Egg Eater			†
Philothamnus semivariegatus	Spotted Bush Snake			†
Telescopus beetzii	Namaqua Tiger Snake			•

Telescopus semiannulatus	Southern Tiger Snake			‡
Telescopus sp. nov.	Damara Tiger Snake			‡
Pythonodipsas carinata	Western keeled Snake			‡
Prosymna frontalis	Shouthwestern Shovel-snout			‡
Aspidelaps lubricus infuscatus	Coral Snake		√	
Aspidelaps scutatus scutatus	Shield-nose Snake			•
Naja anchietae	Angolan Cobra			†
Naja nigricollis nigricincta	Black-necked Spitting Cobra			•
Naja woodi	Black Spitting Cobra			†
Naja nivea	Cape Cobra			†
Dendroaspis polylepis	Black Mamba			•
Bitis arietans	Puff Adder			•
Bitis caudalis	Horned Adder	√		
LIZARDS				
Worm Lizards				
Zygaspis quadrifrons	Kalahari Round-headed Worm Lizard			‡
Skinks				
Mabuya [*Trachylepis*] *acutilabris*	Wedge-snouted Skink			•

Mabuya [*Trachylepis*] *occidentalis*	Western Three-striped Skink			•
Mabuya [*Trachylepis*] *hoeschi*	Western Rock Skink	√		
Mabuya [*Trachylepis*] *spilogaster*	Namibian Tree Skink			•
Mabuya [*Trachylepis*] *sulcata*	Western Rock Skink	√		
Mabuya [*Trachylepis*] *variegata variegata*	Variegated Skink			•
Mabuya [*Trachylepis*] *wahlbergii*	Wahlberg's Striped Skink			•
Old World Lizards				
Nucras intertexta	Spotted Sandveld Lizard			•
Heliobolus lugubris	Bushveld Lizard			•
Meroles knoxii	Round-snouted Sand Lizard			‡
Meroles suborbitalis	Spotted Desert Lizard			‡
Pedioplanis breviceps	Short-headed Sand Lizard			‡
Pedioplanis lineoocellata	Ocellated Sand Lizard			‡
Pedioplanis namaquensis	Namaqua Sand Lizard			•
Pedioplanis gaerdesi	Damara Sand Lizard			‡
Pedioplanis undata	Western Sand Lizard			‡

Pedioplanis inornata	Plain Sand Lizard			‡
Pedioplanis hasabensis	Husab Sand Lizard	√		
Plated Lizards				
Cordylosaurus subtessellatus	Dwarf Plated Lizard			†
Gerrhosaurus nigrolineatus	Black-lined Plated Lizard			†
Gerrhosaurus validus	Giant Plated Lizard			†
Monitors				
Varanus albigularis	Rock Monitor			†
Agamas				
Agama anchietae	Western Rock Agama	√		
Agama planiceps	Namibian Rock Agama			†
Chameleons				
Chamaeleo namaquensis	Namaqua Chameleon	√		
Geckos				
Afroedura africana africana	African Flat Gecko			‡
Chondrodactylus angulifer namibensis	Giant Ground Gecko	√		
Narudasia festiva	Festive Gecko			‡
Pachydactylus bicolour	Velvety Thick-toed Gecko			•

Pachydactylus capensis	Cape Thick-toed Gecko			‡
Pachydactylus fasciatus	Damaraland Banded Thick-toed Gecko			‡
Pachydactylus kockii	Koch's Thick-toed Gecko			‡
Pachydactylus punctatus	Speckled Thick-toed Gecko			‡
Pachydactylus turneri	Turner's Thick-toed Gecko	√		
Pachydactylus scherzi	Schertz's Thick-toed Gecko			‡
Pachydactylus rugosus rugosus	Rough Thick-toed Gecko			‡
Pachydactylus weberi	Weber's Thick-toed Gecko			‡
Lygodactylus bradfieldi	Namibian Dwarf Gecko			†
Ptenopus garrulus maculatus	Common Barking Gecko	√		
Rhoptropus afer	Common Namib Day Gecko			•
Rhoptropus barnardi	Lesser Namib Day Gecko			‡
Rhoptropus bradfieldi	Bradfield's Namib Day Gecko	√		

Of the 76 reptile species expected to occur in the general Valencia area, only 12 species were confirmed during the fieldwork (this study).

Two species of snakes (Brown House Snake & Coral Snake) were confirmed – i.e. positively identified by staff at the site.

Sixteen (16) species of reptiles are viewed to be marginal to the area – i.e. habitat not quite suitable (e.g. Marsh/Helmeted Terrapin – known to occur in temporary pools in ephemeral rivers such as the Khuiseb, Khan, Swakop or Leopard Tortoise – known to occasionally enter the true Namib under favourable conditions) or could occur in the area under favourable local conditions (e.g. Monitor lizard – known to migrate into the desert during rainfall episodes or use ephemeral rivers to enter usually unsuitable habitat). This classification was confirmed using numerous references – i.e. literature study on the various species by Branch (1998), Boycott & Bourquin (2000), Broadley (1983), Cunningham (2006b) and Marais (1992).

Eighteen (18) species of reptile are expected to occur (i.e. known from adjacent areas similar in geology & habitat) in the area but were not observed during this current survey (e.g. Velvety Thick-toed Gecko – known to occur in the Trekkopje area) (Cunningham 2006a, Henschel *et al* 2000, Kavari 2007).

The rest – i.e. 28 species of reptiles – are viewed as "status unknown" and could occur in the Valencia area, but due to a lack of reptile surveying in the general area and/or reptiles being very habitat specific and notoriously difficult to observe, were not encountered.

2.4 pecies Accounts

Reptiles encountered during a survey of the Valencia Uranium Mine area:

According to Griffin (2005) at least 76 species of reptiles are known, reported and/or expected to occur in the general Valencia Uranium Mine area. Of these, 31 species are viewed as being endemic to Namibia – i.e. 41% endemic. These endemics include 12 snakes (38.8% of the endemics & 15.8% of all species), 11 geckos (35.5% of the endemics & 14.5% of all species) and 8 skinks (2 species) and lizards (6 species) (25.7% of the endemics & 10.5% of all species).

During the fieldwork conducted early November 2007, 12 species of reptiles were confirmed at various development sites at the Valencia Uranium Mine area. Of these, 4 species are classified as endemic to Namibia (Griffin 2005).

These species are:

- *Rhoptropus bradfieldi* (100% endemic)
- *Mabuya* [*Trachylepis*] *hoeschi* (95% endemic)
- *Pedioplanis husabensis* (100% endemic)
- *Psammophis trigrammus* (75% endemic).

The following tables indicate the species accounts, including additional information, as actually observed in the Valencia Uranium Mine area.

Key:

WRDN – Waste Rock Dump North

WRDS – Waste Rock Dump South

LGS – Low Grade Stockpile

Mining – Mining area

Plant – Plant area

Pit – Mining Pit area

TDO5 – Tailings Dump Option 4

TDO5 – Tailings Dump Option 5

Psammophis trigrammus

Area	Habitat	Substrate	Time	Coordinates		Elevation (m)
TDO4	Undulating gravel plains & rock clusters	Rock cluster	08h00-11h00	7524904	0522584	752

Status:

Endemic – 75% (Griffin 2005)

Distribution:

Throughout the dry western regions of Namibia (Branch 1998, Broadley 1983, Griffin 2003, Marais 1992)

Potential proportion of taxon's range:

± 80%; extralimital range to Angola & RSA (Griffin 2003)

Habitat:

Arid scrubland (Branch 1998)

Diet:

Skinks & lacertids (Branch 1998, Marais 1992)

Psammophis leightoni namibensis

Area	Habitat	Substrate	Time	Coordinates		Elevation (m)
TDO4	Undulating gravel plains & rock clusters	*Calicorema capitata* hummocks	11h00-12h00	7523184	0521408	759

Status:

Secure (Griffin 2005)

Distribution:

Various subspecies range from the south-western Cape to south-western Angola, Botswana and northwest RSA (Branch 1998, Broadley 1983, Griffin 2003, Marais 1992)

Potential proportion of taxon's range:

± 60%; extralimital range to Angola & RSA (Griffin 2003)

Habitat:

Coastal fynbos, desert & semi desert, entering savannah (Branch 1998)

Diet:

Lacertids, skinks, small vertebrates & other snakes (Branch 1998, Marais 1992)

Bitis caudalis

Area	Habitat	Substrate	Time	Coordinates		Elevation (m)
LGS	Gravel plains	Gravel plain	N/A	7527966	0524561	763

Status:

Secure (Griffin 2005)

Distribution:

Widespread in arid western regions, throughout Karoo, Kalahari, Namibia (but avoids the Namib dune sea) to southern Angola + southern Zimbabwe, Gauteng & North West & Northern Provinces of RSA (Branch 1998, Broadley 1983, Buys & Buys 1983, Griffin 2003, Hebbard n.d., Marais 1992)

Potential proportion of taxon's range:

± 30%; extralimital range to southern Angola, Botswana & RSA (Griffin 2003)

Habitat:

Sandy mesic & xeric savannah (Branch 1998)

Diet:

Small lizards skinks & geckos), rodents & amphibians & cannibalistic (Branch 1998, Marais 1992, Hebbard n.d.)

Mabuya* [*Trachylepis*] *hoeschi

Area	**Habitat**	**Substrate**	**Time**	**Coordinates**		**Elevation (m)**
TDO4	Undulating	Rock cluster	08h00-11h00	7525006	0523061	759

	gravel plains & rock clusters					
PIT	Undulating gravel hills	Rock cluster	07h00-10h00	7529136	0524534	751
Mining	Gravel plains	Rock cluster	07h00-10h00	7527267	0524301	765

Status:

Endemic – 95% (Griffin 2005)

Distribution:

Throughout the dry western regions of Namibia & southern Angola (Branch 1998, Griffin 2003)

Potential proportion of taxon's range:

± 75%; extralimital range to southern Angola (Griffin 2003)

Habitat:

Arid savannah (Branch 1998)

Diet:

Wasps, beetles & moths (Branch 1998)

Mabuya [*Trachylepis*] *sulcata*

Area	**Habitat**	**Substrate**	**Time**	**Coordinates**		**Elevation (m)**
Plant	Gravel plains & dolomite ridge	Rock cluster	15h00-17h00	7525587	0523995	804
LGS	Gravel plains	Rock cluster	16h00-19h00	7527390	0524687	774

Status:

Secure (Griffin 2005)

Distribution:

Throughout the dry western regions of Namibia, southern Angola & central western RSA (Branch 1998)

Potential proportion of taxon's range:

± 60%; extralimital range to Angola & RSA (Griffin 2003)

Habitat:

Karroid veld, desert & arid savannah (Branch 1998)

Diet:

Beetles, grasshoppers & other invertebrates (Branch 1998)

Pedioplanis husabensis

Area	Habitat	Substrate	Time	Coordinates		Elevation (m)
Plant	Gravel plains & dolomite ridge	Gravel plains & sparse veg.	15h00-17h00	7525707	0524179	807
Plant	Gravel plains & dolomite ridge	Gravel plains & sparse veg.	15h00-17h00	7525442	0524013	804
Plant	Gravel plains & dolomite ridge	Gravel plains & sparse veg.	15h00-17h00	7525234	0525234	806
Plant	Gravel plains &	Gravel plains	15h00-17h00	7525653	0524129	805

	dolomite ridge	& sparse veg.				
TDO4	Undulating gravel plains & rock clusters	Gravel plains & sparse veg.	08h00-11h00	7524995	0523449	768
TDO4	Undulating gravel plains & rock clusters	Gravel plains & sparse veg.	08h00-11h00	7524766	0523114	763
TDO4	Undulating gravel plains & rock clusters	Gravel plains & sparse veg.	11h00-12h00	7524017	0522289	767
LGS	Gravel plains	Drainage line	16h00-19h00	7527433	0524685	771
LGS	Gravel plains	Drainage line	16h00-19h00	7527482	0524671	770
WRDN	Broken gravel hill area	Drainage line	16h00-19h00	7528392	0524918	757
WRDN	Broken gravel hill area	Gravel plain	07h00-10h00	7528664	0524425	754
WRDS	Broken gravel hill area	Hill	16h00-19h00	7527986	0523899	758

Status:

Endemic – 100% (Griffin 2005)

Distribution:

Restricted to junction of the Khan and Swakop Rivers in the Husab Mountains in central western Namibia (Branch 1998, Griffin 2003)

Potential proportion of taxon's range:

100% (Griffin 2003)

Habitat:

Rocky desert (Branch 1998)

Diet:

Small lizards (Branch 1998, Marais 1992)

Agama anchietae

Area	Habitat	Substrate	Time	Coordinates		Elevation (m)
LGS	Gravel hills	Rock cluster	15h00-17h00	7527680	0524410	762
TDO4	Undulating gravel plains & rock clusters	Rock cluster	08h00-11h00	7524908	0522601	751
WRDN	Broken gravel hill area	Gravel plain (on veg.)	07h00-10h00	7528717	0524490	749

Status:

Secure (Griffin 2005)

Distribution:

North-western Cape Province, throughout western Namibia and Angola to the southern DRC (Branch 1998, Griffin 2003)

Potential proportion of taxon's range:

± 35%; extralimital range to southern Angola & RSA (Griffin 2003)

Habitat:

Semi desert & Arid savannah (Branch 1998)

Diet:

Ants, termites, beetles, grasshoppers & plants (Branch 1998)

Chamaeleo namaquensis

Area	Habitat	Substrate	Time	Coordinates		Elevation (m)
TDO4	Undulating gravel plains & rock clusters	Gravel plain (on veg.)	11h00-12h00	7524057	0522118	765

Status:

Secure (Griffin 2005)

Distribution:

Western karroid regions of RSA, Namibia & southern Angola (Branch 1998, Griffin 2003, Hebbard n.d.)

Potential proportion of taxon's range:

± 70%; extralimital range to RSA (Griffin 2003)

Habitat:

Sandy regions with scrub vegetation (Branch 1998)

Diet:

Anything small enough to eat – mainly arthropods, but also small snakes as well as known to be cannibalistic (Branch 1998, Hebbard n.d.)

Chondrodactylus angulifer namibensis

Area	Habitat	Substrate	Time	Coordinates		Elevation (m)
Plant / Mining	Gravel plains & dolomite ridge	Gravel plains & sparse veg.	20h00-22h00	7526836	0524600	762

Status:

Secure (Griffin 2005)

Distribution:

Throughout Namib Desert, southern Namibia & karroid regions of RSA (Branch 1998, Griffin 2003)

Potential proportion of taxon's range:

± 40%; extralimital range to Botswana & RSA (Griffin 2003)

Habitat:

Gravel plains, inter-dune spaces & sandy flats (Branch 1998)

Diet:

Termites, moths, beetles, spiders & other smaller lizards (Branch 1998)

Pachydactylus turneri

Area	Habitat	Substrate	Time	Coordinates		Elevation (m)
TDO5	Gravel plains	Dam	12h00-13h00	7524237	0525891	787
TDO5	Gravel plains	House	12h00-13h00	7524173	0525743	782
WRDS	Broken gravel hill area	Drainage line	20h00-22h00	7527480	0524230	759
WRDS	Broken gravel hill area	Drainage line	20h00-22h00	7527496	0524197	752
WRDS	Broken gravel hill area	Hill	20h00-22h00	7527481	0524126	764
LGS	Gravel plains	House	20h00-22h00	7527966	0524561	763

Status:

Secure (Griffin 2005)

Distribution:

Wide range – Namibia, Angola, Botswana, Zimbabwe, Tanzania & northern parts of RSA (Branch 1998, Griffin 2003)

Potential proportion of taxon's range:

±95% for subspecies *P. t. laevigatus* (other subspecies = marginal); extralimital range to all neighbouring countries (Griffin 2003)

Habitat:

Semi desert & arid savannah, but enters moister areas in north east (Branch 1998)

Diet:

Ants, termites, beetles, grasshoppers & smaller lizards (Branch 1998)

Ptenopus garrulus maculatus

Area	Habitat	Substrate	Time	Coordinates		Elevation (m)
TDO5	Gravel plains	Gravel plain	20h00-22h00	7524639	0525601	783
WRDS	Broken gravel hill area	Gravel & sand	20h00-22h00	7527442	0524284	764

Status:

Secure (Griffin 2005)

Distribution:

Western arid regions of southern Africa – *P. g. maculates* = Namibia, Namaqualand & Karoo in RSA (Branch 1998, Griffin 2003)

Potential proportion of taxon's range:

± 70% = *P. g. maculates*, other subspecies = 40%; extralimital range to Botswana & RSA (Griffin 2003)

Habitat:

Desert & semi desert (Branch 1998)

Diet:

Ants, termites & beetles (Branch 1998)

Rhoptropus bradfieldi

Area	Habitat	Substrate	Time	Coordinates		Elevation (m)
TDO4	Undulating gravel plains & rock clusters	Boulders	11h00-12h00	7524536	0521666	755
TDO4	Undulating gravel plains & rock clusters	Boulders	11h00-12h00	7524525	0521670	756
PIT	Undulating gravel hills	Boulders	07h00-10h00	7528850	0524029	744
PIT	Undulating gravel hills	Boulders	07h00-10h00	7528899	0524386	754
PIT	Undulating gravel hills	Boulders	07h00-10h00	7529352	0524485	730

Status:

Endemic – 100% (Griffin 2005)

Distribution:

From the Khuiseb River to Twyfelfontein (Huab River) in north-western Namibia (Branch 1998, Griffin 2003, Hebbard n.d.)

Potential proportion of taxon's range:

100% (Griffin 2003)

Habitat:

Semi desert - rupicolous (Branch 1998)

Diet:

Ants, moths & beetles (Branch 1998, Hebbard n.d.)

Due to the fact that reptiles are generally an understudied group of animals, especially in Namibia, it is expected that more species may be located in the Valencia Uranium Mine area than presented above.

2.5 Important Species

Of the approximately 76 species of reptiles known, reported and/or expected to occur in the general Valencia Uranium Mine area (Griffin 2005) a high proportion (41%) are classified as being endemic to Namibia. Snakes and geckos have the highest proportion of endemic species with 38.8% and 35.5% of all the expected endemics in the area, respectively.

A survey of the Valencia Uranium Mine area (this study) confirmed 4 endemic species only (i.e. *Rhoptropus bradfieldi*, *Mabuya* [*Trachylepis*] *hoeschi*, *Pedioplanis husabensis* & *Psammophis trigrammus*), although more endemics may occur in the area.

Of the above mentioned 4 endemics actually encountered, *Pedioplanis husabensis* (100% endemic) and *Rhoptropus bradfieldi* (100% endemic) are viewed as the most important species due to their restricted range in Namibia.

1. *Pedioplanis husabensis* is restricted to the Central Namib Desert, between Rössing Mine and the Swakop River on stony substrates (Griffin 2003). In the Valencia Uranium Mine area they were encountered 12 times, 4 times on gravel plains in the PLANT (Plant area – south of the proposed PIT), 3 times on gravel

plains in TDO4 (Tailings Dump Option 4 – west of the proposed PIT), 2 times in drainage lines in LGS (Low-Grade Stockpile area – directly south of the proposed PIT), 2 times on gravel plains and drainage line in WRDN (Waste Rock Dump North – north of the proposed PIT) and 1 time on gravel hill in WRDS (Waste Rock Dump South – southwest of the PIT). From the observations it is clear that they prefer gravel plains (67% of observations) to any other habitat. In suitable habitat they are often encountered (pers obs) although often overlooked unless fleeing at pace on approach due to their camouflage and habit of slowly moving throughout their area hunting prey.

2. *Rhoptropus bradfieldi* is restricted to the coastal and pro-Namib Desert from the Kuiseb River to the Ugab River to rocky outcrops (boulders – i.e. rupicolous behaviour) (Griffin 2003). In the Valencia Uranium Mine area they were encountered 5 times, 2 times on boulders in the TDO4 (Tailings Dump Option 4 – west of the proposed PIT) area and 3 times on boulders in the PIT (PIT – actual mining area) area. From the observations it is clear that they prefer boulder outcrops (100% of observations) to any other habitat. In suitable habitat they are often encountered (pers obs) although often overlooked due to their camouflage and habit of motionlessly awaiting prey.

3. Other species not observed in the area, but known from the area and deemed important as they are all viewed as 100% endemic to Namibia (Griffin 2005), include:

6 Geckos

* *Pachydactylus bicolor*

* *Pachydactylus fasciatus*

* *Pachydactylus kockii*

* *Pachydactylus scherzi*

* *Pachydactylus rugosus*

* *Narudasia festiva*

2 Lizards

* *Pedioplanis breviceps*

* *Pedioplanis gaerdesi*

1 Worm snake

* *Leptotyphlops labialis*

1 Snake

* *Telescopus* sp. *nov.*

Of these the most restricted range species is *Pachydactylus kockii* with an expected distribution between the Hoanib River and the Kuiseb River (Griffin 2003). The other species listed above have wider ranges. The species probably least known and unstudied include the *Telescopus* sp. *nov.* (Damara Tiger Snake) not yet even properly classified. Snakes face direct persecution by humans throughout Namibia due to being perceived as dangerous. An increase in human activity in the general area does not bode well for this species should it occur here unless a strategy of no killing of any snake is encouraged by the Valencia Uranium Mine management.

The high percentage of endemic reptile species (41%) known and/or expected to occur in the general Valencia area underscores the importance of this area for reptiles. The seemingly barren gravel plains in the general area are host to a variety of reptile fauna not often expected and/or acknowledged. Development and recreation often affect these species negatively.

2.6 Conclusion

It is estimated that at least 76 species of reptiles are known, reported and/or expected to occur in the Valencia Uranium Mine area of which a large proportion are endemics (41%). Although a number of exclusive Namibian endemics (i.e. 100% endemism) are known to occur from the general area, it is currently not clear if all of these are associated with the proposed development areas or how exactly they will be affected by development.

Species of concern are the *Pedioplanis husabensis*, *Rhoptropus bradfieldi*, various *Pachydactylus* species and the snake *Telescopus* sp. *nov.* in the general area. *P. husabensis* and *R. bradfieldi* are however not viewed as rare in the general area as they occur widely on suitable habitat (e.g. gravel plains and rocky outcrops) throughout the area.

As all development have potential negative environmental consequences, identifying the most important faunal species including high risk habitats beforehand, coupled with environmentally acceptable mitigating factors, lessens the overall impact of such development. It is suggested that the Valencia Uranium Mine management declare a sensitive approach to all fauna (including often unappreciated reptiles) to show overall environmental commitment.

3. Assessing Impacts

3.1 Introduction

All developments change or are destructive to the local environment to some or other degree. Assessing potential impacts is occasionally obvious, but more often difficult to predict accurately. Such predictions may change depending on the scope of the development – i.e. development, once initiated, may have a different effect on the environment as originally predicted. Thus continuing monitoring of such impacts during the development phase(s) is imperative.

3.1.1 Envisaged impacts

10.1.1 Reptiles

Reptiles are the group of animals expected to be most adversely affected by the mining/exploration activities at the Valencia Uranium Mine. The following table indicates the potential/envisaged impacts expected regarding reptiles:

Description	Reptiles are generally sedentary in their habits and the destruction of localised preferred habitats (e.g. gravel plains, rocky outcrops & ridges) would negatively affect them.
Extent	LIM & L The major extent of this impact would be limited to the actual mining/excavation sites and associated infrastructure (e.g. plant, stockpile areas, tailings dump areas, roads, etc.) (LIM). Access routes (roads & tracks) locally would also impact on species, but be low and limited to roads/tracks only, especially regarding nocturnal species (L).
Duration	LT & P Once the preferred habitat has been destroyed locally the impact would be permanent (P) – e.g. PIT area. Vehicular movement in the area (roads & tracks) would continuously have an effect on reptiles, especially nocturnal species and be viewed as a long-term (i.e. as long as the mining activities proceed) impact (LT).
Intensity	L, M & H The magnitude of the impact depends on the site – i.e. available habitat in the actual mining site (PIT) would be permanently altered (H). The adjacent sites associated with the actual mining operation (e.g. Stockpile areas, tailings dumps, crusher, plant, mining area, roads, etc.) would be affected moderately (M). Areas not directly affected by the mining operation although within the mining area would be affected minimally (L). Method(s) used in the quantification process: Endemic species are most often associated with specific habitat requirements and cannot tolerate drastic changes. Habitats such as rocky outcrops & ridges affected/destroyed during the mining would thus permanently affect species associated with these.

Mitigation	1. Avoid sensitive habitats such as rocky outcrops & ridges (e.g. ridge west of proposed Mining & Plant area), drainage lines and unique vegetation (also ecotone areas) zones. This would minimize the effect on mainly endemic reptiles associated with these unique areas. 2. Avoid driving randomly through the area, but rather stick to permanently placed roads/tracks. This would minimize roadkills and the overall effect on reptiles moving through the area – i.e. track discipline should be enforced. 3. Avoid excessive vehicle speed in the area. This can be ensured by using/maintaining "speed bumps" on roads/tracks in the area. This would minimize excessive reptile road kills in the area – i.e. track discipline should be enforced. 4. Minimize night driving in the area. Large proportions of desert adapted reptiles are nocturnal and would be affected by night driving. This would minimize road kills of nocturnal reptiles in the area. 5. Remove and/or relocate endemic species (e.g. *P. husabensis*) from area(s) to be mined (including other construction areas & dumping sites) before commencing with such operations. These species could be live captured without too much fuss and relocated to similar habitats. 6. Employ a "no kill" policy – especially with regards to snakes which are often viewed as a threat. 7. Employ a "no collect" policy – i.e. no collection of reptiles be allowed for resale purposes (especially endemics). 8. Consider a breeding (ex situ) programme for future reintroduction to rehabilitated areas for the most endangered species (e.g. *P. husabensis* & *Telescopus* sp. *nov.*). 9. Consider a training programme (importance of) for staff regarding reptiles in general and snakes (avoidance) in particular.
Frequency of occurrence	C Continuous (C) problems regarding reptile road kills could be expected if mitigation measures (See above) are not put in place to limit these.
Probability	HP & D Definite (D – 100%) negative impact on reptiles are expected in the actual mining/excavation area & tailings dump sites. Highly Probable (HP – 75%) negative impact on reptiles are expected in the adjacent developed areas (e.g. crusher, mining area, plant area, roads, etc.) as well as with the associated infrastructure (roads/tracks) to and around the mining area. Precautionary principle (e.g. road bumps, speed limits & limited night driving) would decrease the significance of these potential impacts.
Significance	Before mitigation: **High** After Mitigation: **Low** to **Medium**
Status of the impact	Negative Reptiles associated with specific habitats (e.g. rocky outcrops, ridges & certain gravel plains) would bear the brunt of this proposed mining development.

Legal requirements	N/A
Degree of confidence in predictions	As an ecologist specialising in desert environments and more specifically on desert herpetofauna, I am very sure of the above mentioned predictions made and would suggest that the mitigation measures be implemented to minimise potentially negative aspects regarding the local, especially local endemics in the area.

3.1.2 Reptile Implications

Reptiles are the group of animals expected to be most adversely affected by the mining/exploration activities at the Valencia Uranium Mine. The following table indicates the potential/envisaged implications regarding reptiles under construction & operation phases:

REPTILE IMPLICATIONS	**CONSTRUCTION**		**OPERATION**	
	Before Mitigation	**After Mitigation**	**Before Mitigation**	**After Mitigation**
Extent	Medium Term & Locally	Limited	Medium Term & Locally	Limited
Duration	Permanent & Long Term	Medium Term	Permanent & Long Term	Long Term
Intensity	High & Medium	Low	High & Low	Low
Mitigation	Various	Various	Various	Various
Frequency of occurrence	Continuous	Intermittent	Continuous	Intermittent
Probability	Highly Probable & Definite	Probable	Highly Probable & Definite	Probable
Significance	Medium	Medium to Low	Medium	Medium to Low

Status	Negative	Localised negative	Negative	Localised negative
Legal requirements	N/A	N/A	N/A	N/A
Degree of confidence in predictions	Certain	Certain	Certain	Certain

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Appendix G8 Second survey of *Adenia pechuelli*

SECOND SURVEY OF *ADENIA PECHUELII* AT VALENCIA

Report prepared by

Herta KOLBERG & Tyrone THOLKES

For

Valencia Uranium Limited

November 2007

SECOND SURVEY OF *ADENIA PECHUELII* AT VALENCIA

report prepared by Herta Kolberg & Tyrone Tholkes

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1. Introduction

This Consultant was approached by Dr Lima Maartens of Valencia Uranium Limited (VUL) to do a survey of *Adenia pechuelii* (elephant's foot) plants on farm Valencia in the Karibib District. The survey was to form part of the Environmental Impact Assessment (EIA) for the development of a uranium mine at the site. An initial survey was done in August 2007, covering the Exclusive Prospecting License (EPL) area only. In the report for that work (Kolberg & Tholkes, 2007), it was recommended, that, in order to get a better picture of the size and density of the *Adenia* population in the EPL compared to the larger, surrounding area, a follow-up survey be undertaken. This is a report on the findings of this second survey.

2. Scope of work

A proposal for the survey was submitted to VUL on 8 October 2007 and accepted. The scope of work was agreed upon as follows:

- Work in a band of 2 km width along the north-eastern, south-western (2 short sides of EPL) and south-eastern (long side of EPL) side of the EPL only; the north-western, long side of the EPL was omitted because of the difficult terrain (time-consuming and therefore expensive) and because previous surveys had not found many *Adenia* plants there; exclude areas that are not on farms Valencia and Gaudeamus;
- Mark the location of all individual plants of *Adenia pechuelii* found;
- Identify areas suitable for *Adenia* sanctuary;
- Analyse data, including data from August 2007; and
- Prepare a report on the results.

3. Methodology

In order to cover the area systematically, it was decided to divide it into 100 m wide bands along its longitudinal axis (Figure 1). Based on previous experience, it was decided to use 100 m wide bands rather than 200 m wide bands. The bands were put onto MapSource GIS and uploaded onto two GPS units (Garmin Etrex Legend) in form of a route. The GPS datum was set to WGS84 UTM Zone 33 K.

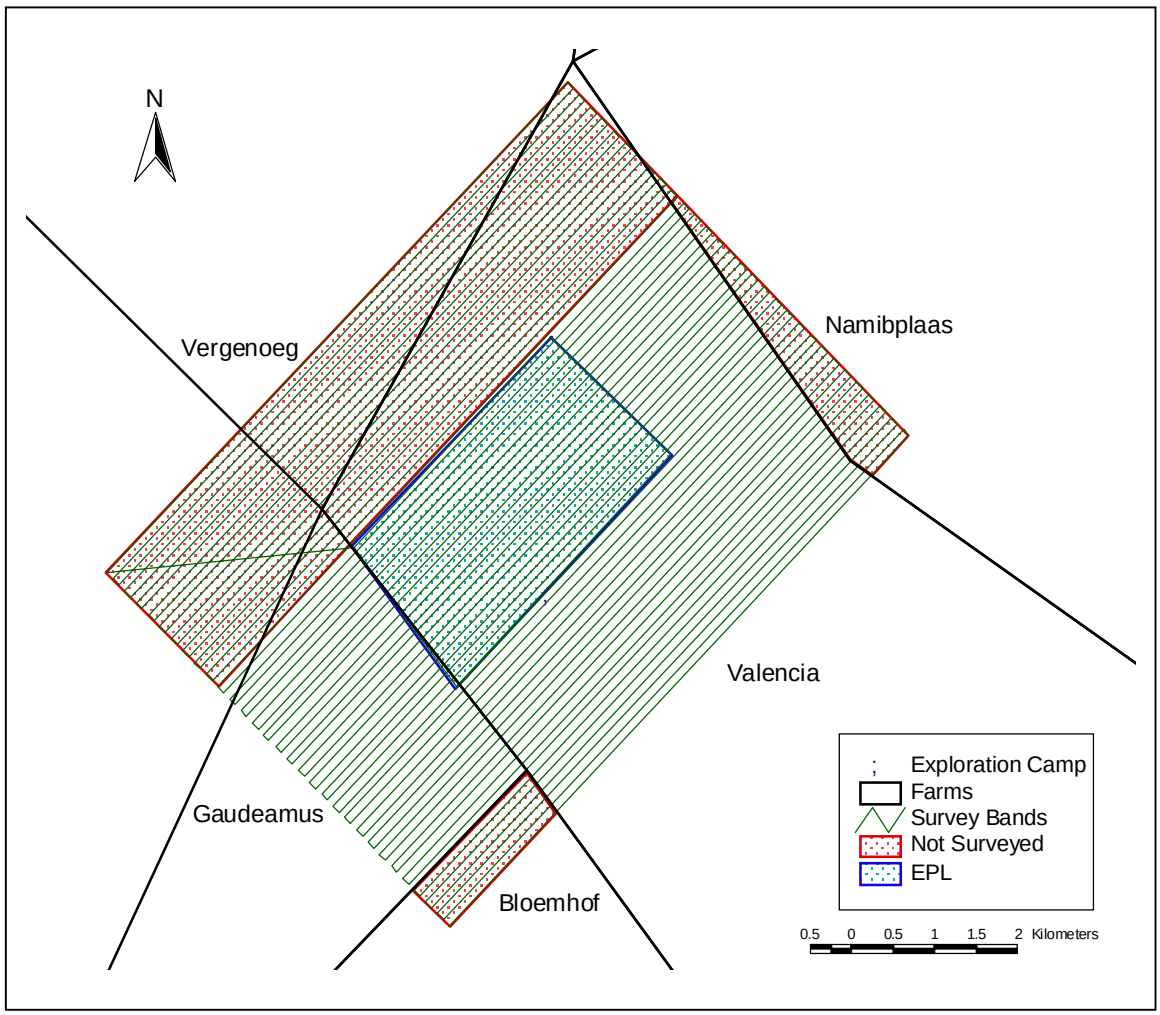

Figure 1: Division of survey area into bands

Fieldwork was carried out between 7 and 30 November 2007. In the field the two surveyors followed a mostly zig-zag path from border to border of the bands. It was found, however, that the surveyor had to be led by the topography of the area in choosing a path so that all areas of a band could be visually scanned for *Adenia* plants.

Plants were marked as waypoints directly onto the GPSs and numbered from 001 consecutively on each machine. The marked plants were tagged with bio-degradable masking tape to prevent double counting.

The waypoints were downloaded onto a personal computer every evening using the DNRGarmin, Version 5.1.1 software (Minnesota Department of Natural Resources, 2001). The waypoints were saved as dBase IV (.dbf) and ArcView shape (.shp) files. The track log facility of the GPSs was also switched on and tracks covered, downloaded daily and saved as ArcView shape files (.shp). At the end of the survey all waypoints were combined into one file. The waypoints were then re-named by adding a prefix consisting of the surveyor's initial and "N" (for November), e.g. TN001 to distinguish these from the waypoints taken in August.

Localities of marked plants and tracks were mapped daily using ArcView GIS (version 3.3 (2)) to check that a band was sufficiently covered and pick up any likely mistakes in marking of plants.

Files with localities of *Adenia* plants marked by previous surveyors (Mannheimer, Westport Resources Namibia (WRN), and two students) were obtained from VUL. These localities were mapped against the new localities and any points that seemed to have been missed by the current Consultants, were uploaded onto the GPSs and re-checked on site.

4. Results and Discussion

4.1 *Adenia* plants surrounding EPL

The proposed area was thoroughly covered by this survey, as a map of the tracks in Appendix 1 indicates. Where the gaps between tracks seem to be large, this is because of either flat terrain, where a large area can be visually scanned, or because of steep cliffs, where only the top and base could be walked.

Where the survey bands entered farms Namibplaas and Bloemhof, they were not surveyed. Similarly, where the bands went over a high mountain (north-east of camp, towards the Namibplaas border) and into the area of red granite south-west of the camp, they were not surveyed because the likelihood of finding *Adenia* plants there did not seem to warrant the effort. It was discovered that the EPL given to this consultant in August 2007 differed from the EPL provided for this survey (see Kolberg & Tholkes, 2007) and the resulting figures for *Adenia* inside and outside the EPL therefore had to be adjusted.

A total of 714 plants of *Adenia pechuelii* was marked in this survey. Of these, 88 were inside the revised EPL area while 17 of the plants marked in August 2007 as being inside the EPL, were now outside the revised EPL. This means that 643 plants were found in the area surveyed outside the EPL and 922 within the revised EPL (Table 1). An electronic copy of the waypoint files was provided to VUL. Appendix 2 shows a map of the plants marked during this survey. Appendix 3 shows a map with marked plants inside and outside the EPL.

Once again, when the localities of *Adenia* plants marked in this survey are overlaid with those of previous surveys (Appendix 4), it can be seen that some plants found by other surveyors could not be found again despite every effort having been made to locate these. These seem to be attributable again to mistakes in the datasets of the previous surveys, where multiple waypoint numbers have exactly the same co-ordinates (see Appendix 5).

Observations made during the survey of the EPL in August 2007 (Kolberg & Tholkes, 2007), were confirmed in this survey. Again more *Adenia* plants were found than by previous workers (mainly the student dataset). Once again, no habitat preference could be distinguished. Subjective observations made regarding condition of individuals as well as age structure of the population were similar to those in the first report (Kolberg & Tholkes, 2007).

4.2 Data Analysis

The total number of *Adenia pechuelii* plants marked at the Valencia mining site thus stands at 1,565 with 922 (59% of total) plants within the EPL and 643 (41%) in the area surveyed outside the EPL (Table 1). The average plant density per unit area (km^2) has been calculated as 123 plants/ km^2 inside the EPL and 32 plants/ km^2 outside of it. These figures thus suggest that in the immediate vicinity of the mine site, the bulk of the *Adenia pechuelii* population is in the area that will be affected by development of the mine.

Table 1: Summary of Data

	August 2007	**November 2007**	**TOTAL**	**Percentage of total**	**Approximate area (km^2)**	**Average density (plants per km^2)**
Inside EPL	834	88	**922**	59	7.5	123
Outside EPL	17	626	**643**	41	20	32
TOTAL	851	714	**1,565**			

If a simplified version of the planned infrastructure (as at 30 November 2007) is overlaid onto the *Adenia* distribution map (Appendix 6), the number of plants that will be affected by this, can be calculated (see Table 2).

Table 2: Number of *Adenia pechuelii* plants affected by the planned infrastructure

Infrastructure	**Number of plants affected**	**Percentage of total *Adenia* population in the area**
Waste Rock Dump North	50	3
Waste Rock Dump South	42	3
Pit	154	10
Low-grade Stockpile	52	3
Tailings Dump	45	3
Plant	0	0
TOTAL	**343**	**22**
Outline of all above	**558**	**36**

structures combined (medium)		
Above structures combined with buffer zones (maximum)	**693**	**44**

Under a best-case, but unlikely scenario a minimum of 343 plants will have to be moved, while under the worst-case scenario (most likely) at least 693 plants will be affected. Even assuming the best-case scenario, re-location will be a huge task, but in light of the fact that up to almost half the total *Adenia* population in the vicinity (44%) is at risk, a necessary undertaking.

4.3 Sites for *Adenia* Sanctuary

During this consultancy the available area for re-location of *Adenia* plants was visually inspected and an area suitable for the sanctuary delimited. In determining this area the following criteria were considered:

- Substrate type (some surface soil, not only hard rock);
- Topography – flat with some rocky outcrops;
- Accessibility by vehicle;
- Distance from mine infrastructure; and
- Presence of some naturally occurring *Adenia* plants.

The proposed sanctuary is situated south of a fairly high marble ridge, which will give some protection from dust and other mining activities. The area is relatively flat with a few rocky outcrops and easily accessible. About 20 *Adenia* plants already occur in this area. It has a total area (approximately 640,000 m^2) that is larger than would be needed for relocation (approximately 2,775 m^2) of the maximum number of plants (693) if space per plant is calculated at a conservative 4 m^2 (plants at least 2 m apart all round). The area could also be extended or moved further south-east, but because of time-limitations this was not included in the proposed area. This leaves some options for actual placement of the re-located plants. It may, for instance, be advisable to seek out rocky outcrops in the area and place plants between large rocks to initially support them. Appendix 6 shows the area that would be suitable for an *Adenia* sanctuary.

As an experiment, a plant from the pit area, marked H429 during the August survey, was removed and re-planted in a rocky outcrop (GPS reading: 22.360465°S, 15.243980°E, UTM Zone 33 K: 7527253.34, 525119.75) in the suggested sanctuary area. The plant was small (about 40cm stem height) but had at least 4 thick, long roots which were severed during the process of removing the plant from its original locality (Figure 2). A small hole was dug between two large rocks, the roots inserted and covered with the soil from the hole. The plant was supported by large rocks and watered with about 4 l of water from the exploration camp (Figure. 3). Instructions were left to water this plant again in about 14 days (mid-December). By the time plants need to make way for mine development, this plant should give some indication as to whether re-location in this way is successful or whether the method has to be adapted.

Figure 2: *Adenia* before re-planting

Figure 3: Watering re-planted *Adenia*

5. Recommendations

This survey confirms the recommendations made in the August report (Kolberg & Tholkes, 2007). A large proportion of the *Adenia* population in this area will be affected. Hence, plants need to be rescued somehow and the suggestion of a sanctuary, made in the August report, is supported.

Since no information is available about the success of re-locating *Adenia* plants under the conditions on site, it is recommended, that a small experiment be started to find the best methods to do this.

Plants should only be moved as the need arises. This will make the task more manageable and gives the opportunity to change the methodology, if necessary.

The recommendations about donations of plants to botanic gardens and state nurseries also still hold.

Given the large number of *Adenia* plants that will have to be moved, it could be considered to rather donate the other species suggested for re-location in the August report, if re-locating these would compromise saving and re-locating *Adenia* plants.

6. References

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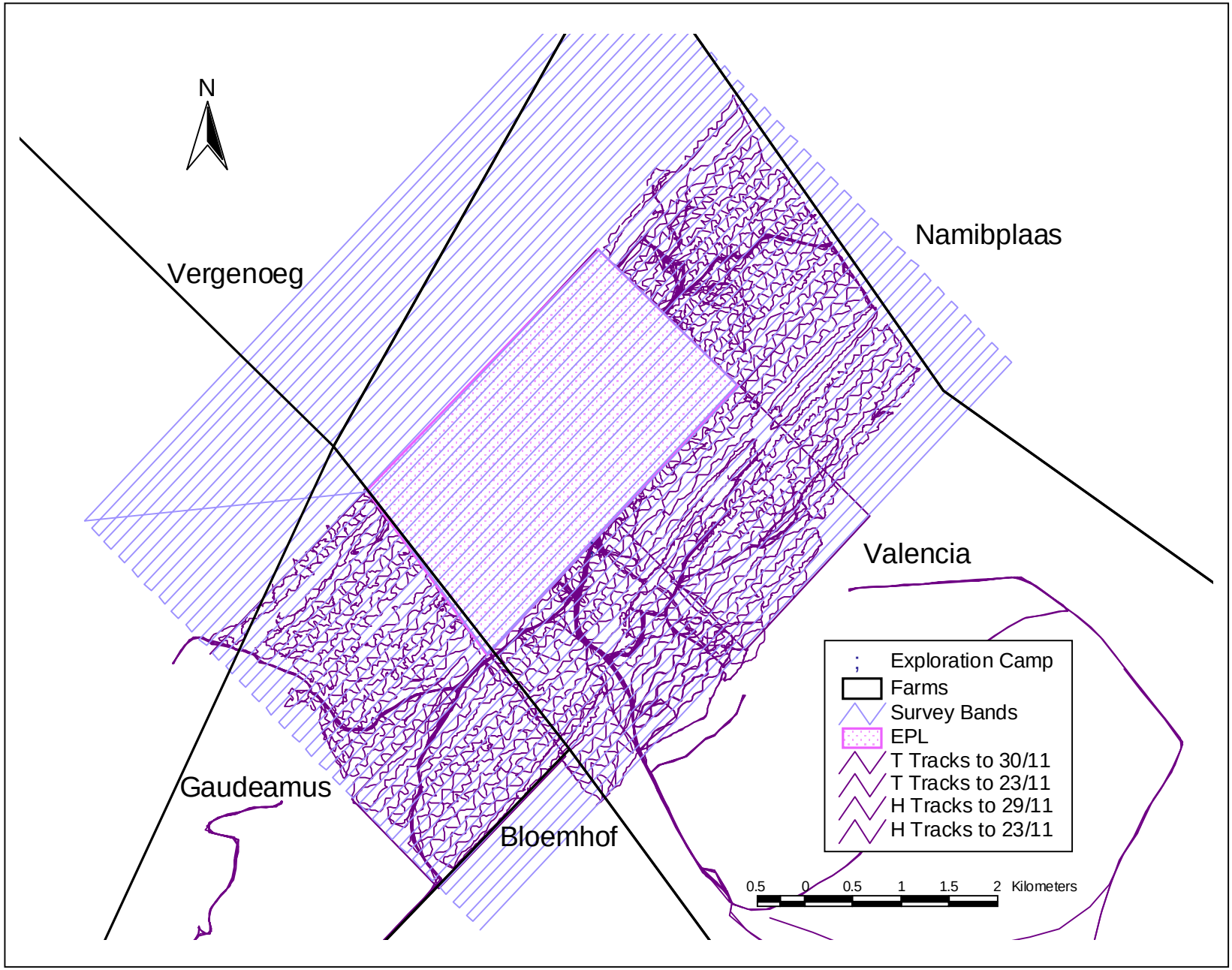
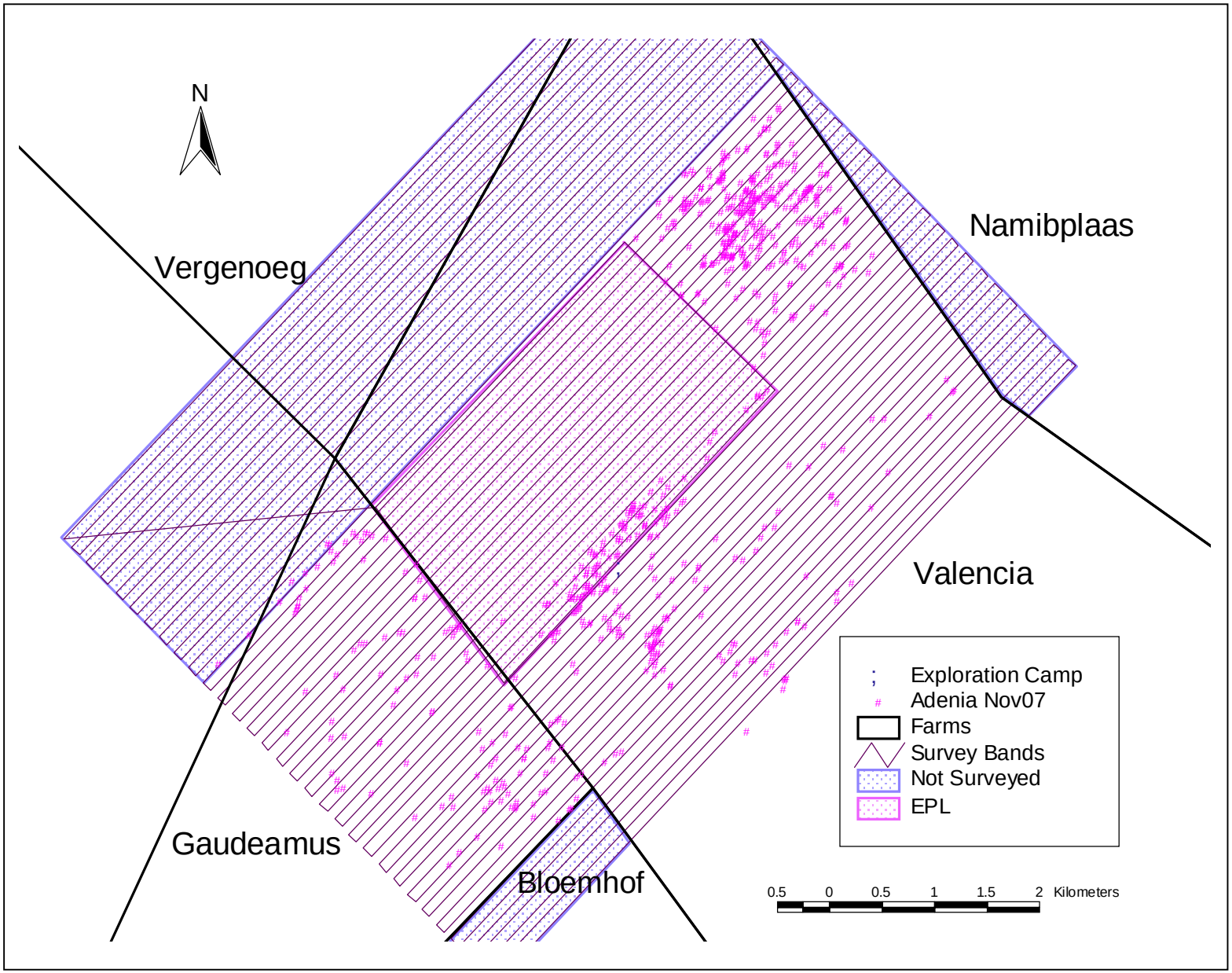
Minnesota Department of Natural Resources. 2001. DNR Garmin software. Garmin Communications using pcoGarmin by Ron Whately. http://www.c-nav.com; Image Information using Shotgraph by Mikhail Tchikalov. http://www.shotgraph.com; Proj4 projection engine by Gerald Evenden. http://www.remotesensing.org/proj

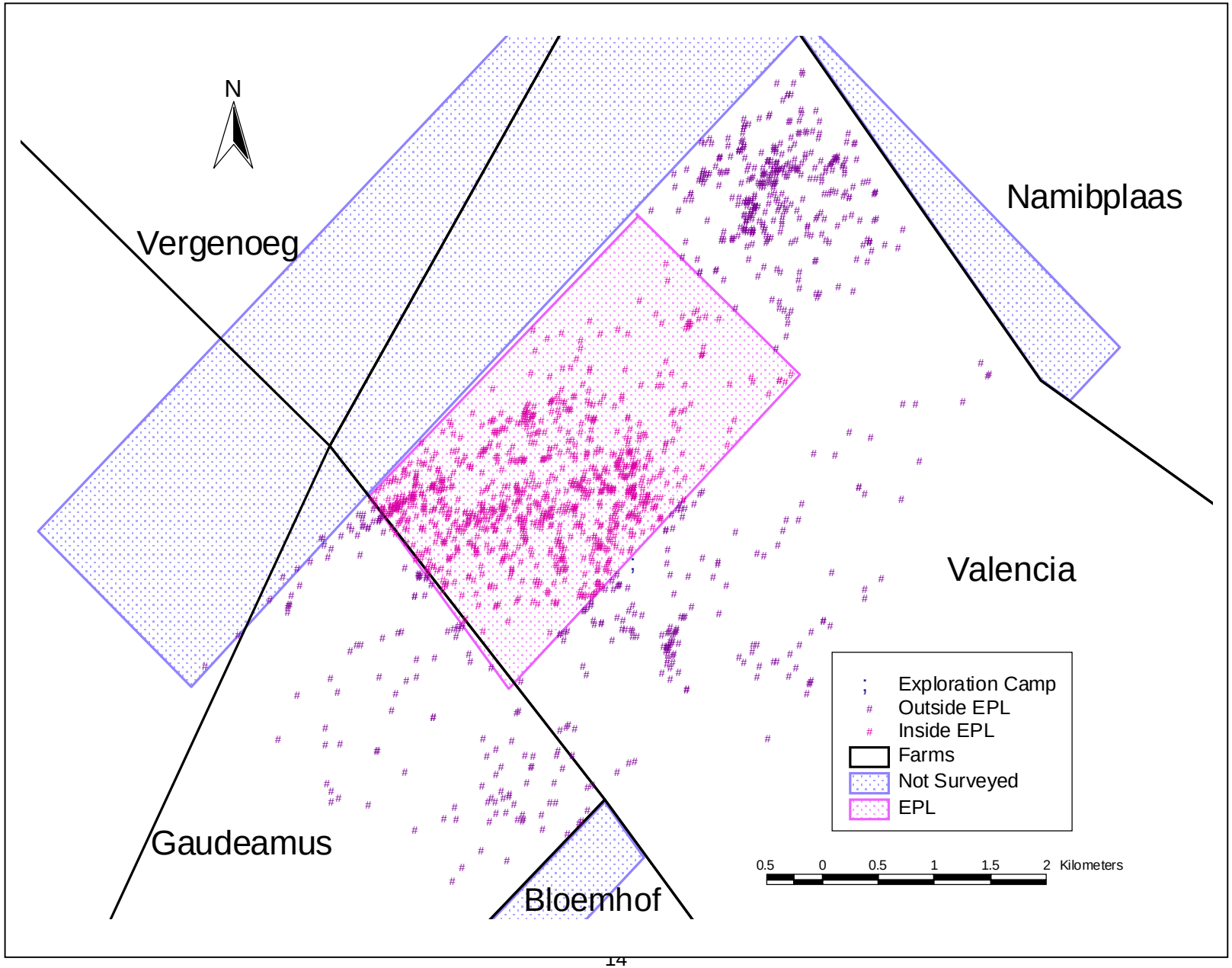
Appendix 1: Tracks walked/driven for this survey


N
Vergenoeg
Namibplaas
Valencia
Gaudeamus
Bloemhof
Exploration Camp
Farms
Survey Bands
EPL
T Tracks to 30/11
T Tracks to 23/11
H Tracks to 29/11
H Tracks to 23/11
0.5 0 0.5 1 1.5 2 Kilometers

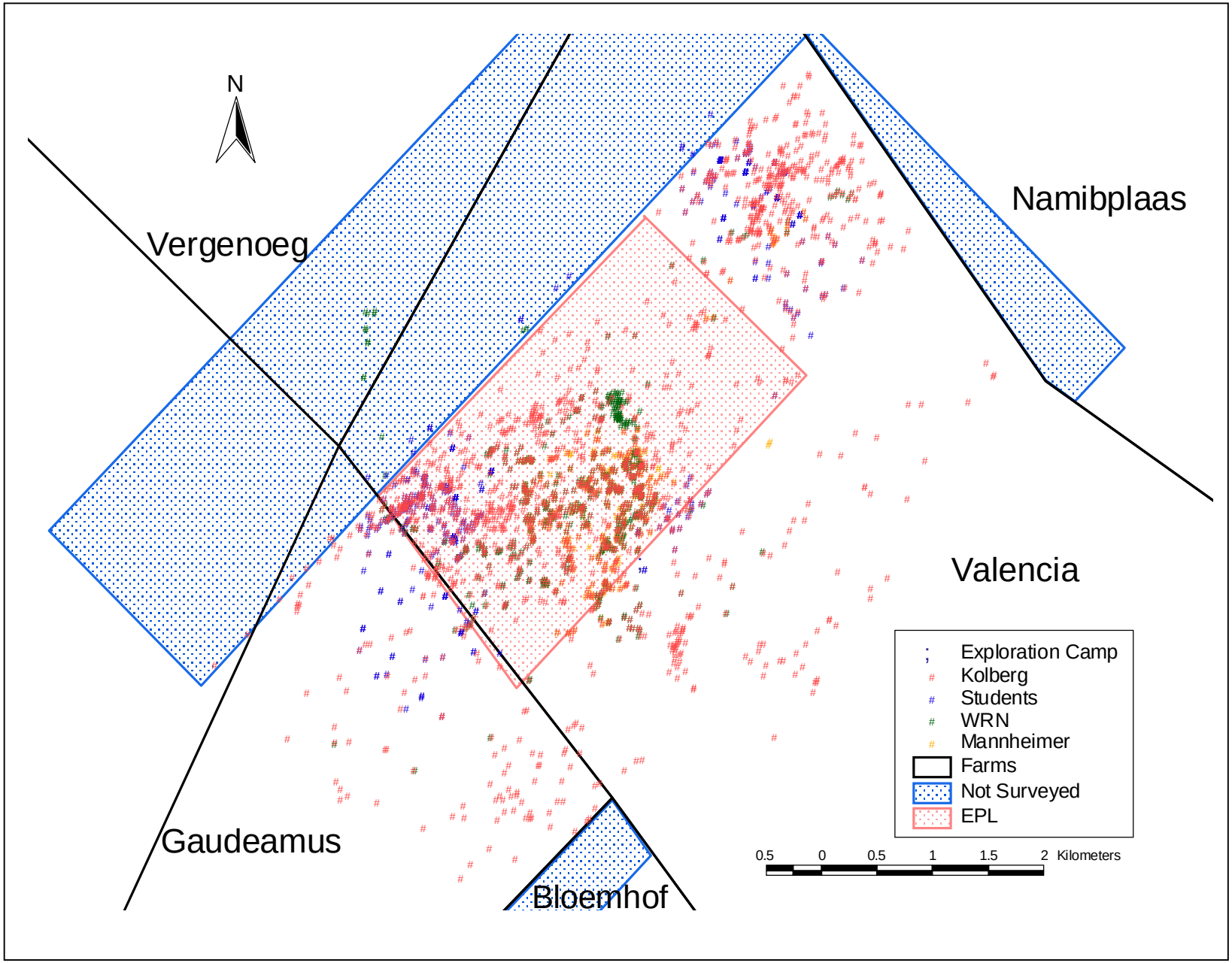
Appendix 2: *Adenia pechuelii* plants marked during this survey



Appendix 3: *Adenia pechuelii* plants marked inside and outside EPL


N
Vergenoeg
Namibplaas
Valencia
Gaudeamus
Bloemhof
Exploration Camp
Outside EPL
Inside EPL
Farms
Not Surveyed
EPL
0.5 0 0.5 1 1.5 2 Kilometers

Appendix 4: Overlay of all four surveys

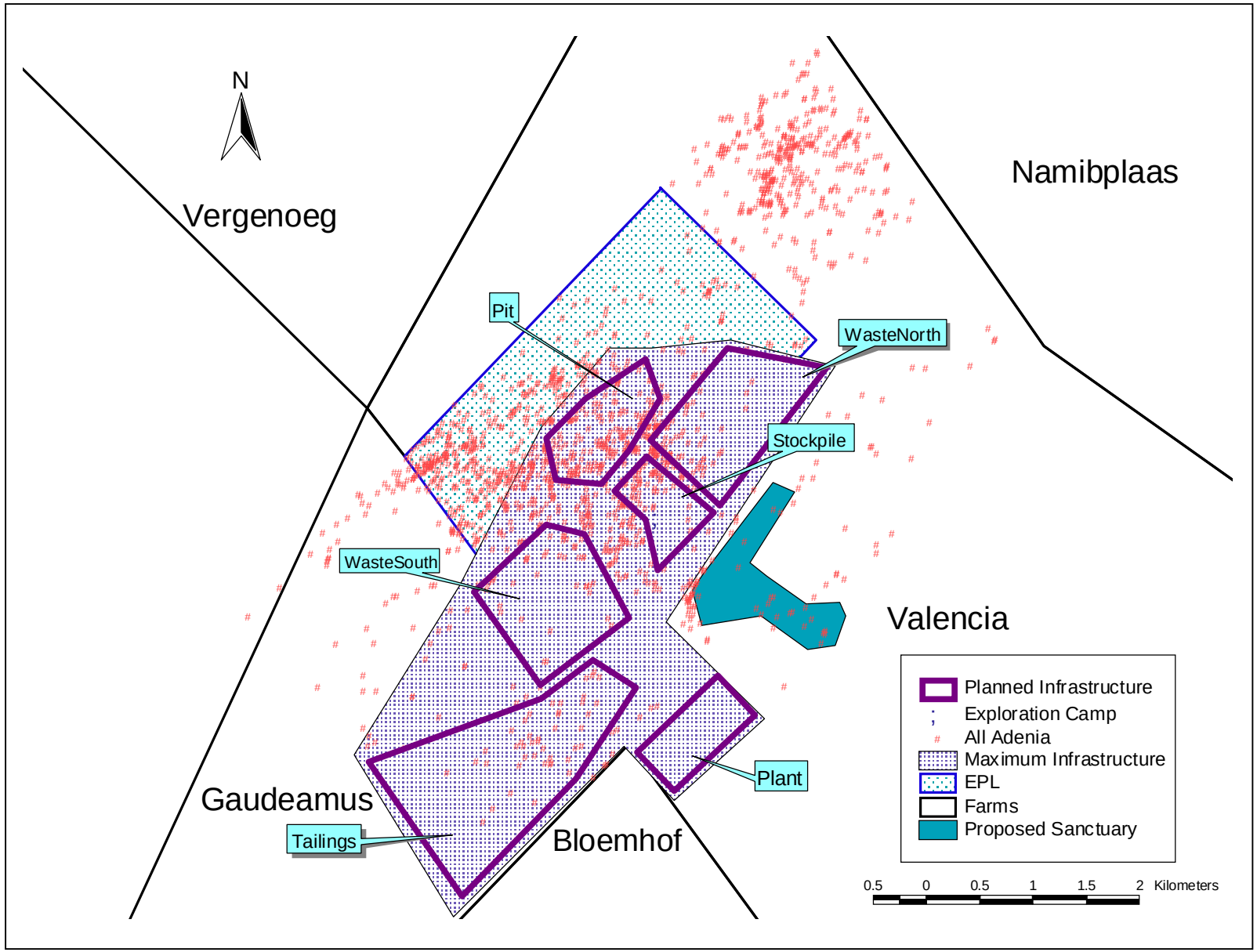

N
Vergenoeg
Namibplaas
Valencia
Gaudeamus
Bloemhof
Exploration Camp
Kolberg
Students
WRN
Mannheimer
Farms
Not Surveyed
EPL
0.5 0 0.5 1 1.5 2 Kilometers

Appendix 5: Localities marked by previous surveyors that could not be confirmed

Surveyor	Waypoint number	Comment
Students	EF051	checked but could not be found
	EF057 to EF058	exactly same co-ordinates for both points; checked but could not be found
	EF060	checked but could not be found
	EF061	checked but could not be found
	EF062	checked but could not be found
	EF064 to EF066	exactly same co-ordinates for both points; checked but could not be found
	EF068 to EF076	exactly same co-ordinates for both points; checked but could not be found
	EF95 to EF127	exactly same co-ordinates for both points; checked but could not be found
	EF128 to EF129	exactly same co-ordinates for both points; checked but could not be found
	EF133	checked but could not be found
	EF134	checked but could not be found
	EF135 to EF140	exactly same co-ordinates for both points; checked but could not be found
	EF141 to EF142	exactly same co-ordinates for both points; checked but could not be found
	EF160 to EF165	exactly same co-ordinates for both points; checked but could not be found
	EF174 to EF178	exactly same co-ordinates for both points; checked but could not be found
	EF194	checked but could not be found
	EF199 to EF201	exactly same co-ordinates for both points; checked but could not be found
	EF209 to EF 210	exactly same co-ordinates for both points; checked but could not be found
	EF212	checked but could not be found
	EF214 to EF216	exactly same co-ordinates for both points; checked but could not be found
	EF218 to EF219	exactly same co-ordinates for both points; checked but could not be found
	EF220 to EF221	exactly same co-ordinates for both points; checked but could not be found
	EF222	checked but could not be found
	EF223 to EF224	exactly same co-ordinates for both points; checked but could not be found
	EF227 to EF233	exactly same co-ordinates for both points; checked but could not be found
	EF234 to E235	exactly same co-ordinates for both points; checked but could not be found
	EF237 to EF238	exactly same co-ordinates for both points; checked but could not be found
	EF239	checked but could not be found

	EF255	checked but could not be found
Mannheimer	M011	checked but could not be found
	M012	checked but could not be found
WRN	W537	checked but could not be found

Appendix 6: Planned infrastructure in relation to *Adenia pechuelii* distribution



INITIAL SURVEY OF *ADENIA PECHUELII* AT VALENCIA

Report prepared by

Herta KOLBERG & Tyrone THOLKES

For

Tsumeb Exploration Company (TECo)

August 2007

SURVEY OF *ADENIA PECHUELII* AT VALENCIA

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1. Introduction

This Consultant was approached by Dr Lima Maartens of Tsumeb Exploration Company (TECo) to do a survey of *Adenia pechuelii* (elephant's foot) plants at the license area of TECo on farm Valencia in the Karibib District. The survey was to form part of the environmental impact assessment for the development of a uranium mine at the site.

Adenia pechuelii is a plant found in the central and northern Namib and was thought to be endemic to Namibia for a long time, until it was seen in south-western Angola recently (P. Craven, pers. comm.). *Adenia* belongs to the family Passifloraceae and is thus related to passuion fruit. The species is dioecious, meaning that male and female flowers occur on separate plants (de Wilde, 1976). The conservation status of this species has been evaluated according to the IUCN (World Conservation Union, formerly International Union for the Conservation of Nature and Natural Resources) criteria and was found to fall outside the threatened categories (Loots, 2005).

2. Scope of work

A proposal for the survey was submitted to TECo on 3 August 2007 and accepted. At a meeting with Dr Maartens on 9 August 2007, the details of the scope of work were discussed and agreed upon as follows:

- work only within the Exclusive Prospecting License (EPL) area but cover the entire EPL
- mark the location of all individual plants of *Adenia pechuelii* that were not marked (orange tape) by the two students previously working on this survey
- prepare a report on results
- make recommendations regarding mitigation of effect of mine development on *Adenia pechuelii* population.

3. Methodology

In order to cover the EPL systematically, it was decided to divide it into 200 m wide bands along its longitudinal axis (Fig. 1). The bands were put onto MapSource GIS and uploaded onto two GPS units (Garmin Etrex Legend and Garmin Etrex Vista) in form of a route. The GPS datum was set to WGS84 UTM Zone 33 S.

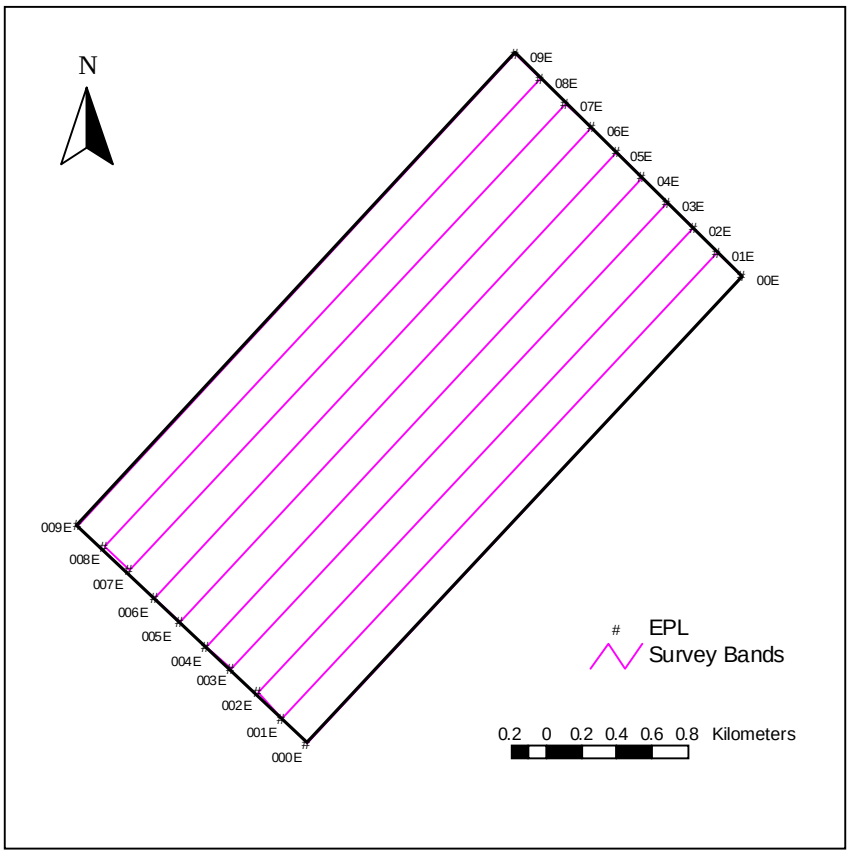


Fig. 1: Division of EPL into survey bands

Fieldwork was carried out between 13 and 25 August 2007. In the field the two surveyors followed a mostly zig-zag path from border to border of the bands or from border to middle of a band with two surveyors working together in one band. It was found, however, that the surveyor had to be led by the topography of the area in choosing a path so that all areas of a band could be visually scanned for *Adenia* plants. For instance, the surveyor had to be certain that all sides and the summit of any outcrops were seen, since plants tend to hide under or behind rocks.

Plants were marked as waypoints directly onto the GPSs and numbered from 001 consecutively on each machine. The marked plants were tagged with bio-degradable masking tape onto which the waypoint number was written.

The waypoints were downloaded onto a personal computer every evening using the DNRGarmin, Version 5.1.1 software (Minnesota Department of Natural Resources, 2001). The waypoints were saved as dBase IV (.dbf) files. The track log facility of the GPSs was also switched on and tracks covered, downloaded daily and saved as ArcView shapefiles (.shp). At the end of the survey all waypoints were combined into one file. The waypoints taken on the Etrex Legend were then re-named by adding a "T" prefix (e.g. T001) and those on the Etrex Vista by adding a "H" prefix.

Localities of marked plants and tracks were mapped daily using ArcView GIS (version 3.3 (2)) to check that a band was sufficiently covered and pick up any likely mistakes in marking of plants.

Files with localities of *Adenia* plants marked by previous surveyors (Mannheimer, WRN, students) were obtained from TECo. These localities were mapped against the new localities and any points that seemed to have been missed by the current Consultants, were uploaded onto the Etrex Legend GPS and re-checked on site.

4. Results and Discussion

4.1 *Adenia* plants inside EPL

The EPL was thoroughly covered by this survey, as a map of the tracks in Appendix 1 indicates. Where the gaps between tacks seem to be large, this is because of either flat terrain, where a large area can be visually scanned, or because of steep cliffs, where only the top and base could be walked.

A total of 851 plants of *Adenia pechuelii* was marked within the EPL. An electronic copy of the waypoint file was provided to TECo. This number is considerably higher than found by previous surveys. Mannheimer found 453 plants, which included plants outside the EPL; WRN marked 537, also including plants outside the EPL and the students found 428 individuals, mainly outside the EPL. The spread of plants over the EPL is also wider than previous surveys indicated, but the densest concentration of individuals is in the central and south-western areas of the EPL (Appendix 2).

When the localities of *Adenia* plants marked in this survey are overlaid with those of previous surveys (Appendix 3), it can be seen that some plants found by other surveyors could not be found again despite every effort having been made to locate these (see Appendix 4). Especially a dense group of points in the WRN dataset could not be confirmed. There also seem to be mistakes in the datasets of the previous surveys, where up to 12 waypoint numbers have exactly the same co-ordinates (e.g. EF382 to EF392). It is mainly these points that could not be located. At two points (WRN012, WRN281) dead plants were found, which were not marked in this survey.

4.2 Other Observations

Our experience during this survey was, that the occurrence of *Adenia pechuelii* could not be linked to any physical, topographical, geological, aspect, slope or other features of the landscape. This is however only a subjective observation and no data was collected to support this.

This Consultant first observed these plants during March 2007, after some rain was received in the area. At that time, plants were in very good condition bearing fresh shoots, leaves and flowers or immature fruit. In comparison, a large proportion of the plants were in very poor condition in August 2007. Most of the fresh growth was heavily browsed by presumably zebra and rodents, signs (dung, tracks) of both being particularly abundant. Since flowers, and therefore fruit, are borne on young shoots, this may have an influence on seed production of *Adenia*.

Another subjective observation regards the age structure of the *Adenia* population. It seems that there is a healthy number of both small (at least 11 plants smaller than 15 cm stem height, spread throughout population) and very old plants with the majority of plants being in the middle classes. Again no detailed data was collected to confirm this observation.

During previous visits to this population in March and April 2007, it was observed that the flowering of male and female plants was not properly synchronised. The female plants already had immature fruit in March and immature and mature fruit in April, while the male plants had only small buds in March and were in full flower in April. When some nearly mature-looking fruit present on plants in April, were opened, many did not contain any seed. This may be because pollination did not occur since the male flowers were not producing any pollen at the stage when the female flowers were ready. This may well be a reason for poor seed-set and small harvest - only 7 plants had mature fruit in April, from which about 150 presumably viable seeds were collected. Another reason for poor seed harvest is the considerable competition from birds and rodents, who seem to find the fleshy red fruit and seed covering very attractive. To collect a

meaningful amount of seed for *ex situ* conservation would require an almost daily visit to all productive plants over several months (March to May). This situation is not unique to the Valencia population though and was also observed in other areas of Namibia. Further investigation of this issue may be a good subject of study for a post-graduate student.

5.1 Recommendations

There is no doubt that this population of *Adenia pechuelii* is exceptional in its size and density. The envisaged development of a uranium mine at this site, would, no doubt, have an impact on this population in as far as quite a number of plants will be in the way of planned infrastructure and/or mining activities.

At this stage it is not possible to say what percentage of the local, national or global population of *Adenia pechuelii* will be affected by mine development. The reason being, that no detailed survey of the entire local or national/global population has been made. It is therefore recommended, that **a further survey of the area surrounding the EPL be undertaken**. Judging by experiences during this survey, this may become a very time-consuming exercise and a less intensive methodology may have to be chosen. This method should, however, still cover the area in a systematic way. The exact method will have to be developed in collaboration with TECo.

During visits to the area in March 2007, three young plants were removed and taken to the National Botanic Garden in Windhoek. The plants were put into the desert house and seem to be growing. Similarly, specimens of *Adenia* have been transplanted elsewhere (e.g. Vergenoeg homestead) and seem to survive. Based on this, it is recommended by this Consultant, that **any plants, as and when they come in the way of development, be transplanted to an "*Adenia* sanctuary" on site.** This site needs to be accessible by trucks and motor vehicles since some of the larger plants will have to be moved using front-end loaders and trucks. For subsequent maintenance of the sanctuary, access by vehicle needs to be easy. Ideally an area needs to be found that is well away from the mining operations but not too far for moving of plants and periodic maintenance, flat, not too rocky and where some *Adenia* already grow naturally. The soil needs to be loosened (by bulldozer?) and plants positioned at a spacing of no less than 2 x 2 m. It is recommended that immediately after replanting, plants are watered once and then left without watering. Ideally, re-location should be just before the active growing season (February to April) but this may not be practical. The advantage of establishing this sanctuary is that the genepool of *Adenia* plants in the area remains nearly unchanged and any pollen or seed that may develop on the plants is still available for reproduction and recruitment of the species in the area. The plants in the sanctuary could easily be used as a subject of

study (e.g. pollination problem, success of transplanting) and for awareness and education. Once mining operations cease, the plants would also be available for rehabilitation.

This unique plant of the Namib is highly sought after by plant lovers the world over and would make a striking display in any garden. Since very many plants would need to be removed and the population in the EPL alone is quite large, it may be considered to **donate some individuals to renowned botanic gardens** that specialise in arid region plants.

There are a few plants of two species of *Aloe* within the EPL, viz. ***Aloe dichotoma*** (quiver tree) **and *A. namibensis***. All aloes are protected species in Namibia and *A. namibensis* is also endemic to the central Namib. Species of *Aloe* generally transplant very successfully. It is therefore recommended, that wherever specimens of these species are in the way of development, they be **moved to a sanctuary similar to *Adenia***. For *A. namibensis* this may be more complicated, since these plants were observed only on marble ridges and may not grow very well under other conditions. A number of small (less than 1 m high) individuals of *A. dichotoma* were seen in the EPL and these would be particularly suited for relocation.

Other species seen within the EPL that have **value as ornamental plants** are:

Commiphora glaucescens (endemic to central and northern Namib i.e. also in SW Angola)

C. saxicola (endemic to central and northern Namib)

C. tenuipetiolata (common and widespread)

C. virgata (endemic to central and northern Namib)

Euphorbia guerichiana (common and widespread)

E. lignosa (near-endemic to Namibia)

E. virosa (endemic to central and northern Namib)

Moringa ovalifolia (near-endemic to Namibia)

Sarcocualon marlothii (endemic to Namibia)

Sterculia africana (common and widespread)

Most of these species are relatively common within the EPL, its surroundings or the country, which would not warrant transplanting all of them into a sanctuary. **Some plants** could be **transplanted to a sanctuary for use in future rehabilitation**. Seeing that these species do have value as ornamentals and most are known to transplant quite successfully, it would be a pity if all plants would simply be destroyed. It is recommended, that the **National Botanic Garden of the NBRI be given the opportunity to remove any specimens** that they may want for display in their desert house or garden. The use of indigenous plants in Namibian gardens is something that should be promoted and it may be a good idea to **offer the above plants to the nurseries of the Directorate of Forestry**, Ministry of Agriculture, Water and Forestry, who sell indigenous plants to the public on a cost-recovery basis (current price for indigenous plants is N$8.00).

5.2 Summary of recommendations

- a further survey of *Adenia pechuelii* in the area surrounding the EPL to be undertaken
- establish a sanctuary for *Adenia pechuelii* plants in near vicinity and translocate individuals to this area
- donate some individuals of *Adenia pechuelii* to interested and competent botanic gardens
- translocate plants of *Aloe dichotoma* and *A. namibensis*
- translocate some individuals of other species (listed) to a sanctuary
- offer plants of other species to National Botanic Garden and Directorate of Forestry nurseries

6. References

De Wilde, W.J.J.O. 1976. Passifloraceae. *Flora of Southern Africa* 22:111.

Environmental Systems Research Institute (ESRI). 2002. ArcView GIS software, Version 3.3(2). ESRI, Redlands California, USA.

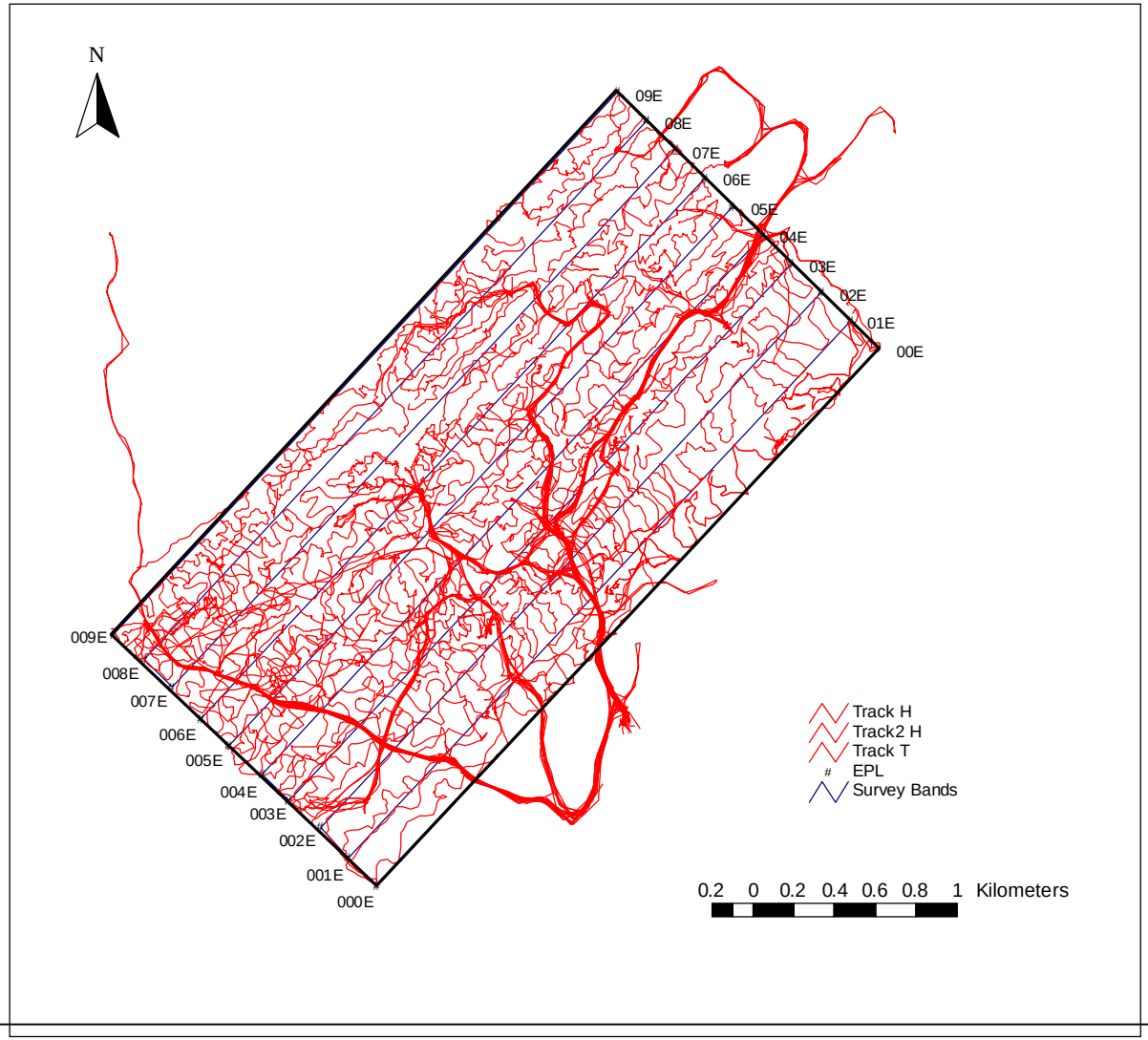
Loots, S. 2005. Red data book of Namibian Plants. *Southern African Botanical Diversity Network Report* No. 38, pp.124.

Minnesota Department of Natural Resources. 2001. DNR Garmin software. Garmin Communications using pcoGarmin by Ron Whately. http://www.c-nav.com; Image Information using Shotgraph by Mikhail Tchikalov. http://www.shotgraph.com; Proj4 projection engine by Gerald Evenden. http://www.remotesensing.org/proj

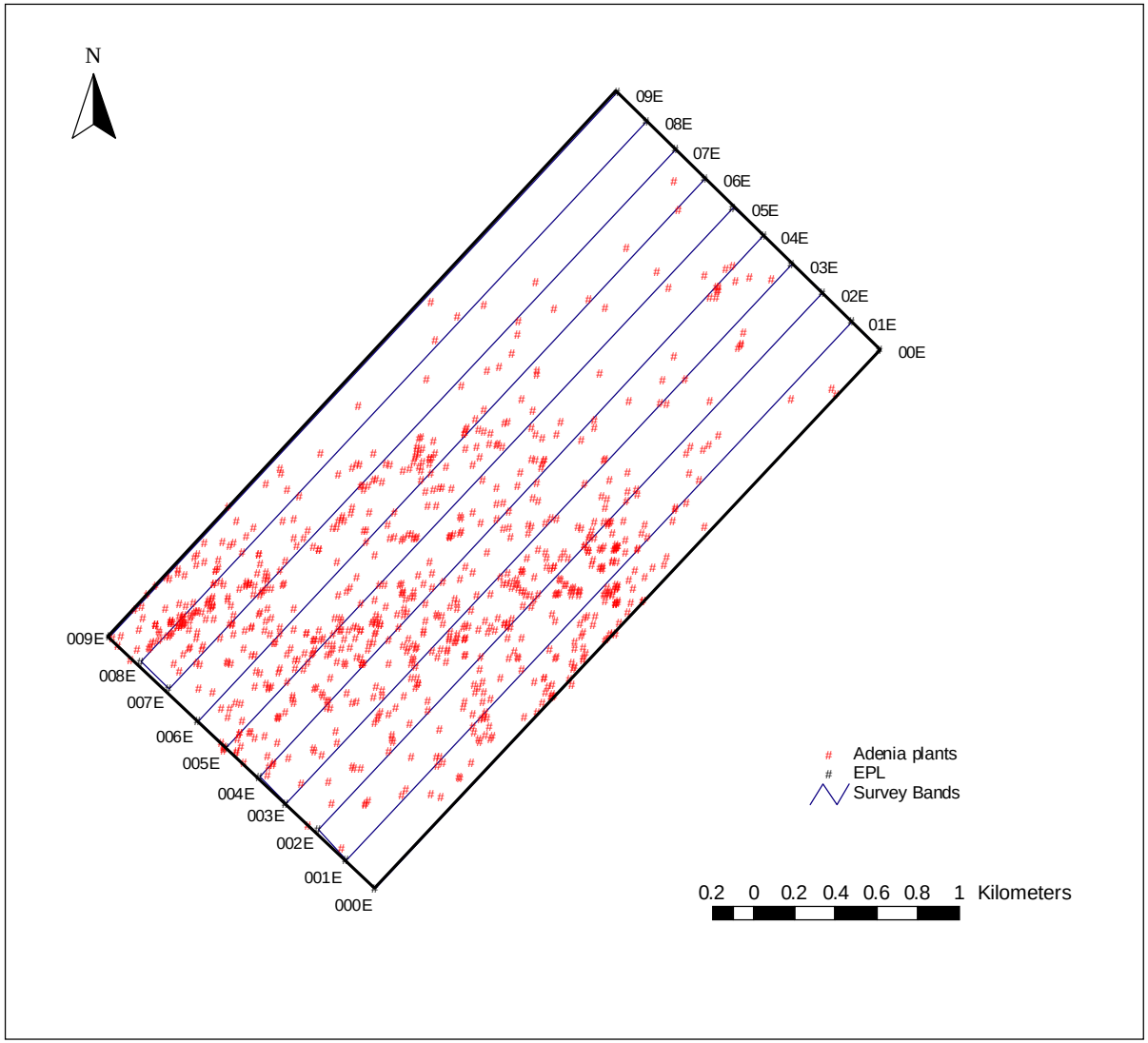
Personal communications:

Patricia Craven, independent botanist, P.O. Box 399, Tel. 064 – 570 542, Omaruru.

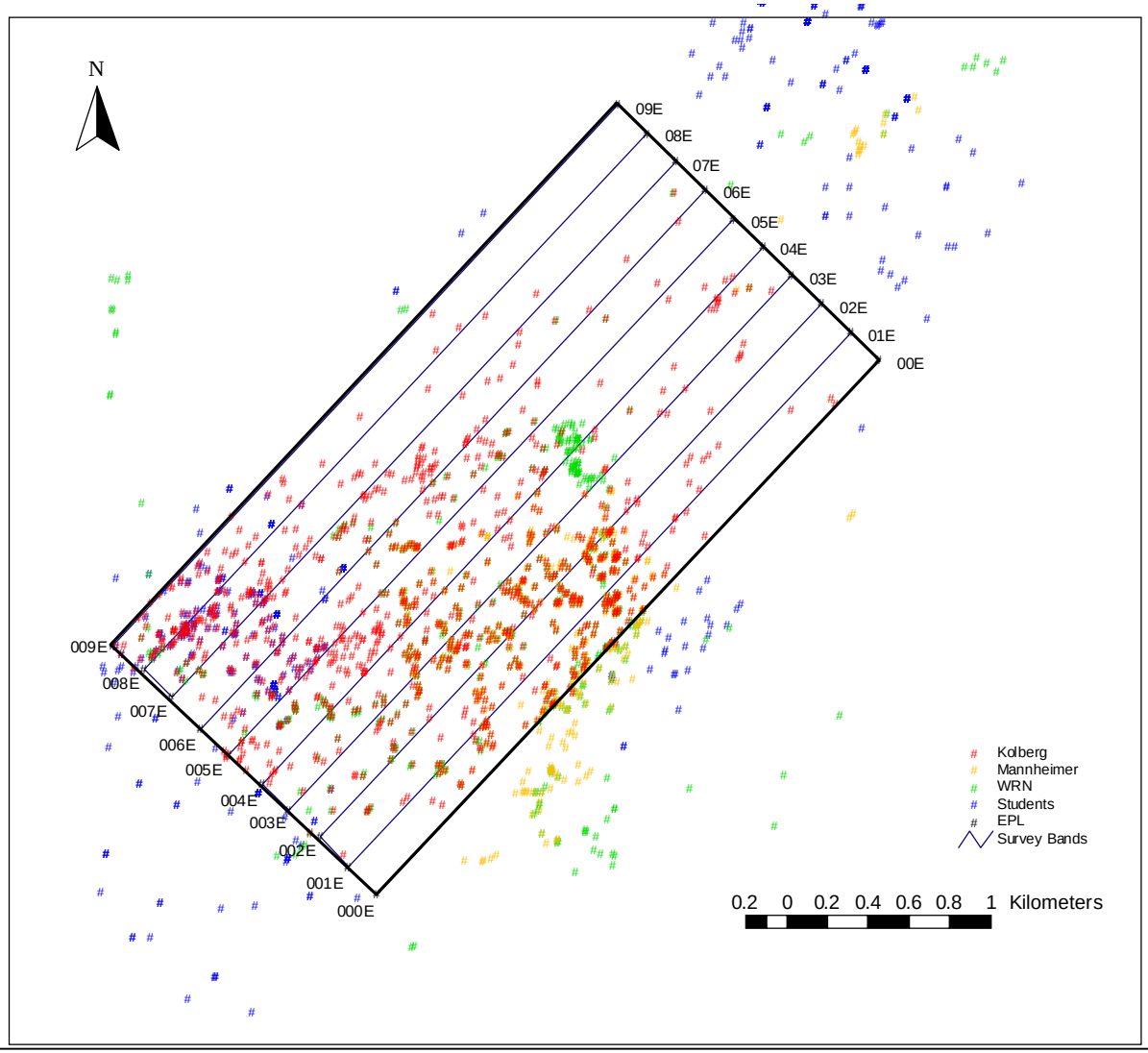
Appendix 1: Tracks walked/driven for this survey



Appendix 2: *Adenia pechuelii* plants marked by this survey



Appendix 3: Overlay of all 4 surveys



Appendix 4: Localities marked by previous surveyors that were checked

Surveyor	Waypoint number	Comment
Students	EF223, EF224	exactly same co-ordinates for both points; checked but could not be found
	EF290, EF291	exactly same co-ordinates for both points; checked but could not be found
	EF292 to EF301	exactly same co-ordinates for all points; checked but could not be found
	EF302 to EF308	exactly same co-ordinates for all points; checked but could not be found
	EF309, EF310	exactly same co-ordinates for both points; checked but could not be found
	EF311	checked but could not be found
	EF382 to EF392	exactly same co-ordinates for all points; checked but could not be found
	EF400	checked but could not be found
	EF416, EF417	exactly same co-ordinates for both points; checked but could not be found
	EF424 to EF428	exactly same co-ordinates for all points; checked but could not be found
Mannheimer	M002	checked but could not be found
	M007 to M010	exactly same co-ordinates for all points; checked but could not be found
	M066	checked but could not be found
	M300, M301	exactly same coordinates for both points; checked but could not be found
WRN	W012	found dead plant here
	W259	checked but could not be found
	W274	checked but could not be found
	W281	found dead plant here
	W307	checked but could not be found
	W334	checked but could not be found
	W336	checked but could not be found
	W337	checked but could not be found
	W341	checked but could not be found
	W342	checked but could not be found
	W343	checked but could not be found
	W346	checked but could not be found
	W347	checked but could not be found
	W348	checked but could not be found

	W349	checked but could not be found
	W350	checked but could not be found
	W351	checked but could not be found
	W352	checked but could not be found
	W353 to W382	exactly same co-ordinates for all points; checked but could not be found
	W384 to W412	exactly same co-ordinates for all points; checked but could not be found
	W439	checked but could not be found
	W517	checked, found *Aloe dichotoma* here
	W547	checked but could not be found