ZIRCO ROODE HEUWEL (PTY) LTD, NORTHERN CAPE

KAMIESBERG PROJECT, NAMAQUALAND, SOUTH AFRICA

BOTANICAL BASELINE AND IMPACT ASSESSMENT REPORT

Prepared for:	**Prepared by:**
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Nic holds a BSc (Env Sci and Zoology), BSc (Hons) and MSc (with distinction) in Environmental Science from Rhodes University. His MSc dealt with valuing the tangible contributions of natural resources to urban households' livelihoods from the surrounding municipal commonage of three different towns in South Africa. Nic's experience in the consulting field relates to ecological and land use studies throughout southern Africa, but also incorporates facilitating sustainable development, public participation and budget management. He is also competent with GIS particularly with ArcGIS 9. His interests include natural resource management, ecological studies dealing with indigenous fauna and flora, particularly terrestrial, wetland, and avifaunal studies.

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Nick holds a BSc (Botany & Zoology) and BSC (Hons) in Botany from the University of Cape Town. He has worked as a botanical consultant since 1998, specialising in the diverse flora of the greater Cape Floristic Region. During this period he has undertaken over 1200 site assessments, has contributed to various publications, including the Red List of South African Plants, the SA Vegetation Map, and the Conspectus of Cape Plants, has published various scientific papers on new plant taxa that he has discovered, and undertook the fine scale vegetation mapping for four large regions for CapeNature.

Dr A.M (Ted) Avis - Reviewer
Ted Avis is a leading expert in the field of Environmental Impact Assessments, having project-managed numerous large-scale ESIAs to international standards (e.g. International Finance Corporation). Ted has worked across Africa, and also has experience in large scale Strategic Environmental Assessments in southern Africa, and has been engaged by the International Finance Corporation (IFC) on a number of projects.

Ted was instrumental in establishing the Environmental Science Department at Rhodes University whilst a Senior lecturer in the Department of Botany, based on his experience running honours modules in EIA practice and environmental. He was one of the first certified Environmental Assessment Practitioner in South Africa, gaining certification in April 2004. He has delivered papers and published in the field of Vegetation Science, Plant Ecology, EIA, Strategic Environmental Assessment and Integrated Coastal Zone Management and has been a principal of CES since its inception in 1990, and Managing Director since 1998.

Ted holds a PhD in Botany, and was awarded a bronze medal by the South African Association of Botanists for the best PhD adjudicated in that year, entitled "Coastal Dune Ecology and Management in the Eastern Cape". Ted is a professional member of the South African Council for Natural Scientific Professionals (since 1993).

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1. INTRODUCTION

1.1 OBJECTIVES

The following objectives have been defined for this assessment:

- To provide a general description of the natural vegetation of the proposed mine area, and of the adjacent areas that may be impacted. Two specific areas were assessed:
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    1. The prospecting areas of Roode Heuvel, Leeuvlei and Sabies.
    2. The coastal area where the coastal intake pipeline is likely to be placed for the desalination plant.

- To provide a general description of the indigenous flora of the area, using a habitat approach and based on the natural vegetation of the site. The identification of plant species of special concern and suitable species for rehabilitation are important outcomes.

1.2 TERMS OF REFERENCE

The following terms of reference were provided for the dry season baseline ecological report:

1. Identify and map the main vegetation types and plant communities;
2. Identify and record the main plant species that may occur within the prospecting areas as well as the coastal area;
3. Where possible identify any plant Species of Conservation Concern (SCC);
4. Describe the likelihood of other SCC occurring in the vicinity;
5. Identify and record plant species that might be suitable for rehabilitation.
6. Assess the extent of alien plant species over the site, and associated risks of alien invasion as a result of the mining project;
7. Identify any significant landscape features or rare or important vegetation associations such as seasonal wetlands, seeps or rocky areas that might support rare or important vegetation associations;
8. Place the project area within the biodiversity context of the region; and
9. Provide a sensitivity map of the concession and coastal areas in order for the proponent to better place the layout of the project's infrastructure.

1.3 ASSUMPTIONS AND LIMITATIONS

Study specific assumptions and limitations include:

1. SCC are often difficult to find, as they are often sparsely distributed in the landscape, and may thus be under-recorded. Small bulbs (*eg. Lachenalia* sp nov) may easily be obscured by adjacent low shrubs, even when flowering, and one can walk right past them without noticing them. For this reason location points were not included for species where this was an issue, and these taxa are instead mapped as polygons within areas in which the species was recorded.
2. Not all areas were equally intensively sampled, as the overall study area is very large and some areas were far from access roads, and some habitats may thus be relatively poorly described. An attempt was made to target habitats within the proposed mining area, and to sample representative examples of all subjectively identified habitats.
3. Many plant species are identifiable only for relatively short periods (a matter of weeks), which may not have coincided with the timing of the two field visits, or of the follow-up visit. In addition, if not in flower some species may be very cryptic (such as *Agathosma elata*).
4. Some plant groups are problematic in terms of their taxonomy (such as the large vygie genus *Ruschia*), and names in these groups may not be easy to assign even when good field material is available.

5. Vegetation mapping is often complicated by diffuse, broad ecological gradients where one vegetation type gradually merges into another. At the other end of the scale problem mapping is also complicated by the mosaic nature of some vegetation types in this area, and rapid transitions over a small distance (<30m), which preclude separate units being mapped in a large study area of many thousands of hectares.
6. The proposed pipeline route from the sea to the mine had not yet been finalized at the time of the assessment, and is thus not assessed.
7. The footprints of the proposed mine infrastructure were not available at the time of assessment, but are assumed to be less than 50ha. This figure is thus used for the mine construction phase impact, as opposed to the much greater actual mining footprint, which technically takes place at the operational phase.
8. The mine footprint as assessed is shown in Figure 1-1. The total development footprint is assumed to be about 3815ha, and it is assumed that not more than 300ha will be strip mined at any one time (the largest blocks shown), meaning that most of the site will support some sort of either undisturbed or rehabilitated natural vegetation at any particular moment in time.

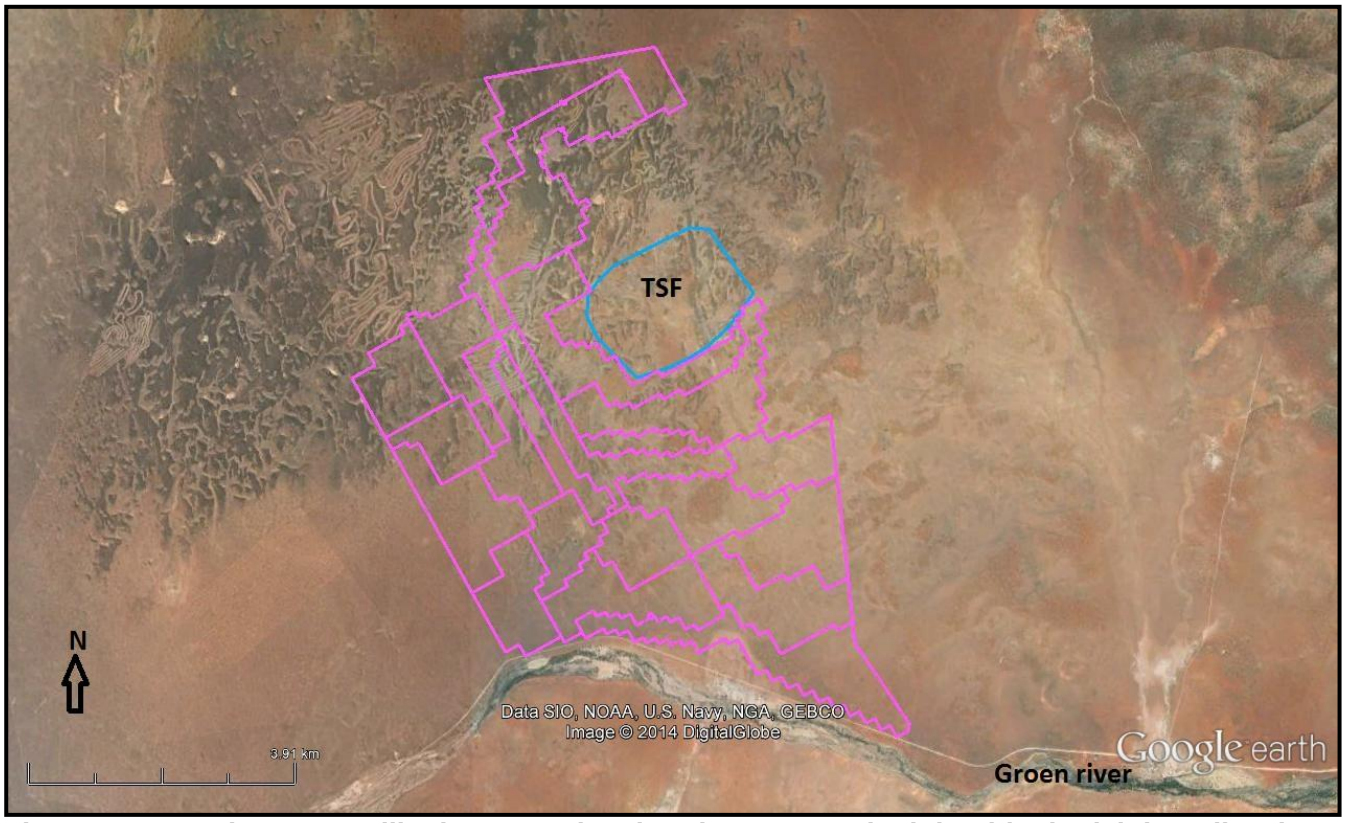


Figure 1.1: Overlay on satellite imagery showing the proposed mining blocks (pink outlines) and Tailings Facility (blue outline), as assessed. The Sand Fynbos is clearly visible in the northern half of the mining area as a mosaic of darker patches.

2. METHODOLOGY

2.1 THE ASSESSMENT

The aim of this assessment was to identify areas of ecological importance and to evaluate these in terms of their conservation importance. In order to do so, the ecological sensitivity of areas was assessed as well as the species of conservation concern that may occur in habitats occurring in the area.

It was not the aim of this study to produce a complete list of all plant species occurring in the region and the study area, but rather to examine a representative sample. It is however important to note areas of high sensitivity as well as species of conservation concern which may occur within the identified habitats. The aim of this study was to identify areas of high ecological sensitivity and those that may be subject to significant impacts from the project. Aspects that would increase impact significance include:

- Presence of plant Species of Conservation Concern (SCC), especially those known from only a few other localities.
- Vegetation types of conservation concern, particularly those that are poorly conserved and below national targets.
- Areas of high biodiversity, especially where these coincide with the above two points.
- The presence of areas that support clear ecological processes, such as:
    - Ecological corridors
    - Soil type transitions
    - Wetlands (including rivers)
    - Complex topographical features (especially steep and/or rocky slopes that provide niche habitats for both plants and animals)

2.2 SPECIES OF CONSERVATION CONCERN

Species of Conservation Concern (SCC) in terms of the project area are defined as:

- **Threatened species**:
    - Species listed as threatened in the revised South African Red Data Books. In the case of plants the most up to date resource is online (www.redlist.sanbi.org), and this site is updated annually.
    - Species included in other international lists (e.g., 2012 IUCN Red List of Threatened Animals).
        - Definitions include:
            - Critically Endangered (CR) - A taxon is Critically Endangered when the best available evidence indicates that it meets any of the criteria A to E for Critically Endangered (see Section V), and it is therefore considered to be facing an extremely high risk of extinction in the wild.
            - Endangered (EN) - A taxon is Endangered when the best available evidence indicates that it meets any of the criteria A to E for Endangered (see Section V), and it is therefore considered to be facing a very high risk of extinction in the wild.
            - Vulnerable (VU) - A taxon is Vulnerable when the best available evidence indicates that it meets any of the criteria A to E for Vulnerable, and it is therefore considered to be facing a high risk of extinction in the wild.
            - Near Threatened (NT) - A taxon is Near Threatened when it has been evaluated against the criteria but does not qualify for Critically Endangered, Endangered or Vulnerable now, but is close to qualifying for or is likely to qualify for a threatened category in the near future.

- **Endemic species**: Endemic species are restricted to a particular area, and thus species may for example be endemic to the Garies region, or to Namakwaland, or to South Africa. Note that only locally endemic plant species are generally noted, as >70% of the total species in the area are endemic to the Cape region, and >85% to South Africa. Local endemism is taken to mean being restricted to either the vegetation type concerned, or to the Namaqualand Sandveld/Strandveld in general.

- **Rare species:** South African plants are also SCC if listed as Rare or Critically Rare. A taxon is Critically Rare when it is known to occur only at a single site, but is not exposed to any known direct threat and does not qualify for a category of threat according to the five IUCN criteria. A taxon is Rare when it is known from more than just one site, and meets any of the four South African criteria for rarity, but is not exposed to any known direct and does not qualify for a category of threat according to the five IUCN criteria.

- **Undescribed species:** Various undescribed plant species (as determined by the relevant taxonomic experts) were recorded in the study area, and as these have not yet been named they do not yet have a Red List status, but can generally be assumed to have a fairly narrow ecological range and/or distribution, making them potentially vulnerable, and are thus of conservation concern.

SCC on site were recorded during two site visits – a 4 day visit in early July 2013, and a 3 day visit in mid-August 2013. Many of the available tracks were driven, and additional areas were accessed on foot. Voucher specimens were collected for most species (with GPS coordinates), and these have been deposited in the Compton Herbarium at Kirstenbosch (NBG). Specimens were identified using available literature, by comparison with material at the Compton and Bolus Herbaria (UCT), and by checking with the relevant taxonomists. Digital photographs were also taken of many species and all habitats, and these photos are often very useful for identification purposes. Many of these photos have been uploaded to iSpot, a virtual museum maintained by SANBI, where anyone can access them, and contribute identifications.

A follow-up study was undertaken in August 2014 by Nick Helme and Simon Todd. The purpose of this study was to survey similar habitat both within the Namaqua National Park and in adjacent, privately owned areas of similar habitat in order to gain a better understanding of the true distribution of some of the rarer SCC recorded during 2013 in the mining and prospecting area. The fieldwork was undertaken from 1-12 August 2014, and the main focus species were *Lachenalia* sp. nov., *Elegia* sp. nov, *Agathosma elata, Lampranthus procumbens* and *Leucoptera nodosa*. During this survey all locations of these species were recorded, population sizes were recorded, and the areas were subsequently mapped on Google Earth. Voucher specimens were also taken for observations made within the Namaqua National Park, and duplicates will be lodged with SANParks Research Centre in Cape Town.

2.3 VEGETATION MAPPING

The vegetation was mapped using visual interpretation of pattern evident on colour satellite imagery available on Google Earth, and was verified by data gathered on the ground during the two site visits (July and August 2013). The botanical specialist has many years of experience in mapping vegetation patterns in the broader region, and is familiar with pattern recognition and satellite imagery. The maps were also compared to the national vegetation map created by SANBI (Mucina & Rutherford, 2006). The latest available satellite imagery is of high quality and was taken in May 2013. Ancillary data in the form of a Digital Elevation Model (DEM) which was created from one metre contours were also used in some instances to help differentiate between vegetation types.

Mapping varied from a scale of 1:10 000 for smaller vegetation units, up to a scale of 1:30 000 for larger more uniform vegetation communities, using a high resolution raster satellite image (Lidar ECW Mosaic) with a cell size of 30 cm relative to the ground. Low resolution aerial photographs (1999 eSAT - 15 m) were also used as a comparative alternative where necessary.

2.4 SENSITIVITY ASSESSMENT

The approach to mapping the sensitivity of the project area identifies zones of very high, high, moderate (medium) and low sensitivity according to a system developed by CES and used in numerous proposed development studies. It must be noted that the sensitivity mapping in this study is based solely on ecological characteristics and not on social or economic factors. The sensitivity analysis described here is based on 10 criteria which are considered to be of importance in determining ecosystem and landscape sensitivity, and have been used in past studies (e.g. CES 2002 – N2 Toll Road Study; de Wet *et al.* 2012 - Ranobe Mine Project - Madagascar). The method involves identifying sensitive vegetation or habitat types, presence of SCC, topography and land transformation (Table 2.1).

The study area was zoned into areas which were homogenous in terms of vegetation types (see section 2.3 above). Alternatively topography and drainage areas were used as boundaries for homogenous zones. Once the study area had been zoned, the sensitivity criteria described in Table 2.1 were applied to each zone and scored as VERY HIGH, HIGH, MODERATE or LOW. A total score for each zone was then calculated and the overall ecological sensitivity was determined using the following percentage scale:

- 0 - 33.3% : LOW ecological sensitivity
- 33.4 – 64.9% : MODERATE ecological sensitivity
- 65 – 85% : HIGH ecological sensitivity
- 85.1 – 100%: VERY HIGH ecological sensitivity.

Although very simple, this method of analysis provides a good, yet conservative and precautionary assessment of the ecological sensitivity.

Table 2.1: Criteria used for the analysis of the sensitivity of the area

CRITERIA		LOW SENSITIVITY	MODERATE SENSITIVITY	HIGH SENSITIVITY	VERY HIGH SENSITIVITY
1	**Topography**	Level, or even	Undulating; fairly steep slopes	Complex and uneven with steep slopes	Complex and uneven with steep slopes
2	**Vegetation -** Extent of habitat type in the region	Extensive	Restricted to a particular region/zone	Restricted to a specific locality / site either within or close to the study area	Restricted to a specific locality / site within the study area
3	**Conservation status** of fauna/ flora or habitats	Well conserved, independent of conservation value	Not well conserved, moderate conservation value	Barely or not conserved - has a high conservation value	Barely or not conserved - has a high conservation value
4	**Species of Conservation Concern** - Presence and number	None, although occasional regional endemics	No endangered or vulnerable species, some indeterminate or rare endemics	One or more endangered and vulnerable species, or more than 2 endemics or rare species	Ten or more very localised, endangered or vulnerable species
5	**Habitat fragmentation** leading to loss of viable populations	Extensive areas of preferred habitat present elsewhere in region not susceptible to fragmentation	Reasonably extensive areas of preferred habitat elsewhere and habitat susceptible to fragmentation	Limited areas of this habitat, susceptible to fragmentation	Limited areas of this habitat, susceptible to fragmentation
6	**Biodiversity** contribution	Low diversity, or species	Moderate diversity, and moderately high	High species diversity, complex	High species diversity, complex

CRITERIA		LOW SENSITIVITY	MODERATE SENSITIVITY	HIGH SENSITIVITY	VERY HIGH SENSITIVITY
		richness	species richness	plant and animal communities	plant and animal communities
7	**Visibility** of the site or landscape from other vantage points	Site is hidden or barely visible from any vantage points with the exception in some cases from the sea.	Site is visible from some or a few vantage points but is not obtrusive or very conspicuous.	Site is visible from many or all angles or vantage points.	Site is visible from many or all angles or vantage points.
8	**Erosion potential** or instability of the region	Very stable and an area not subjected to erosion.	Some possibility of erosion or change due to episodic events.	High possibility of erosion, change to the site or destruction due to climatic or other factors.	High possibility of erosion, change to the site or destruction due to climatic or other factors.
9	**Rehabilitation** potential of the area or region	Site is easily rehabilitated.	There is some degree of difficulty in rehabilitation of the site.	Site is difficult to rehabilitate due to the terrain, type of habitat or species present.	Site is difficult or impossible to rehabilitate due to the terrain, type of habitat or species present.
10	**Disturbance** due to human habitation or other influences (Alien invasives)	Site is very disturbed or degraded.	There is some degree of disturbance of the site.	The site is hardly or very slightly impacted upon by human disturbance.	The site is hardly or very slightly impacted upon by human disturbance.

3. PHYSICAL DESCRIPTION OF THE AREA

This chapter describes the physical setting of the project area, and does not comment on the flora, which is described in detail in the following chapters.

3.1 LOCATION OF THE SITE

Zirco Roode Heuvel (Pty) Ltd (hereafter referred to as Zirco) currently holds the prospecting right to the Roode Heuvel (6134 ha) and Leeuvlei (5986 ha) deposits, located approximately 500 km north of Cape Town and approximately 35 km to the southwest of the town of Garies in the Northern Cape Province of South Africa. They are also in the process of acquiring prospecting rights for a further deposit immediately east and adjacent to Roode Heuvel, referred to as “Sabies” (8674 ha). This report deals with all three areas.

Figure 3.1 shows the location of the project in relation to the regional setting. The town of Garies is located approximately 35 km northeast of the site. The town of Bitterfontein, with a suitable railway siding, is located 65 km south of Garies. Springbok, the regional administration centre for the Namaqua area, is located 117 km north of Garies.

In addition to the prospecting areas, this assessment also covers a 9.5km section of the coast between Island Point (the location of the Namaqua wreck) and Strandfontein Point (also known as Khnyp Punt). Zirco intend to extract and use seawater from the Atlantic Ocean for their operation. This assessment seeks to assist in the location of a suitable site for the extraction pipe to be placed (Figure 3.1).

3.2 TOPOGRAPHY

Namaqualand covers 55 000 km^2 of quartz-strewn plains, undulating hills, granite outcrops and rugged mountains (Olivier, 2005). Namaqualand is bordered to the north by the Orange (Gariep) River and to the south by the Olifants River. To the east it borders Bushmanland, and to the west the Atlantic Ocean. The project site occurs in the southern half of this area, in a belt within 20 km of the Atlantic Ocean.

The topography of the area is mostly flat with occasional low hills (Figure 3.2). Elevation is at an average of 143 meters above mean sea level.

3.3 SURFACE HYDROLOGY

The project area is drained by the Bitter and Outeep rivers to the north of the Leeuvlei prospecting area. The Outeep River is a tributary of the Bitter River. To the south is the Groen River, which borders the southern border of the Roode Heuvel prospecting area (Figure 3.3). All these rivers are ephemeral, meaning that they only flow temporarily after heavy rainfall.

3.4 GEOLOGY AND SOILS

The underlying geology consists of quaternary unconsolidated to cemented sand overlaying Kamieskroon leucocratic gneisses (Zirco, 2012) (Figure 3.4).

The surface aeolian sand varies in thickness over the project area from a few centimetres to 25 m. Dunes are predominantly orientated NNE to SSW due to prevailing wind conditions (Zirco, 2012). The surface sands are part of a typical silicic soil structure, which is described in more detail in the following paragraph.

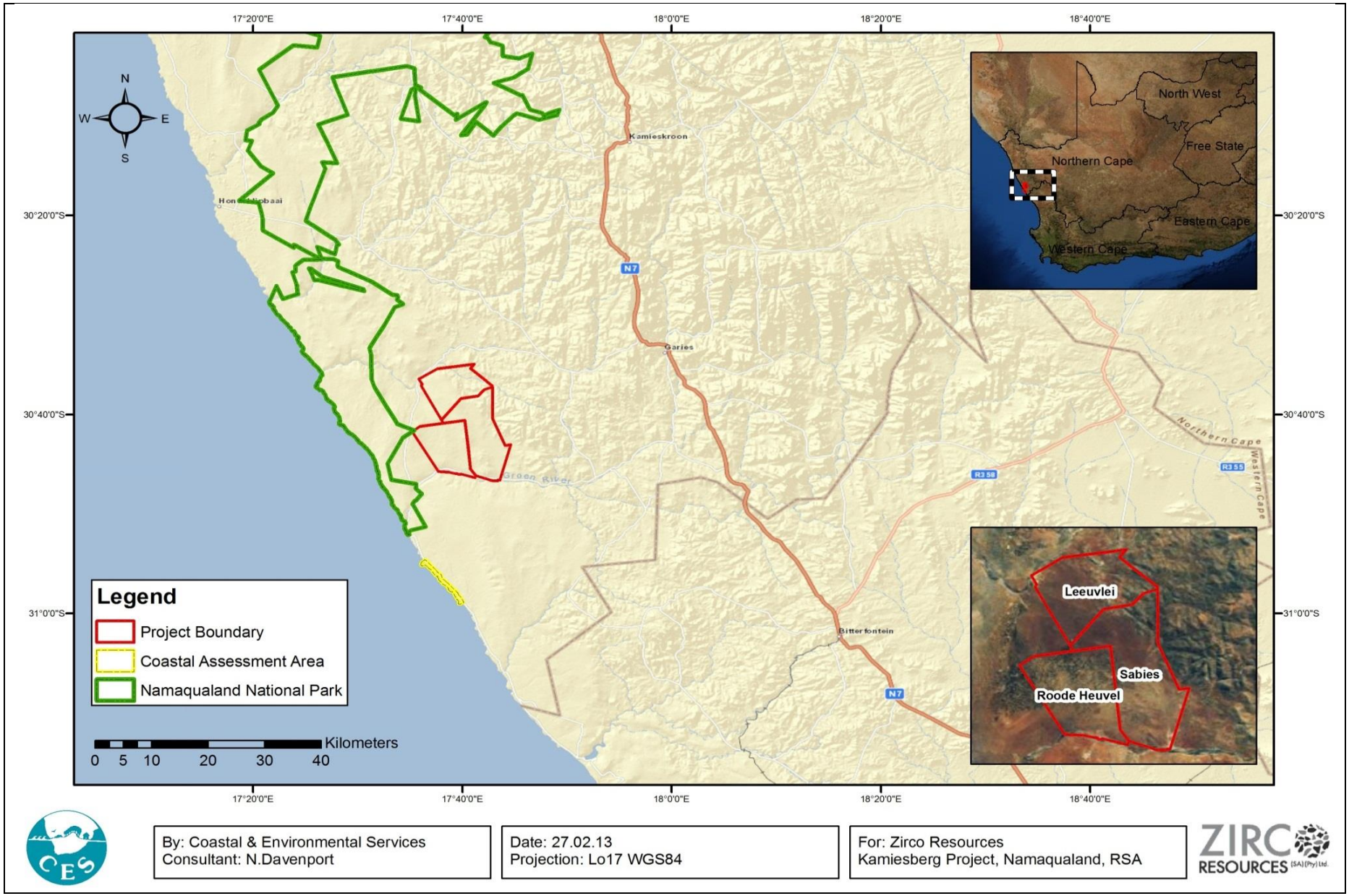


Figure 3.1: Locality map of the Zirco Kamiesberg Project.

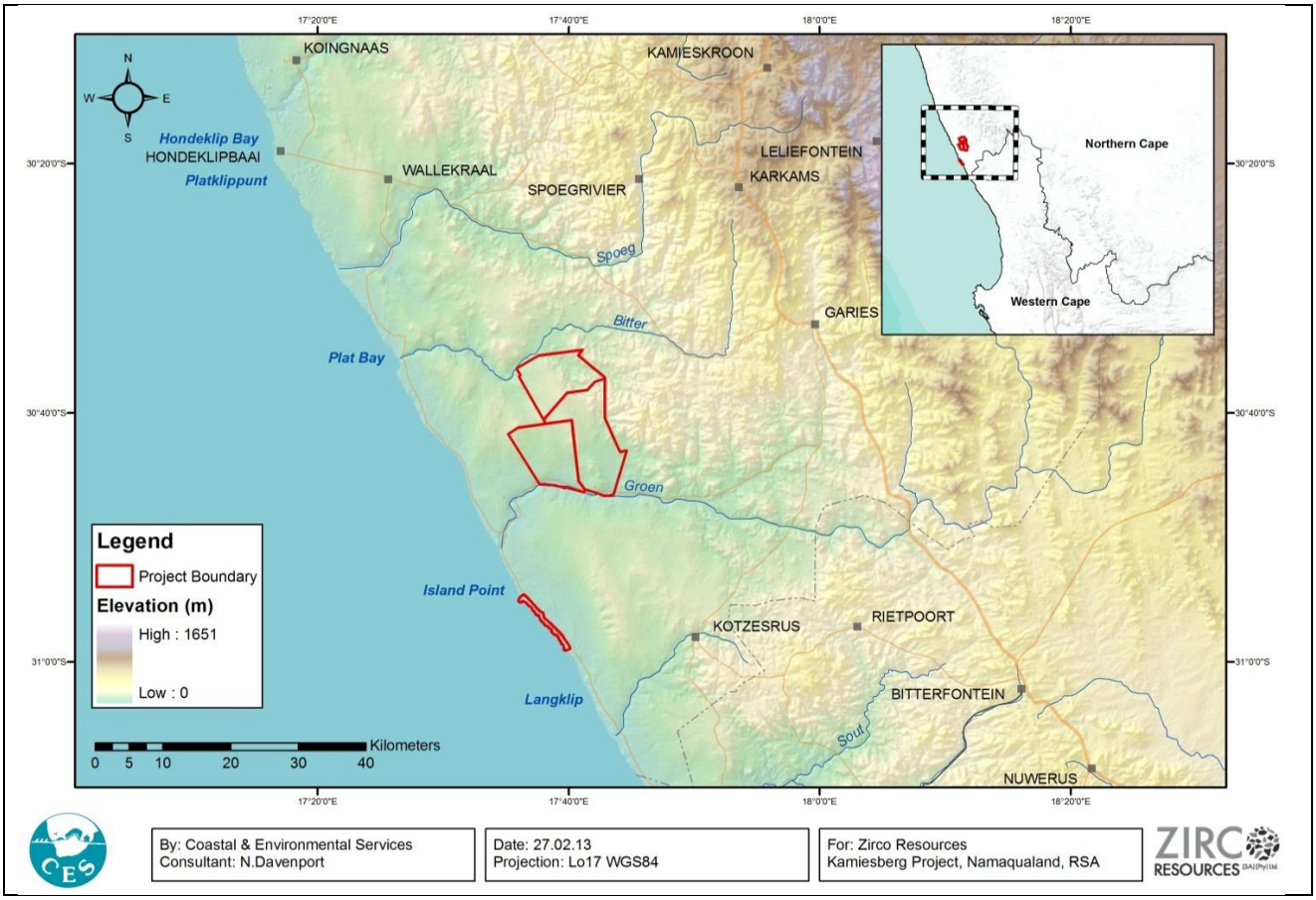


Figure 3.2: General topography and elevation of the greater Zirco Kamiesberg Project area.

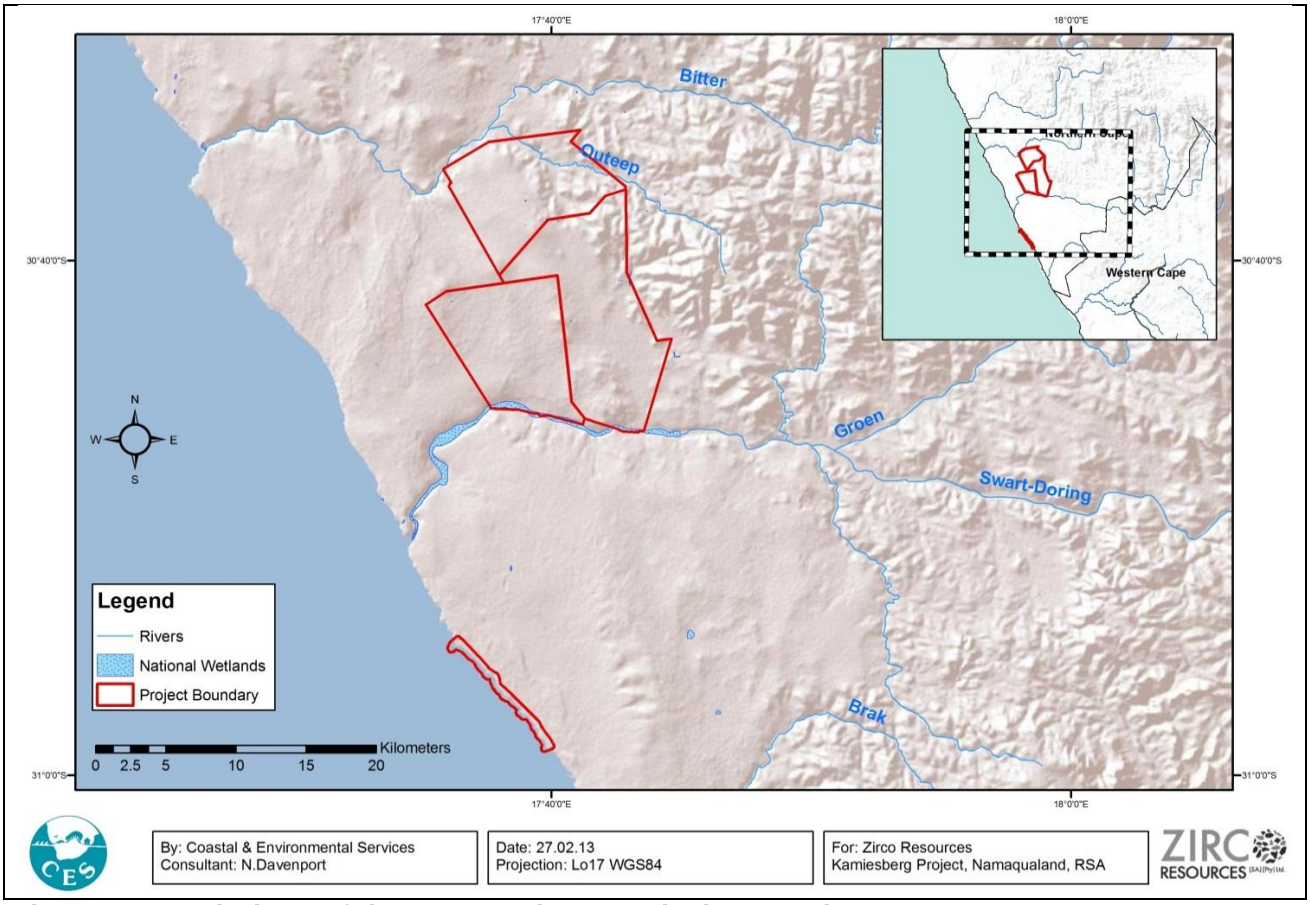


Figure 3.3: Hydrology of the greater Zirco Kamiesberg Project area

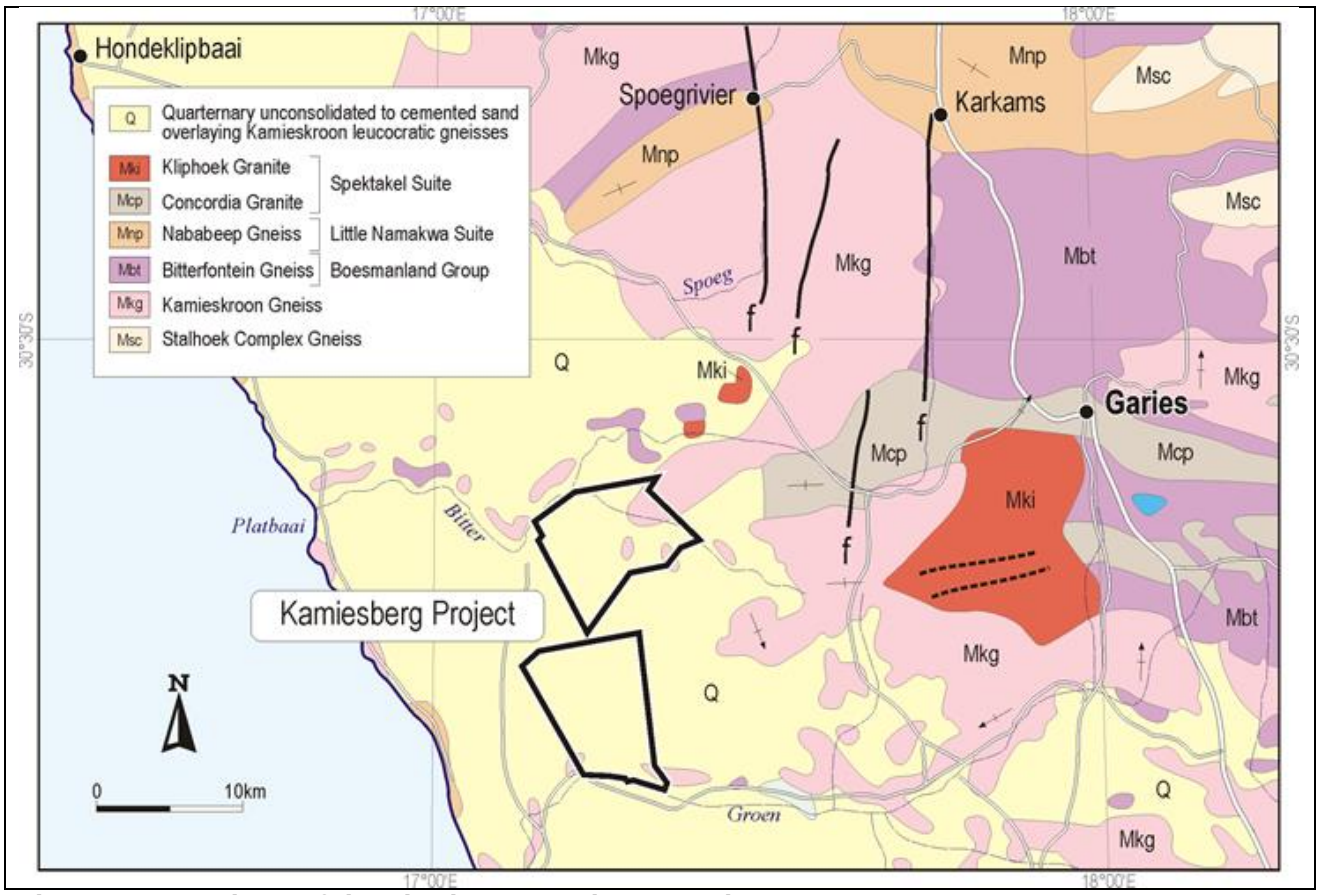


Figure 3.4: Geology of the site (Source: Zirco, 2012)

The distribution of silicic soils is associated exclusively with arid landscapes (Fey, 2010). Mineralogical work to date shows these soils have a subsurface horizon cemented primarily by kaolin with minor iron (Fe) in indurated zones, and not silica dorbank, which is more typical of these areas. Silicic soils are usually medium to coarse textured and well to moderately drained. The pH of the parent material varies between 5 and 10, but typical values are between 7.5 and 9. The physical properties of the silicic soils in the area will depend on the depth at which the kaolin occurs in the profile, and the thickness of any overlying soil material. The often coarse texture of the overlying horizons means that plant available water contents are low. The erosion susceptibility of silicic soils is low to moderate since they are most common on gentle slopes and generally have sufficient cover in the form of grass and short succulent shrubs.

Within South Africa the agricultural use of silicic soils is limited by the dry environment in which they occur, shallow soil depth, especially high pH in those with sodic properties, and low water holding capacity due to the sandy texture (Fey, 2010).

3.5 CLIMATE

Namaqualand is a semi-desert area with dry summers and rainfall occurring during the winter months, with most rainfall between May and August (Desmet, 2007). The area receives an average of 95 mm rainfall per annum, fluctuating between the highest rainfall in June (16.7 mm average) and the lowest in December (0.8 mm average). Other important sources of precipitation are in the form of coastal fog and heavy dew, the source of which is the nearby Atlantic Ocean. The temperature regime is moderate with a mean maximum summer temperature of less than 30°C, and an average of 18.4°C in July. Coastal areas (areas with 5km of the coast) are usually significantly cooler than areas even only 10km inland.

The area experiences wind on a daily basis, peaking in the evening, when average wind speeds are 25km/hr. During the day wind speeds are often much lower dropping to below 10km/hr. Southerly winds dominate in summer, with southwest to northwest winds common in winter. Easterly "berg" winds may blow for short periods in the cooler months, dramatically dropping humidity and raising temperatures. A strong berg wind for a couple of days can bring a rapid end to an otherwise good flowering season.

3.6 LAND USE

The once plentiful and diverse set of large nomadic ungulates of the Karoo have been replaced by intensively stocked monocultures of small livestock with specialist feeding habits, such that the region now holds some 10 million sheep (*Ovis aries*) and goats (*Capra hircus*). Nearly 200 years of this land use have had a devastating effect on the soils and vegetation. The Succulent Karoo holds 506 threatened plant species, some 21% of the threatened plants in southern Africa (Raimondo et al. 2009). Prolonged heavy grazing and trampling, especially around watering points, leads to compositional changes, depletion and thinning-out of the vegetation; this greatly accelerates rates of soil erosion (Barnes et al. 2001).

The Namaqualand Kamiesberg project area is no different to the rest of the Succulent Karoo in terms of land use. The area consists of farms which focus on sheep and goat husbandry. The farm portions in the Kamiesberg project area (<5km from boundary; n=69) range in size from 4.5 ha to 6420 ha, with a mean of 1196 ha. The dominant sheep in the area is the Dorper sheep (black headed and white headed varieties are present), while Damara sheep also occur in the area. Farms which have riverine vegetation also hold Boer goats and in some cases cattle (of mixed breed). Ostriches and in rare cases Emu's also occur in the area.

The region has a low carrying capacity. In Namaqualand the carrying capacity is generally given as 1 small stock unit per 10 to 12 hectares. The official carrying capacity for farms in the Leliefontein area was set at 12 ha per small stock unit, although this changed to 10 ha per small stock unit (SSU) by November of the same year (2002). Current recommended stocking levels in Namaqualand are based on a survey undertaken in the late 1980s by the Department of Agriculture (DoA) to identify carrying capacities for various veld types in the area. It resulted in a map of Namaqualand being developed, which is divided into different units with corresponding carrying capacities. Average carrying capacity for Namaqualand was set at approximately 10 ha per small stock unit. The map produced from this survey is today used by the DoA as a general guide to what the Namaqualand veld can tolerate in terms of grazing pressure. The study area falls into the range of 0 – 48 ha per Large Stock Unit, or 0 – 16 ha per SSU (Lebert 2004).

Certain farms, especially those with Sand Fynbos, also have fallow cereal fields. It seems that very few farmers still plant cereals, in spite of currently higher than average grain prices, and this is due to consistently lower rainfall than decades ago, when most of these fields were developed; however, the old lands are still clearly visible, as heavy livestock grazing has resulted in limited natural rehabilitation in these areas.

4. VEGETATION OF THE STUDY AREA

The project site is located within the Succulent Karoo biome which stretches from the Luderitz district of Namibia along the western extremes of the Northern Cape down towards Cape Town, and thence eastwards into the Little Karoo as far east as Steytlerville. It is the fourth largest biome in South Africa, and much of it consists of flat to undulating terrain, with hilly and more rugged terrain occurring in parts of Namaqualand, and notably so in the Kamiesberg and Richtersveld (Mucina and Rutherford, 2006).

The Succulent Karoo is part of what is now recognised as the Extra Cape Subregion (ECR) of the Greater Cape Floristic Region (GCFR; Snijman 2013). The GCFR is essentially defined by its predominantly winter rainfall, and a distinct flora. The GCFR is one of only six Floristic Regions in the world, and it is also by far the smallest floristic region. The Extra Cape Subregion occupies only 0.1% of the world's land surface, and supports about 3720 plant species, almost 20% of all the plant species in southern Africa, and some 8% of the plant species in sub-Saharan Africa. About 40% of all the plant species in the Extra Cape Subregion do not occur outside this region (Snijman 2013), and many have very small home ranges (these are known as narrow endemics). Although land use pressures are relatively low in the region (apart perhaps from overgrazing and mining), and there are consequently far fewer threatened plants in the region than in the Core Cape Region (commonly referred to as the Fynbos), many of the range restricted species are vulnerable to intense local development due to their very small ranges and specific habitat requirements.

The semi-arid Succulent Karoo is a winter-rainfall region, and is characterized by low to dwarf, open, succulent shrubland, typically including the families *Mesembryanthemaceae* and *Crassulaceae*. This shrubland is dominated by stem and leaf succulents, many of which are deciduous, and a few fine-leaved evergreen shrubs. Grasses are infrequent (partly due to heavy selective grazing) and are mainly annuals. The mass spring flowering displays of annuals (mainly Asteraceae) and geophytes, particularly in disturbed areas, are highly characteristic of the Succulent Karoo. Low trees are common only along river courses, where they may form woodland corridors (Barnes *et al.* 2001).

4.1 REGIONAL VEGETATION

Namaqualand, which forms the largest portion of the Succulent Karoo biome, is best known for its spring floral displays. This winter rainfall desert is home to a unique arid-land flora that is unparalleled globally in terms of its diverse mixture of both species and growth forms. The region is recognized as the only desert biodiversity hotspot on earth (Mittermeier et al. 2000) and hosts the world's greatest variety of succulent plants.

Mucina and Rutherford (2006), which is the most comprehensive data for vegetation types in South Africa, define the following vegetation types (Figure 4.1) from which source these descriptions are derived:

4.1.1 Namaqualand Strandveld (SKs7)

Namaqualand Strandveld (which is part of the Namaqualand Sandveld bioregion) occurs in the Northern and Western Cape Provinces and is characterised by a flat to slightly undulating landscape of coastal peneplain. It is found on Quaternary stabilised deep aeolian red or yellow sands and on stable dunes and deep sand overlying marine sediments and gneisses. These sands are alkaline or neutral, as opposed to the Sand Fynbos sands which are usually slightly acidic. Sometimes weakly defined scattered heuweltjies (circular, abandoned termite mounds) are found further away from the sea. Although predominantly coastal, this vegetation may penetrate as far as 40 km inland from the sea, especially where coastal dune plumes extend inland and where there is a high incidence of coastal fog. Strandveld vegetation structure is highly variable, ranging in height from an average 30cm to an average 1.2m, but it is typically low, species-rich shrubland dominated by a variety of erect and creeping succulent and often deciduous shrubs. This widespread vegetation type could perhaps be divided into at least 6 or 8 distinct forms based on morphology

and species composition, but this has not yet been done on a formal basis.

Namaqualand Strandveld is classified as a **Least Threatened** vegetation type on a national basis (DEA 2011), with a conservation target of 26% of its total original extent, and about 10% of its total extent has been transformed (Rouget *et al.* 2004). Relatively little was formally conserved until recently, although the nearby Namaqua National Park does now include significant areas of this vegetation type (>60 000ha, or >15% of the total original extent, being over half of the conservation target of 26%). This vegetation type covers about 46% of the total prospecting area, and about 40% of the proposed mining area.

4.1.2 Namaqualand Heuweltjieveld (SKn4)

This vegetation type occurs in the Northern Cape along the western foothills of the Namaqualand Escarpment. It characterised by undulating plains that lead up the escarpment, and soils are typically relatively rich and derived from underlying granite or gneiss. The vegetation cover comprises a mosaic of low shrubland communities dominated by leaf-succulent shrubs that occur on slightly raised, rounded termite mounds or "heuweltjies"; ascribed to former activity of harvester termites (*Microhodotermes viator*). It is classified as **"Least Threatened"** on a national basis (DEA 2011), with a conservation target of 28% of its original extent. Approximately 11% has been statutorily conserved (mostly in the Namaqua National Park) and 3-4% has been transformed by cultivation (Rouget *et al* 2004). This vegetation type occupies about 18% of the prospecting area, but is not present in the proposed mining area.

4.1.3 Namaqualand Klipkoppe Shrubland (SKn1)

This vegetation type occurs in the Western and Northern Cape in the central and north-central regions of Namaqualand. It is typified by dramatic landscapes of large granite and gneiss domes and disintegrating boulder koppies that support open shrubland dominated by dwarf shrubs with ericoid or succulent leaves, many of which are deciduous. It is classified as **Least Threatened** on a national basis (DEA 2011), with a conservation target of 28%. Approximately 6% has been statutorily conserved and about 5% has been transformed (Rouget *et al* 2004). This vegetation type occupies only about 1% of the prospecting area, and is not present in the proposed mining area.

4.1.4 Namaqualand Sand Fynbos (FFd1)

Namaqualand Sand Fynbos occurs on the coastal plain (usually 5-20km inland), on Quarternary and Tertiary sands of marine and aeolian origin, and is the only Sand Fynbos type found within the Succulent Karoo biome, all the others being part of the Fynbos biome further south. The topography, soil pH and moisture availability determine the dominance of Sand Fynbos or Strandveld communities. Strandveld communities prefer alkaline soils, while Sand Fynbos is found on leached (acidic) soils. In the case of Namaqualand Sand Fynbos, fire does not play a role in regeneration of the Fynbos elements, in contrast to other Sand Fynbos types. There is often a predictable presence of various shrubs of Fynbos affinity on the dune ridges, and Restionaceae are often dominant in dune slacks, and sometimes also on dune ridges.

The boundary (ecotone) between Sand Fynbos and Strandveld is usually dynamic and rather broad, and is driven primarily by soil pH. This boundary may be very diffuse, or it may be complex, and results in a difficult to map mosaic of vegetation types. The width of the ecotone from pure Strandveld to pure Fynbos may vary from quite abrupt to 2-5 km in certain areas (Mucina & Rutherford 2006). Scarps adjacent to riverine and wetland vegetation often support Strandveld, due to higher salinity in these areas.

Namaqualand Sand Fynbos occurs in the Western and Northern Cape along the coastal plain. The vegetation occurs on slightly undulating plains and is dominated by Cape reeds (Restionaceae) that occur between scattered shrubs. It is classified as **Least Threatened** on a national basis (DEA 2011), with a national conservation target of 29% (Rouget *et al* 2004). The Namaqua National Park has recently incorporated an unknown proportion of this vegetation type (perhaps some 11 000ha), but the total area statutorily conserved is probably still under 12% of its original extent. It is estimated that about 7% has been transformed by cultivation and by ongoing mineral sand mining near Brand se Baai, which has resulted in the loss of over 3000ha of this unit. This vegetation type occupies about 29% of the prospecting area, and about 60% of the Roode Heuvel property.

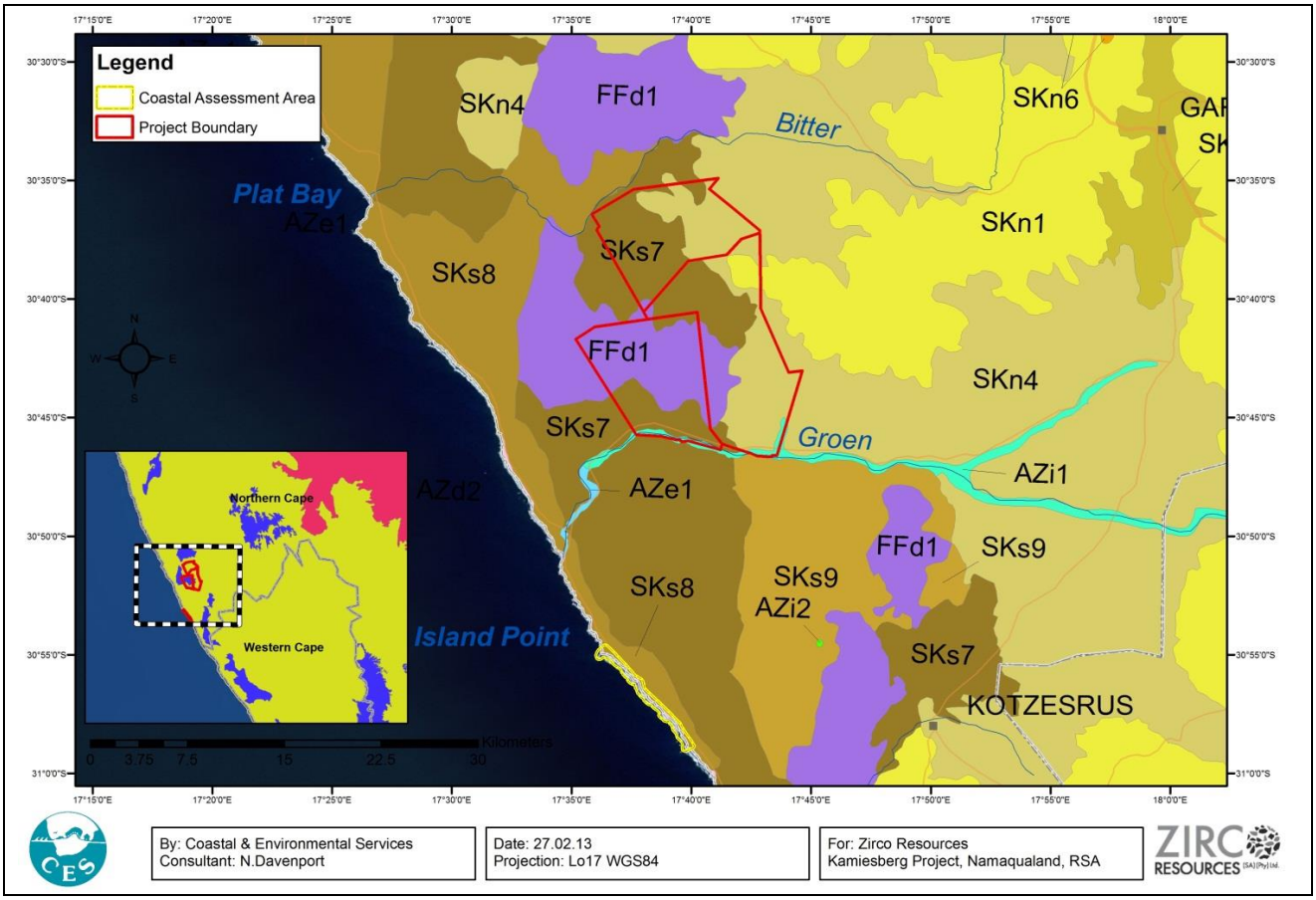


Figure 4.1: Regional vegetation of the study area as per Mucina and Rutherford (2006)
SKs7 - Namaqualand Strandveld; SKn4 – Namaqualand Heuweltjieveld; SKn1 – Namaqualand Klipkpppe Shrubland; FFd1 - Namaqualand Sand Fynbos; AZi1 - Namaqualand Riviere; SKs8 - Namaqualand Coastal Duneveld; AZd2 - Namaqualand Seashore Vegetation.

4.1.5 Namaqualand Riviere (AZi1)

Namaqualand Riviere occurs in the Western and Northern Cape along dry riverbeds throughout Namaqualand. It is characterised by a complex of alluvial shrubland interspersed with patches of tussock graminoids (grasses). Soils are a mix of heavy silts and coarse granitic sands, and are often strongly saline, as reflected by the presence of salt tolerant species such as *Sarcocornia* and *Salicornia*. In places low thickets of *Acacia karroo* and *Tamarix usneoides* are found, and *Phragmites* reeds are common in areas with more regular surface water. The vegetation type is classified as **Least Threatened** (DEA 2011), with a conservation target of 24% (Rouget et al. 2004). Only a small percentage has been statutorily conserved while almost 20% has been transformed through cultivation (Mucina & Rutherford 2006). This vegetation type occupies only about 3% of the prospecting area, and is not present in the proposed mining area.

4.1.6 Namaqualand Coastal Duneveld (SKs8)

This vegetation type occurs in the Western and Northern Cape along the coastal plains. The vegetation is typically dwarf shrubland dominated by erect succulent shrubs and non-succulent shrubs. Spiny grasses are common on the windblown semi-stable dunes. The Namaqualand Coastal Duneveld is classified as **Least Threatened** with a conservation target of 26%. As of 2004 none was statutorily conserved, but the Namaqua National Park has recently incorporated a significant but unknown area of this vegetation type (estimated at about 20% of its total original extent). Some 8% of its original extent has been transformed through diamond mining, mainly in the Hondeklipbaai area (Mucina & Rutherford 2006). This vegetation type occurs in the study area along the coast between Island Point and Knyp Point, but not in the prospecting or mining area.

4.1.7 Namaqualand Seashore Vegetation (AZd2)

Namaqualand Seashore Vegetation is distributed along the Northern Cape coastline, in a very narrow strip above the high water mark, from Holgat River to Olifants River. It is typically found on alkaline coastal dunes, and is typically a sparse vegetation community of partly succulent hummock-forming and spreading dwarf shrubs, grasses and herbs. Namaqualand Seashore Vegetation is classified as **Least Threatened** with a conservation target of 26%. As of 2004 none was statutorily conserved, but the Namaqua National Park has recently incorporated a significant but unknown area of this vegetation type. About 5% has been transformed through diamond mining (Mucina & Rutherford 2006). This widespread vegetation type occurs between the high water mark and the Namaqualand Coastal Duneveld, along the coast between Island Point and Khnyp Point.

4.2 VEGETATION AND FLORISTICS OF THE PROJECT AREA

4.2.1 Prospecting areas

Five (5) key vegetation types occur on the Zirco prospecting area (Figure 4.2), namely:

1. Strandveld (Namaqualand Strandveld)
2. Sand Fynbos (Namaqualand Sand Fynbos)
3. Heuweltjieveld (Namaqualand Heuweltjieveld)
4. Riparian vegetation (Namaqualand Riviere)
5. Klipkop Shrubland (Namaqualand Klipkoppe Shrubland)

A full plant species list for all vegetation units is included as Appendix 1. This list includes a surprisingly high total of 25 plant Species of Conservation Concern.

Strandveld (9544 ha) is the dominant vegetation unit in the study area and occurs all along the Groen River basin in the southern sections of Roode Heuvel and Sabies areas (Plate 4.1A). It is also found scattered throughout Sabies, and extends into Leeuvlei (Figure 4.2). Strandveld merges with Sand Fynbos all along the boundary between the two vegetation types, and in places it can be difficult to distinguish a clear boundary. Degraded Strandveld (181 ha) occurs along the southern section of Roode Heuvel (Plate 4.1B). The cause of degradation is overgrazing, resulting from water points and livestock pens (kraals) which occur along the road, and incidentally along the Groen River.

A. Strandveld

B. Previously cultivated and degraded Strandveld which is now dominated by grass species

C. Sand Fynbos, dune slack in foreground, dune ridge behind. The restio *Thamnochortus bachmanii* is dominant in the foreground.

D. Fallow fields in Sand Fynbos

E. Heuweltjieveld, with a high density of dwarf succulents in the foreground

F. Degraded Heuweltjieveld dominated by 'kraalbos' (*Galenia africana*)

G. Riparian bush along the Groen River, with *Acacia karroo*

H. The Groen River riparian vegetation includes salt tolerant succulent shrubs

I. Klipkop shrubland

J. Rocky outcrop with Klipkop Shrubland

Plate 4.1: Examples of the various vegetation types which occur in the prospecting area.

Typical species in Strandveld include *Zygophyllum morgsana* (skilpadbos; slaaibos)*, Othonna cylindrica* (ossierapuisbos)*, Othonna coronopifolia, Tetragonia fruticosa* (klimopkinkelbossie), *Cladoraphis cyperoides*, *Berkheya fruticosa, Tripteris oppositifolia, Osteospermum incanum, Leucoptera nodosa*, *Lycium strandveldense* (muisbos), *Salvia africana-lutea* (bruinstrandsalie), *Limonium peregrinum* (strandroos), *Limonium* sp. nov. (*L. dagmarea* MS), *Calobota angustifolia* (fluitjiesbos), *Ruschia floribunda, R. subpaniculata, R. fugitans, Lampranthus watermeyeri, L. stipulaceus, Heliophila lactea, Euphorbia mauritanica* (melkbos), *Pelargonium gibbosum* (dikbeen malva), *Hermannia trifurca* (poprosie), *H. scordifolia*, *Thesium spinosum, Exomis microphylla, Microloma sagittatum, Pteronia divaricata, Manulea altissima, Stoeberia utilis* (asbos), *Manochlamys albicans* (spanspekbos; seepbos; soutbos), *Cissampelos capensis, Conicosia pugioniformis* ssp*. alborosea* (vetkousie), *Vanzijlia annulata, Phyllopodium pumilum, Gorteria personata, Tylecodon wallichii* (krimpsiektebos), *Eriocephalus racemosa* (kapokbossie; wilderoosmaryn), *Asparagus africana*, *Adenogramma mollugo, Pharnaceum lanatum*, and *Helichrysum tricostatum.* Scattered larger woody shrubs are a feature in some areas, especially in transitions to Sand Fynbos, and may include *Searsia longispina* (taaibos) and *Gymnosporia buxifolia* (pendoring). Grasses may be prominent after rains, mainly *Ehrharta calycina* (rooisaadgras), *Schismus barbatus* and *Stipagrostis zeyheri*. Bulbs include *Babiana brachystachys*, *B. grandiflora*, *Lachenalia unifolia*, *Oxalis flava*, *O. luteola*, *Trachyandra divaricata* (duinekool)*, Trachyandra falcata* and *T. muricata* (veldkool), *Drimia capensis* (maerman), and *Boophone haemanthoides* (gifbol).

Relatively few **SCC** are known to occur in true Strandveld, but nevertheless six SCC were recorded in this unit (24% of those in the total study area).

1. *Leucoptera nodosa* (Plate 4.2) is Red Listed as Vulnerable (Helme & Raimondo 2006). This is a succulent shrub in the daisy family, previously known from only five definite localities in the Strandveld between Hondeklipbaai and Lamberts Bay. The species was recorded at three new localities within the study area (see Figure 4.2), and at various other new localities within the Namaqua National Park during the August 2014 survey. The species seems to usually occur as scattered individual plants, although one of the localities (Leeuvlei area) supported what is to date the largest known population of the species (about 150 plants).
2. *Arctotis sp nov.1* is an undescribed perennial daisy known only from this unit, and although widespread (Brand se Baai to Hondeklipbaai) it may be threatened by mining (pers. obs.). As it is yet to be described the species has not been assessed for the Red List.
3. *Calobota lotononoides* (Near Threatened; Helme et al. 2008) is common in this habitat, often on the ecotone with Sand Fynbos.
4. *Helichrysum tricostatum* (Near Threatened) is also fairly common in this habitat, but is a very widespread species (Saldanha to Orange River).
5. *Hermannia* sp nov. is common in this unit, but has not yet been assessed. The species is common in the region from Brand se Baai to Hondeklipbaai.
6. *Wahlenbergia asparagoides* (Vulnerable) is most common in Sand Fynbos, but may also occur in this unit.

Plate 4.2: Leucoptera nodosa is a perennial daisy Red Listed as Vulnerable, photographed here west of Leeuvlei. This is the largest known population of this rare species.

Sand Fynbos (6072 ha) is the second largest vegetation unit in the area. It is the dominant vegetation on Roode Heuvel, but also extends into Sabies and Leeuvlei (Figure 4.2). Sand Fynbos occurs on slightly undulating plains and is often dominated by restios (typically *Thamnochortus bachmanii* and *Restio macer*) in the dune slacks (troughs), and asteraceous fynbos or restios (*Willdenowia incurvata*) on the dune ridges (Plate 4.1C). The vegetation on the dune ridges often includes Strandveld elements.

Species typical of this unit include *Nenax arenicola, Arctotis canaliculata, Willdenowia incurvata* (sonkwasriet), *Thamnochortus bachmanii, Restio macer, Kedrostis psammophila, Ficinia argyropa, Ficinia indica, Grielum humifusum* (pietsnot), *Chrysocoma longifolia., Eriospermum arenosum*, *Salvia lanceolata, Wahlenbergia asparagoides, Lebeckia ambigua, Aspalathus cuspidata, A. quinquefolia, A. spinescens ssp. lepida, Chlorophytum viscosum, Coelanthum grandiflorum, Albuca* sp., *Nemesia affinis, Justicia cuneata, Elegia sp nov., Diosma ramosissima, Osteospermum incanum, Trichogyne pilulifera, Elytropappus rhinocerotis* (renosterbos), *Stoebe nervigera, Aspalathus cuspidata, Leucospermum rodolentum* (luisbos), *Leucadendron brunioides ssp. brunioides, Metalasia densa, M. adunca, Macrostylis* sp*., Wiborgia obcordata, Ornithoglossum viride* (slangblom), *Moraea ciliata, Calobota lotononoides*, *Muraltia obovata*, *Gethyllis* sp. (kukumakranka), *Asparagus juniperoides, Pteronia onobromoides* and *Limeum africanum*.

This habitat unit is known to support at least **15 SCC**, and is the richest vegetation type in the study area in terms of number of threatened plant species. This is a highly significant number of SCC for a single vegetation unit, being 60% of all SCC recorded in the total study area. See Appendix 2 for a full list of the SCC in this unit, and a list of the significance of the populations of all SCC. Only the most significant are outlined below.

The unit includes a number of undescribed or only recently described species, which is indicative of how poorly known the unit is, or at least was until recently.

- *Elegia* sp nov is a striking, undescribed restio that is only known from the northern Sandveld. Originally (in 2009) recorded close to Kotzesrus, it was found to be fairly common on site (the second known locality) only on the northern edge of RoodeHeuvel (Figure 4.3). The August 2014 fieldwork showed that it also occurs in about a 20ha patch of the adjacent Namaqua National Park, and again in a small area north of the Bitter River, where new cultivation had already resulted in loss of about half this population.
- *Lachenalia* sp nov (Plate 4.3) is a bulb that was first discovered in September 2012 close to Koekenaap, and was then found to be fairly common in the study area, where the Type collection was made, and the species will be described in 2014 (as *L. arenicola* MS). The August 2014 fieldwork revealed this species to be present but never common as far north as Riethuis (giving it a total known range of about 170km), and is fairly well represented within the Namaqua National Park.
- *Lampranthus procumbens* (Plate 4.4) is a creeping vygie that was described in 2009, and is known from Kommagas south to Kotzesrus, and the species is common on site only in the northern areas of RoodeHeuvel. It was found to be common in the adjacent parts of the Namaqua National Park, but was rare elsewhere in the Park.
- *Agathosma elata* is a buchu that was previously only known from near Vanrhynsdorp and Klawer, some 150km to the southeast, and its discovery here was thus a major surprise. The species is Red Listed as Endangered, and the population in the study area is small. In August 2014 the species was found at various other localities as far north as Riethuis (40km NW of the site), including 3 within the Namaqua National Park, but it is never common, and the total population is small (estimated at <500 plants).
- *Caesia sabulosa* is a common geophyte in Sandveld, but was also only recently described, and is here at or close to its northernmost distribution.

Fallow cereal (oats, rye and wheat) fields (308 ha) occur scattered throughout large sections of the Sand Fynbos communities, especially in the north western sections of Roode Heuvel (Figure 4.2; Plate 4.1D). The Pilot mine (5 ha) is located on Roode Heuvel on the ecotone between Sand Fynbos and Strandveld. These disturbed areas support a limited number of widespread, pioneer species, and generally do not support any SCC. However, a population of *Wahlenbergia asparagoides* (Vulnerable) was observed in the rehabilitated portion of the pilot mine, suggesting that this shrubby species is tolerant of disturbance, and is perhaps a pioneer species. Similar observations from Namakwa Sands support this idea, but it does seem to be the only SCC readily able to colonise the mined areas. Alien invasive species are rare, even in these disturbed areas.

Rehabilitation potential of these disturbed areas is fairly good, as they are generally narrow strips surrounded by extensive areas of natural vegetation which could act as a seed source. Rehabilitation success would be significantly better in the absence of livestock grazing, as heavy grazing of recovering veld promotes the abundance and dominance of unpalatable species such as *Galenia africana* (kraalbos).

Plate 4.3: This bulbous plant is an undescribed species of Lachenalia found in the Sand Fynbos on site (see Figure 4.3), and will be formally described in 2014 as L. arenicola.

Plate 4.4: Lampranthus procumbens is a rare and recently described creeping vygie known only from the northern Sandveld, between Komaggas and Kotzesrus, and is uncommon in the study area. These flowers have yet to open.

Heuweltjieveld (3798 ha) may be found all along the eastern extent of Leeuvlei, and a large part of north eastern Sabies (Figure 4.2). It generally occurs on undulating topography of the Kamiesberg escarpment foothills, and comprises largely succulent dwarf shrubland communities amongst a mosaic of heuweltjie communities. Degraded Heuweltjieveld (252 ha) occurs in the south eastern sections of Sabies adjacent to alluvial corridors, and is dominated by the unpalatable shrub *Galenia africana* (kraalbos). This vegetation type may be spectacular after good winter rains, when extensive displays of annuals, herbs and bulbs colour the landscape, and at that stage is capable of supporting a high diversity of insects, birds and other animals.

Common species in this unit include *Drosanthemum hispidum, Othonna sedifolia, Osteospermum pinnatum, Oncosiphon suffruticosum* (stinkkruid), *Zalusianskya villosa, Ursinia cakilefolia, Leysera tenella, Felicia tenella, Zygophyllum retrofractum*, *Aridaria noctiflora, Lycium cinereum, Manochlamys albicans, Ruschia leucosperma,Stoeberia frutescens, Didelta carnosa, Salsola aphylla* (gannabos), *Tetragonia fruticosa, T. spicata, Berkheya fruticosa, Limeum africanum, Lampranthus otzenianum, Psilocaulon foliosum, P. junceum* (asbos), *Ehrharta calycina, Rhynchopsidium pumilum, Oxalis annae* and *Pharnaceum croceum*.

This unit is relatively poorly researched, but at least six **SCC were recorded here, two of which are undescribed species discovered for the first time.** The conservation value of the poorly known quartz patches within this unit (the habitat of 4 of the 6 SCC) is thus Very High (Figure 4.3).

Both the new species were discovered on an isolated quartz patch in the Leeuvlei area, near the Outeep River (Figure 4.3), and both are vygies. The two new species are a species of *Jacobsenia* (Plate 4.5) and a species of *Cheiridopsis* (Plate 4.6). Both species are being sequenced and described by Dr C. Klak of the Bolus Herbarium. Both seem to be restricted to this isolated quartz patch, which is less than 5ha in extent, and other suitable looking quartz patches in the region (not all within the study area) were surveyed for these species, with no success. This pattern of extreme endemism is not uncommon amongst quartz patch specialists in the region.

Othonna lepidocaulis (Plate 4.7) is a rare, perennial, tuberous daisy known previously only from the Knersvlakte, some 150km to the south, and its occurrence here, on the same quartz patch (Figure 4.3), is both very interesting and highly significant. *Aloe krapohliana* is a dwarf aloe that was also observed primarily in the vicinity of this quartz patch, and the species is Red Listed as Data Deficient and, according to the available data, should be listed as Threatened (von Staden 2008).

Plate 4.5: A new species of what is likely to be a Jacobsenia vygie, discovered near the Outeep River on Leeuvlei. The species will be described by Dr C Klak.

Plate 4.6: A new species of Cheiridopsis discovered near the Outeep River, in a different part of the same quartz patch.

Plate 4.7: Othonna lepidocaulis – a rare species previously only known from 150km to the south, and also found on the quartz patch on Leeuvlei.

Riparian (564 ha) areas consist largely of alluvial corridors of the Groen River in the south and Bitter River in the north, but also includes tributary alluvial drainage lines scattered largely in the eastern sections of Leeuvlei and Sabies, commencing in the Kamiesberg escarpment foothills and draining down to the larger river basins (Figure 4.2, also refer to Figure 3.3). The vegetation varies from *Acacia* thicket to alluvial halophytic shrublands. These areas serve as important corridors for bird species.

Acacia karoo is characteristic of this unit, and may form dense thickets in places. The only other notable tree is *Tamarix usneoides*. Shrubs include *Galenia africana* (kraalbos), *Zygophyllum retrofractum, Hoplophyllum spinosum*, *Lycium* spp., *Cephallophyllum* sp., *Malephora lutea, Suaeda fruticosa, Atriplexa cinerea, Salsola tuberculata and Ballota africana*, and the perennial grass *Stipagrostis namaquensis* may be prominent. The succulent *Mesembryanthemum guerichianum* may be prominent in silty areas. Where surface or near surface water accumulates there are also some large patches of reedbed (*Phragmites australis)*, which provide critical roosting sites for many bird species. The reedbeds may be interspersed with *Odyssea paucinervis, Scirpoides dioecus, Juncus* sp. and *Sporobolus virginicus* (brakgras).

Saline areas may be dominated by *Salicornia* sp. (an undescribed species, according to L. Mucina, in Snijman 2013) and *Sarcocornia pillansii* (brakkoraal), with *Salsola* sp. (gannabos), *Odyssea paucinervis* and *Spergularia bocconii*.

No SCC were recorded in this unit, and no such species are likely to occur here in significant numbers.

Klipkop Shrubland (251 ha) vegetation occurs as scattered communities surrounding rocky outcrops of the Kamiesberg escarpment foothills. These can be found in central Leeuvlei and northern Sabies (Figure 4.2). These serve as important sites for local reptile populations.

Typical plant species include *Montinia caryophyllacea* (klappers), *Berkheya fruticosa, Didelta spinosa* (perdebos), *Euphorbia mauritanica* (melkbos), *Leipoldtia schultzei, Manochlamys albicans, Pelargonium crithmifolium, Phyllobolus roseus, Othonna cylindrica, O. furcata, O. macrophylla, Ehrharta calycina, E. barbinodis, Chaetobromus dregei, Stoebera utilis* (asbos*), Senecio junceus, Tylecodon paniculatus* (botterboom), *T. reticulatus, Hermannia disermifolia, Eriocephalus microphyllus* (kapokbos), *Whiteheadia bifolia*, *Calobota sericea, Solanum burchelli, Selago glutinosa, Crassula muscosa, Crassula tomentosa, Conophytum bilobum and C.* spp*., Ornithogalum multifolium, O. rupestre* and *Sarcostemma viminale.*

No SCC are likely to occur within the limited extent of this unit in the study area, but the unit was not surveyed extensively, and it is known to support many SCC in nearby areas.

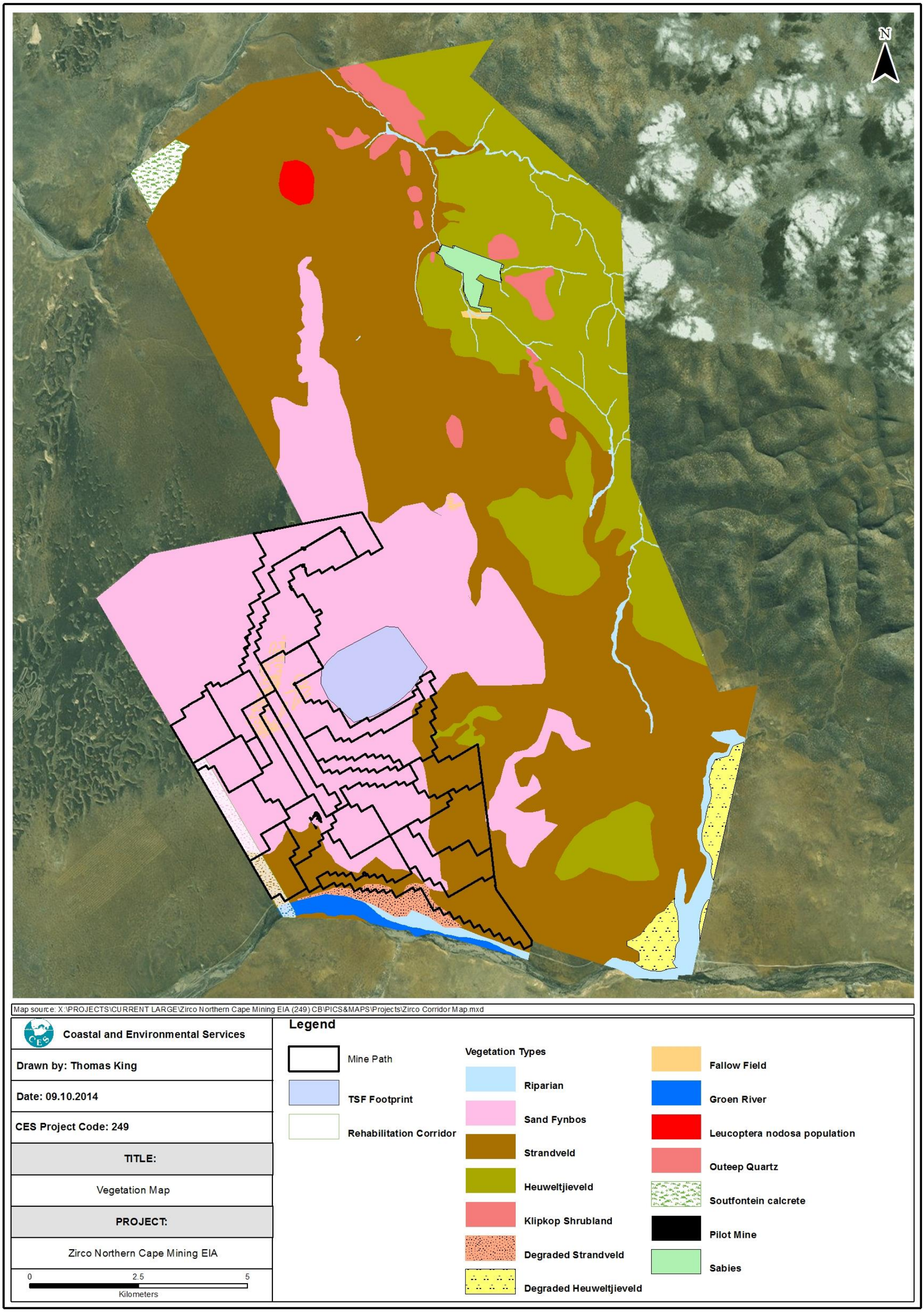


Figure 4.2: Vegetation Map of the Kamiesberg Project area.

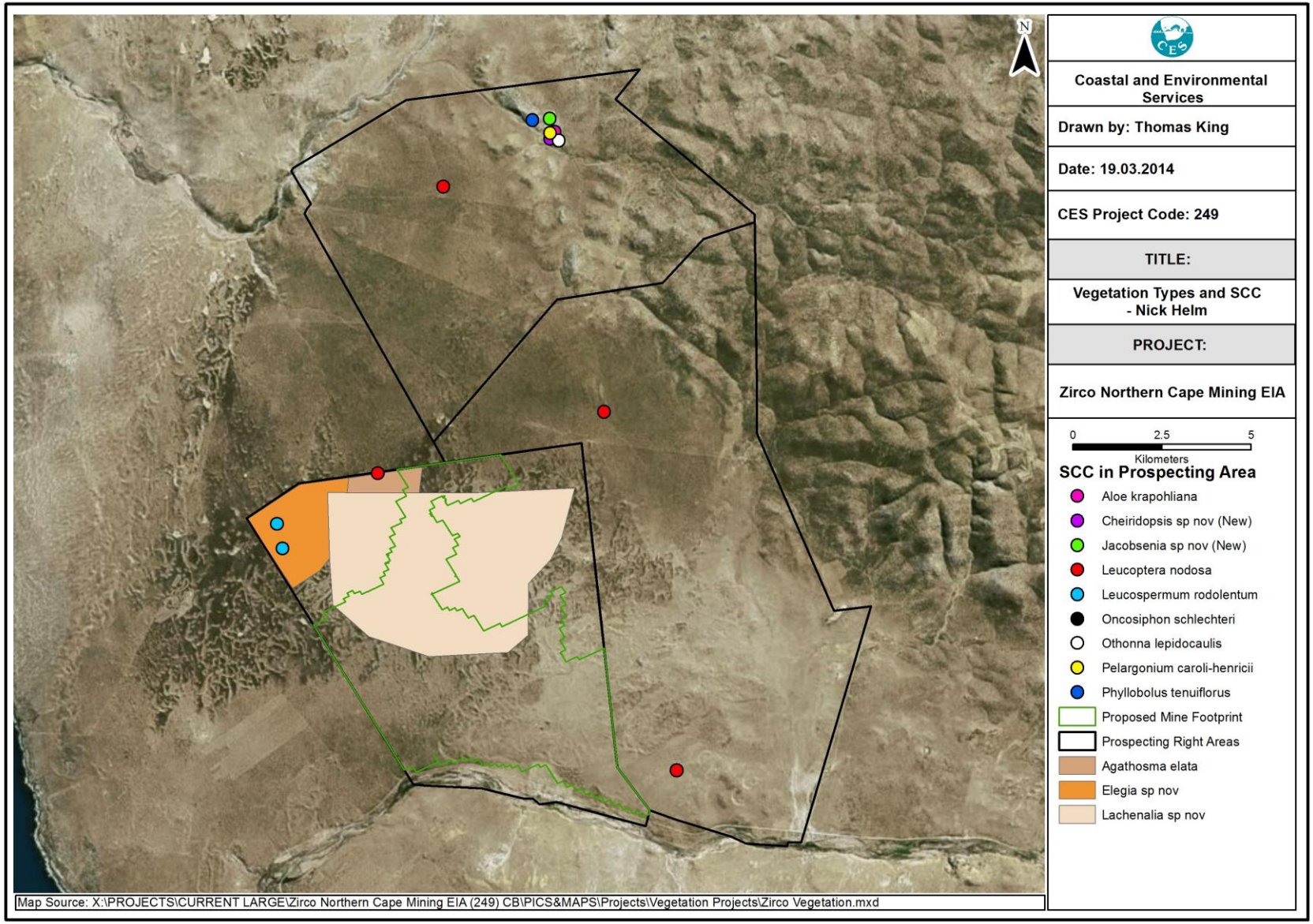


Figure 4.3: Map of 11 of the 23 plant Species of Conservation Concern (SCC) in the project area (black outline). The other 12 SCC are too common and widespread within the RoodeHeuvel property to map at this scale. The green outline is the proposed mine footprint

4.2.2 Coastal Area

Two key vegetation types occur within the coastal assessment area (Figures 4.3-4.6):

1. Seashore Dunes
2. Coastal Duneveld

Seashore Dunes occur as a belt along the coastline, above the high tide water mark, and on the seaward side of the Coastal Duneveld. Essentially it consists of Namaqualand Seashore Vegetation, but also includes transition zones of seashore vegetation occurring on white dune sands, which have taller shrubs, but are not considered part of the Coastal Duneveld (Plate 4.8).

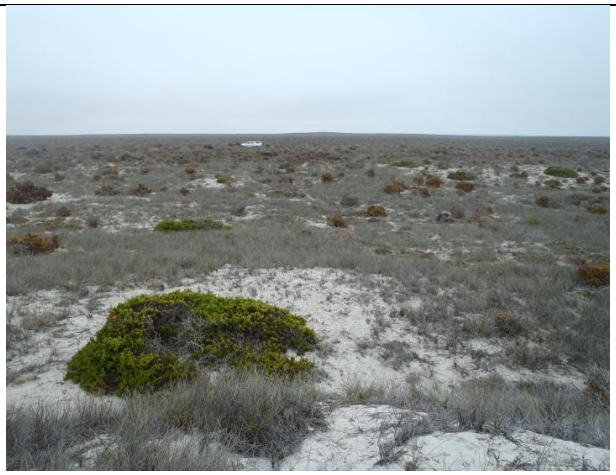
Typical species include *Cladoraphis cyperoides, Eriocephalus racemosus, Lycium strandveldense, Babiana hirsuta, Didelta carnosa, Senecio arenarius, Amphibolia hutchinsonii, Zygophyllum morgsana, Thinopyrum distichum, Arctotheca populifolia, Thesium elatior, Othonna cylindrica, Lessertia* cf. *globosa, Hypertelis angrae-pequenae, Helichrysum tricostatum, Othonna coronopifolia, Arctotis decurrens, Conicosia pugioniformis* ssp. *alborosea, Trachyandra divaricata* and *Tripteris oppositifolia.*

This environment is not known to host many **SCC**, although at Brand se Baai there are at least three SCC in this unit, two of which are local endemics not yet known from the current study area (Desmet & Helme 2003). *Oncosiphon schlechteri* is Red Listed as Endangered, and was recorded only in the vicinity of proposed Gulley Intake 3 (Figure 4.4). What may be *Limonium decumbens* (Data Deficient) was also recorded here. *Helichrysum dunense* (Vulnerable; Helme & Raimondo 2006) is restricted to coastal dunes north of Elands Bay, and was recorded in the study area only in the vicinity of Gulley Intakes 4 and 1 (Figure 4.4). *Manulea cinerea* is restricted to this dune habitat on the Namaqualand coast, and may also occur within the study area (although not recorded), and is Red Listed as Vulnerable (Helme & Raimondo 2005).

Coastal Duneveld is situated on the inland side of the Seashore Dunes, and gradually merges with Strandveld further inland (Plate 4.8 A & D). Common species *Jordaaniella spongiosa, Odyssea paucinervis, Asparagus capensis, Phyllobolus trichotomus, Zygophyllum cordifolium, Z. cuneifolium, Z. morgsana, Mesembryanthemum guerichianum, Dicrocaulon crassum, Ruschia* spp., *Cephallophyllum luteum, Hypertelis salsoloides, Galenia sarcophylla, Didelta carnosa, Drosanthemum* spp*., Leipoldtia schultzei, Osteospermum incanum, Othonna cylindrica, O. sedifolia, Lycium strandveldense* and *Gazania* sp. *aff. krebsiana*.

No SCC were recorded in this unit.

The littoral zone (the area from the high water mark to shoreline areas that are permanently submerged) along the west coast consist of alternating zones of rocky and sandy shores (i.e. sandy beaches), which is true for the coastal assessment area (Figures 4.4-4.7).



A. Seashore Dune vegetation merging inland into Coastal Duneveld, within which the vehicle is parked

B. Seashore Dune vegetation above the high water mark, below which is a sandy beach

C. Seashore Dune vegetation above the high water mark, below which is a rocky shoreline

D. Coastal Duneveld, which in this case comes very close to the littoral zone

Plate 4.8: Examples of the various vegetation types which occur in the coastal assessment area

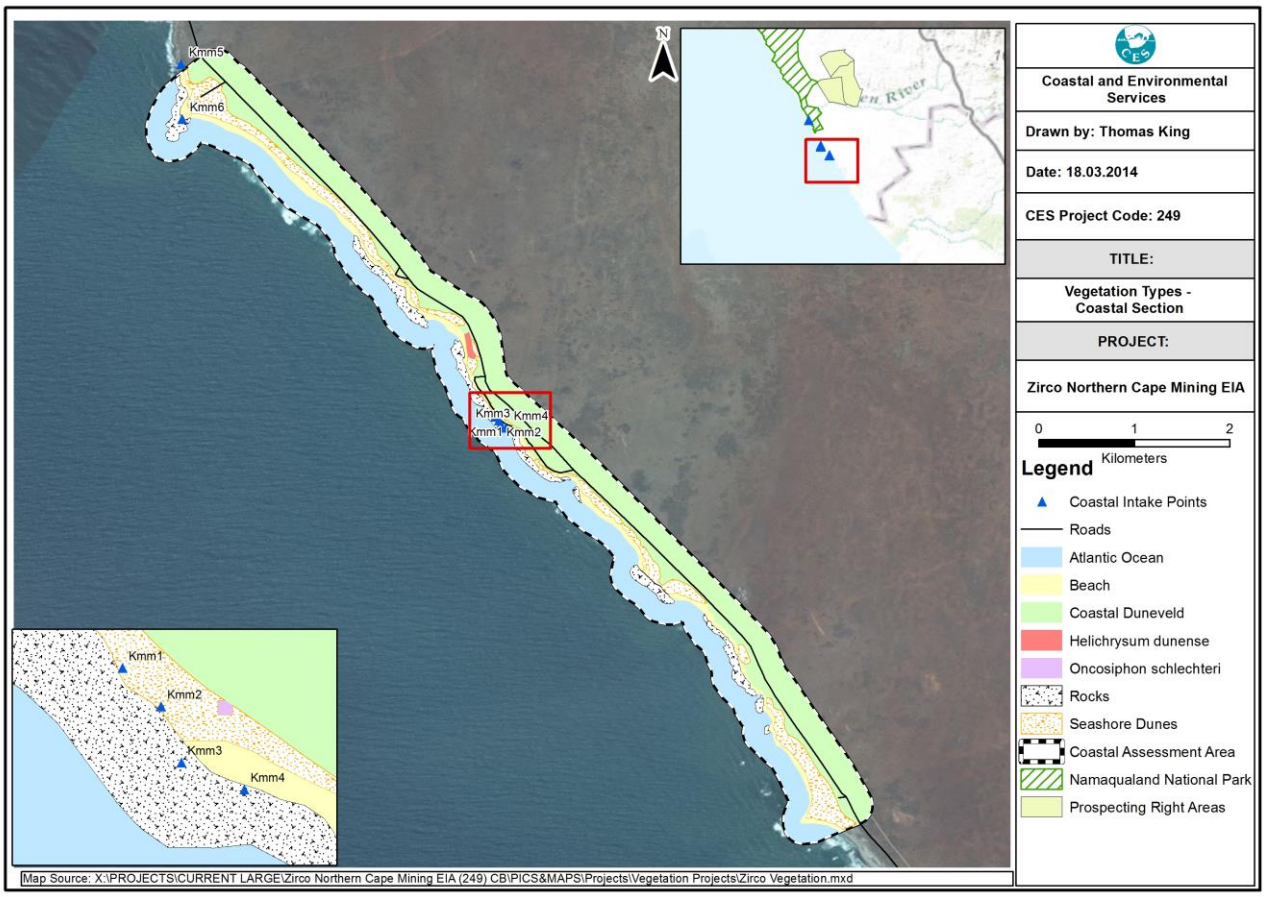


Figure 4.4: Vegetation Map of the coastal assessment area.

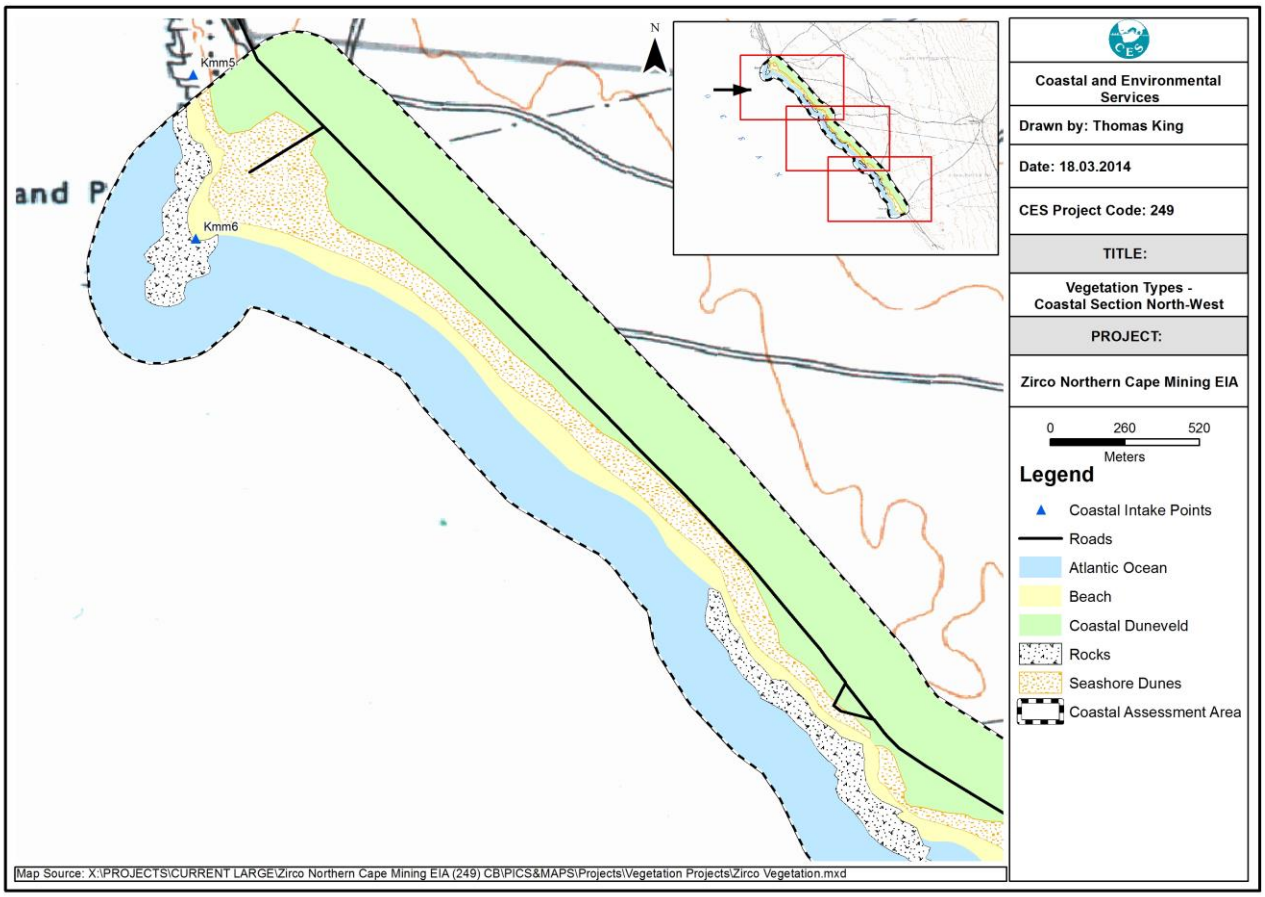


Figure 4.5: Vegetation Map of the coastal assessment area – north western section.

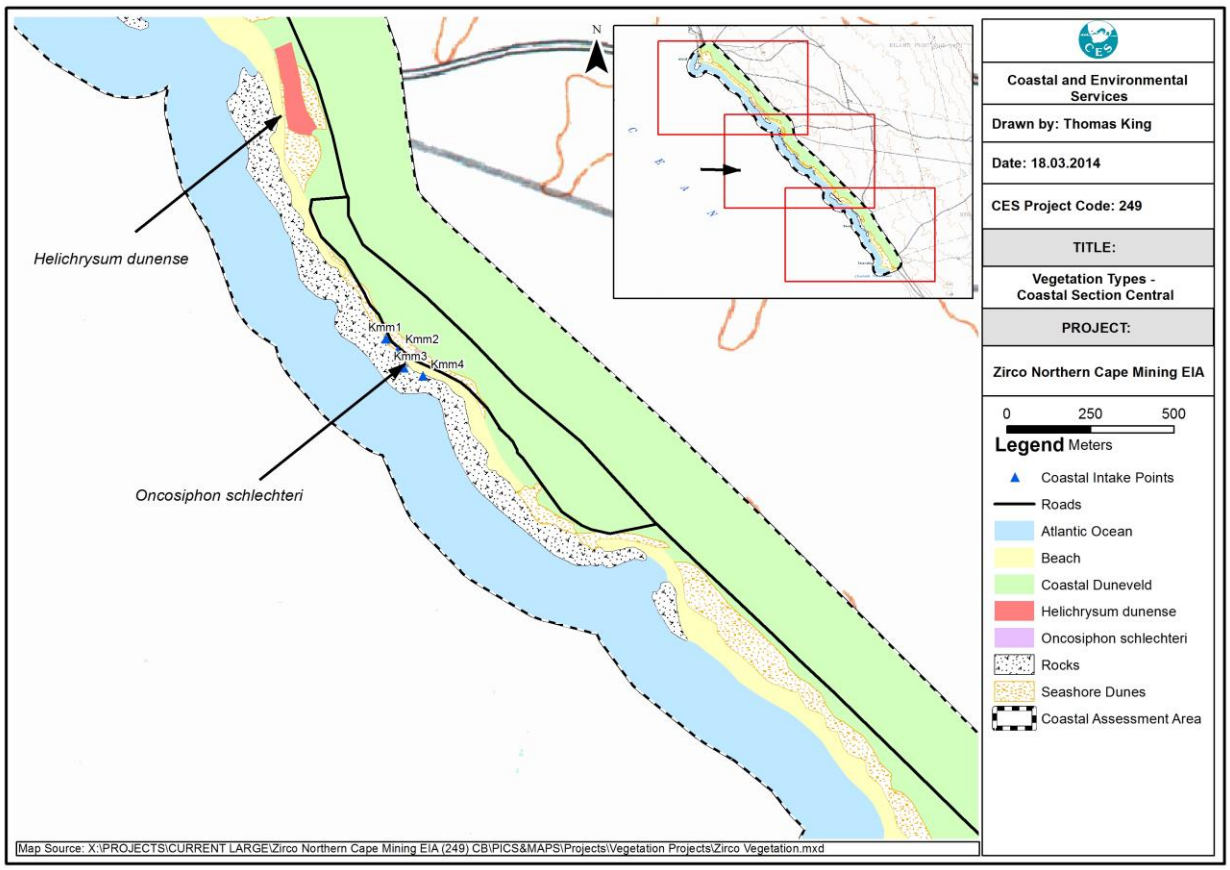


Figure 4.6: Vegetation Map of the coastal assessment area – central section. This map shows the portion of the coastal study area where the two recorded plant Species of Conservation Concern were found

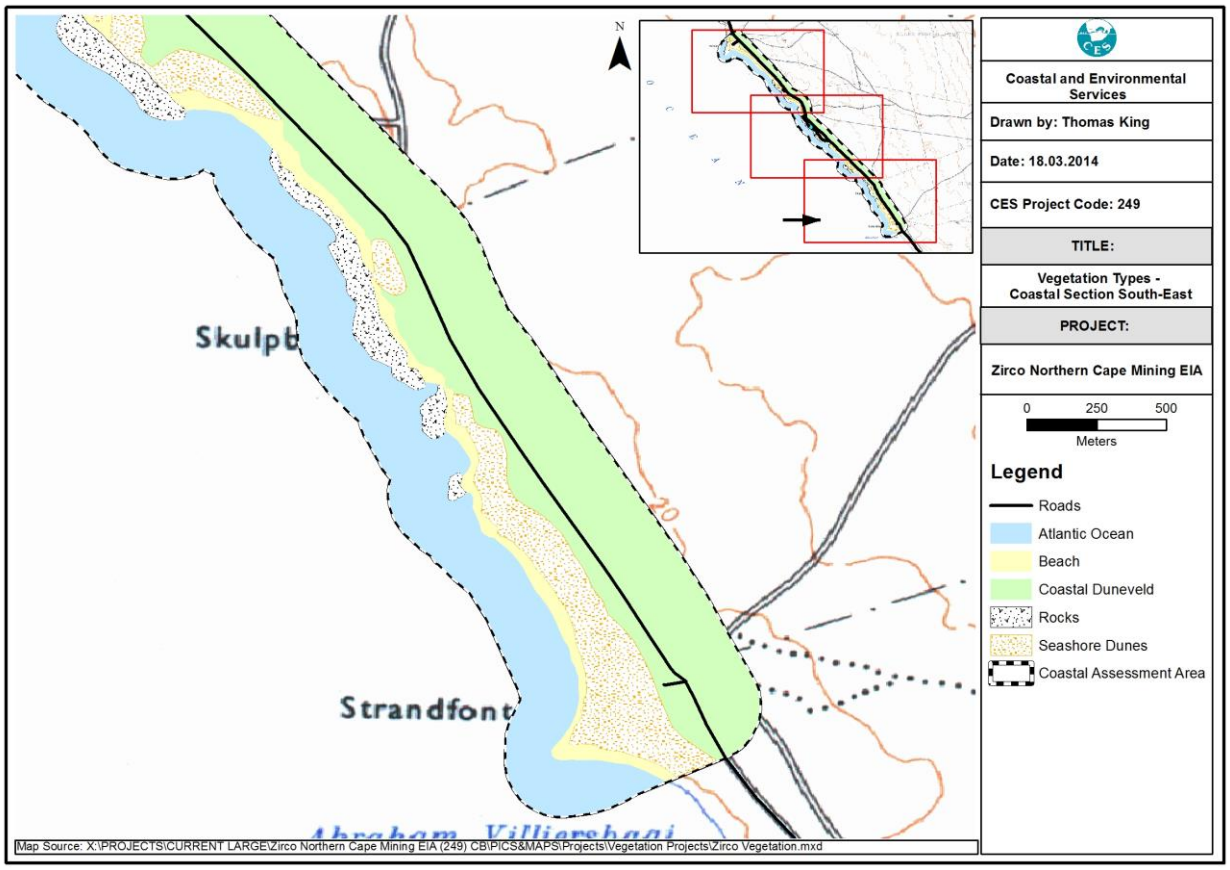


Figure 4.7: Vegetation Map of the coastal assessment area – south eastern section.

4.3 ALIEN PLANT SPECIES

Alien invasive plant species are not a major feature of this area, but there are a limited number of invasive species present, most of which occur only in disturbed environments, notably in old lands, around kraals, and along roads. All the invasives currently in the area are likely to become more prominent in an area disturbed by mining, particularly if these areas are grazed after rehabilitation.

Galenia africana (kraalbos) is indigenous, but is also considered as invasive in disturbed and overgrazed areas, as it is unpalatable, and benefits from the lack of competition from more palatable species. The only way to eradicate it is to rest an area from grazing for long periods (>12 years). *Atriplex lindleyi* ssp. *inflata* (klappiesbrak, blasiebrak) is the most common alien invasive in the area, and is likely to be a prominent feature of any areas disturbed by mining. This is a low, grey perennial shrub with wind and water dispersed seeds, and is best removed by mechanical means. *Salsola kali* (Russian tumbleweed; tolbos) is a spiny shrub that also invades disturbed areas, particularly those with higher nutrient loads, such as around kraals, and is common in places. It also has wind dispersed seeds, and can become a problem. The species was noted in the pilot mine rehabilitation areas. *Brassica tournefortii* (wild mustard) is a winter growing annual that can be surprisingly common in sandy soils, even in relatively undisturbed Strandveld. *Erodium moschatum* (cranesbill) is very common annual herb in some areas, but seldom becomes a problem. *Nicotiana glauca* (wildetabak) is most common along watercourses, but is not a problem in the study area. Two species of invasive tree were recorded. *Prosopis glandulosa* (mesquite) also prefers water courses, but will also invade silty soils. It has been planted for shade, firewood and fodder, but can be very difficult to remove once it starts spreading. *Acacia cyclops* (rooikrans) is present in low numbers in the Sand Fynbos areas, mainly in the vicinity of water troughs, and conditions are too arid for it to become a major problem. Various species of alien, annual grasses are likely to be present, including *Vulpia myuros* (ratstail fescue), *Bromus* spp. (brome), *Lolium* spp. (ryegrass), and *Avena* spp. (wild oats), but they are not likely to be a major problem, due mainly to the arid conditions.

4.4 FLORISTICS AND SPECIES OF CONSERVATION CONCERN IN THE REGION

Due to the large number of Species of Conservation Concern (SCC) found within the prospecting area, an additional survey was undertaken. This focused on the plant SCC that had been identified within the propecting area and whose populations outside of this footprint area were poorly or not known. The survey was undertaken in August 2014, when most Namakwaland plants are flowering. Two botanist with a good knowledge of the West Coast flora spent over a week in the field specifically to find out if these species occurred elsewhere, and in relatively close proximity to the study area, and if so, where and in what numbers. The secondary aim was to assess possible biodiversity offset areas in terms of the presence of suitable habitat and presence of the focus SCC.

The primary focus was on the following species:

- *Lachenalia* sp. nov. (to be described as *L. arenicola* G. Duncan & N. A. Helme)
- *Elegia* sp. nov.
- *Agathosma elata*
- *Lampranthus procumbens* and
- *Leucoptera nodosa*.

***Lachenalia* sp. nov.**

This species (to be *Lachenalia arenicola* - currently in press) was found to be present as far north as the dunes north of Riethuis, some 63km north of the project area. It typically occurs as widely scattered plants, in relatively low numbers. Estimated population density in suitable habitat is about 15 plants/ha. The species is thus now known to occur from Riethuis to near Koekenaap, a distance of some 150km, and the total population, although very difficult to estimate, may be between 35 000 and 100 000 plants, of which as many as 30% may occur within the current boundaries of the Namaqua National Park. The species was found to be widely but sparsely distributed within Focus Areas 10 and 13 (outside the Park, but no data points were taken for this

species, and hence it is not mapped in those areas – Figure 4.8)

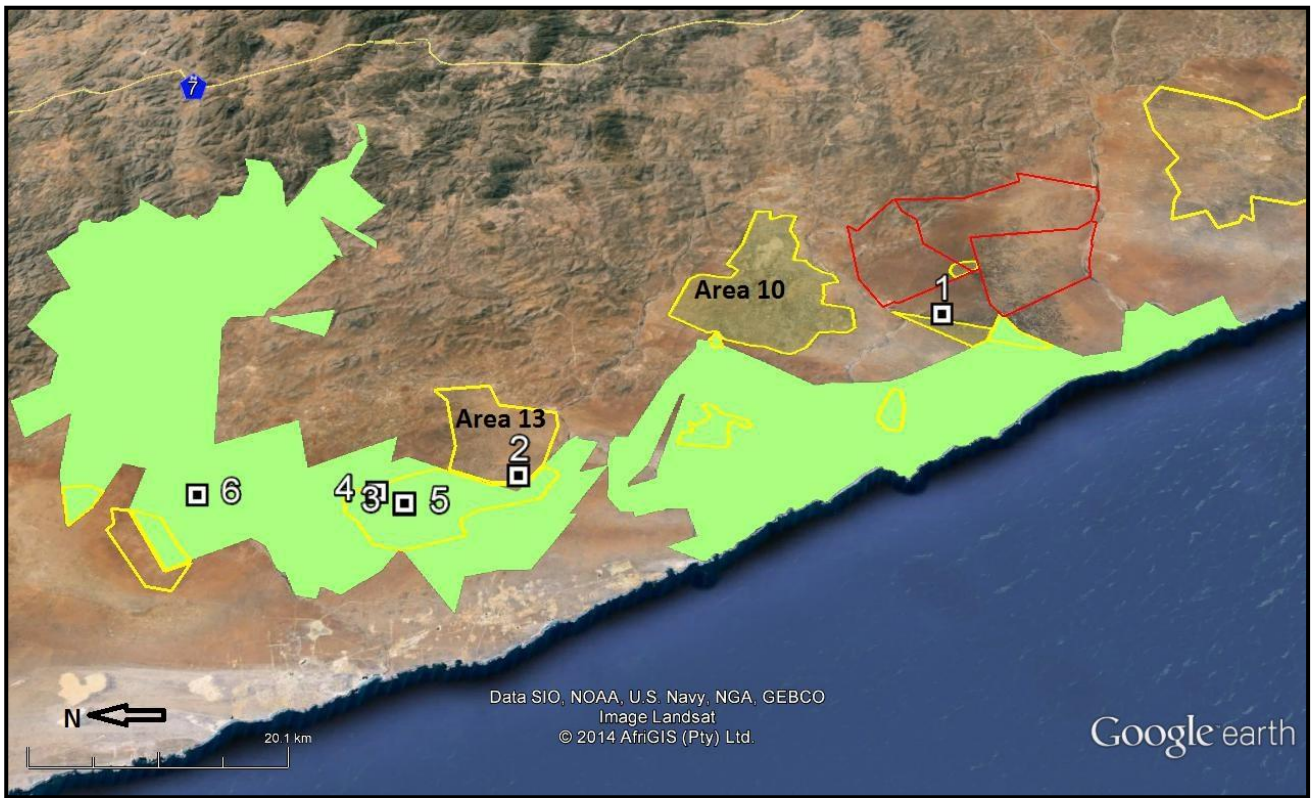


Figure 4.8: The recorded distribution of *Lachenalia* sp nov (numbered squares) in the Namaqua National Park (green shaded area). The Zirco project area is shown as red outlines.

Elegia sp nov.

This species has the most restricted distribution of the focus species, as can be seen in Figure 4.9. In addition to this area it also occurs further south, west of Kotzesrus, where it is also very localised. Its total known range in the study area is 21km, in which it occupies less than 250ha. If one includes the Kotzesrus population this expands to a 70km range, and an occupied area of less than 320ha. Total population in the current study area is estimated to be about 3000 plants, of which no more than 25% are within the Namaqua National Park. With the inclusion of the Kotzesrus population the total population may be about 4000 plants. The Roode Heuvel project area population occurs in an area of just over 200ha, which is about two thirds of the total known area for this species, and the property is thus very important in the context of this species.

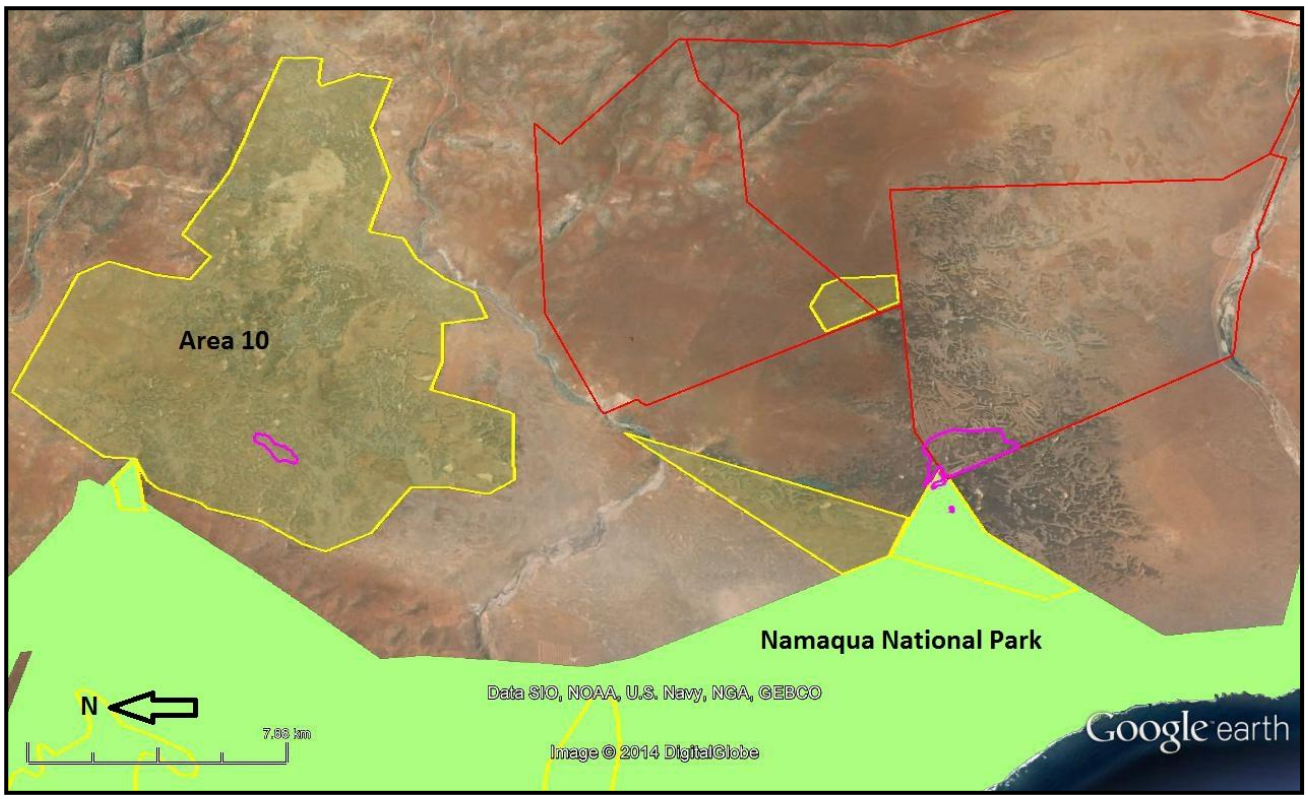


Figure 4.9: The recorded distribution of *Elegia* sp nov (purple polygons) in the total study area. The species is common in the very restricted area where it occurs. The Zirco project area is shown as red outlines.

Agathosma elata

This species, although a perennial shrub, is very cryptic when not in flower. Even allowing for this it appears to be sparsely distributed, and is never very common, although it was found as far north as the Hondeklipbaai area. Given that it occurs as far south as the Vanrhynsdorp area, it has a total range of nearly 200km, and a possible area of occupation of up to 10 000ha. The species was not found in Focus Area 13, but was found in a large part of Area 10 (<100 plants) (Figure 4.10). The species was found at two locations within the Namaqua National Park (totalling about 50 plants), but there are almost certainly more, undetected populations in the Park. The Roode Heuvel project area is estimated to support about 10% (50 plants) of the total estimated population (500 plants) of this rather rare, yet widespread species.

Lampranthus procumbens

This creeping succulent may be locally fairly common, and tends to occur in the transition between Sand Fynbos and Strandveld. It has previously been recorded as far north as the Kommagas dunes, and as far south as Kotzesrus – a total range of about 120km. The population found within the Namaqua National Park was relatively small (estimated to be 10% of the total population of an estimated 3000 plants), whereas the population on the Roode Heuvel project area may constitute as much as 20% of the total population (up to 600 plants). The main populations were actually found in Areas 10 and 13, together estimated to make up about 40% of the total population (Figure 4.11).

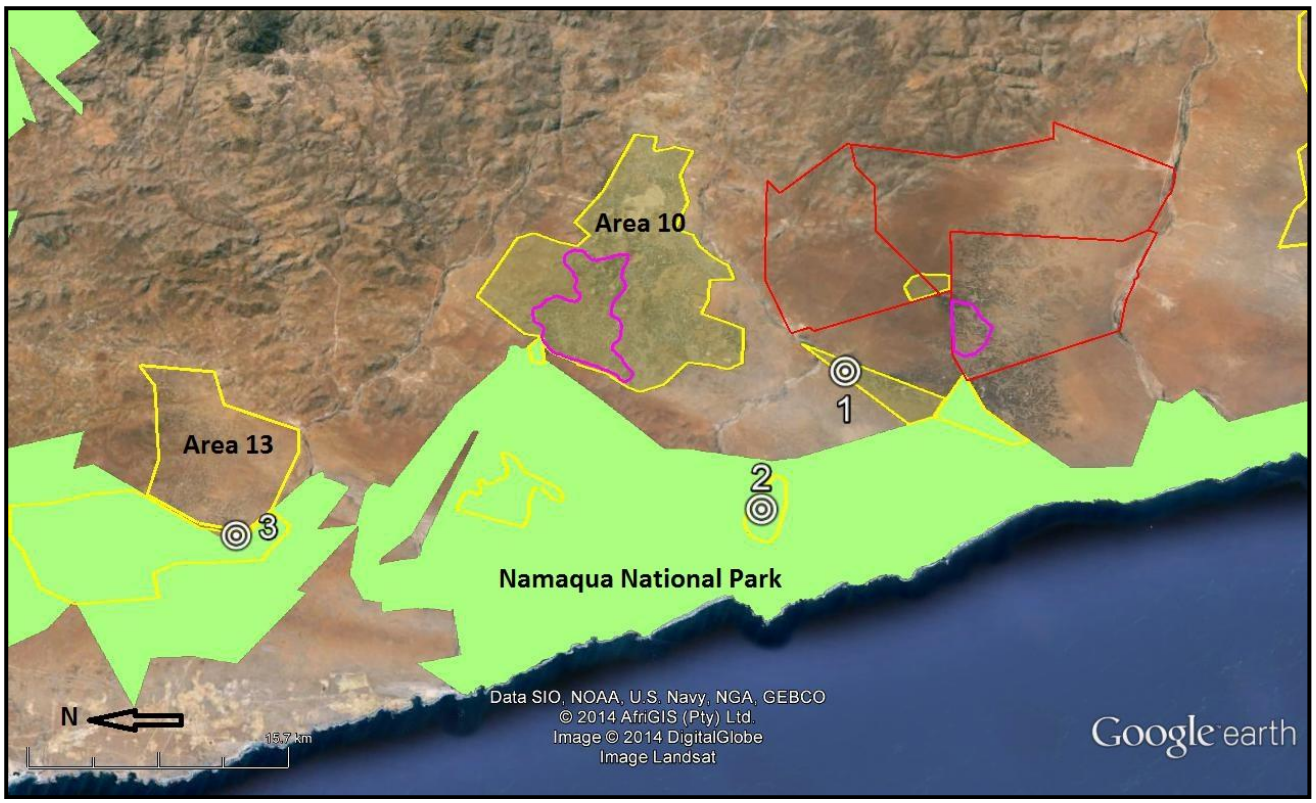


Figure 4.10: The recorded distribution of *Agathosma elata* (purple polygons and numbered circles) in the total study area. The Zirco project area is shown as red outlines.

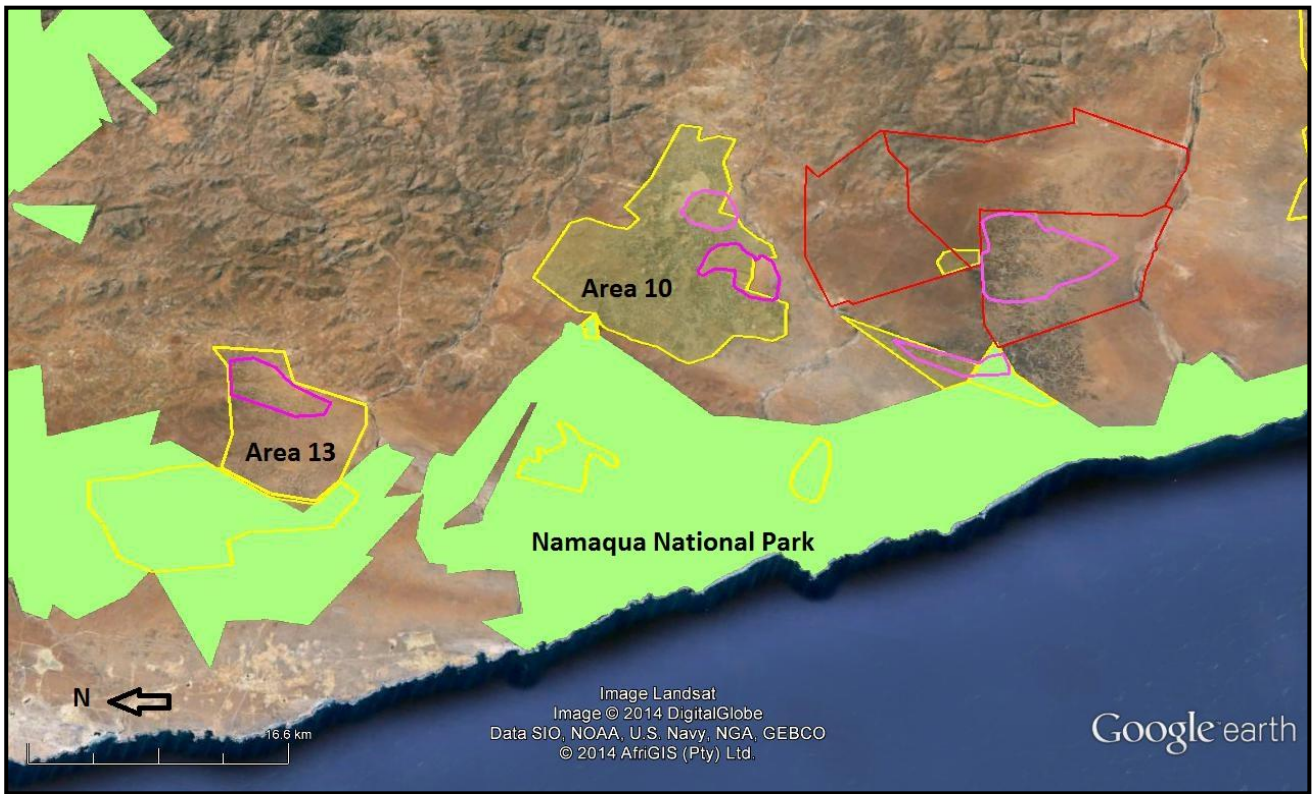


Figure 4.11: The recorded distribution of *Lampranthus procumbens* (purple polygons) in the total study and project area. The Zirco project area is shown as red outlines.

Leucoptera nodosa

This species was found to be fairly common in the Strandveld portions of the Namaqua National Park east of Skuinsbaai (estimated 400 plants), and Simon Todd recorded it as common in Areas 10 and 13 (no estimate of population numbers). The population within the Roode Heuvel project area (<30 plants) is likely to constitute <1% of the total known population, although the population on Leeuvlei (about 400 plants) is still very significant.

Both areas 10 and 13 were found to support significant populations of SCC (including others not discussed in this report), and contain good examples of the key botanical habitats, and are thus identified as potentially suitable biodiversity offset areas, along with the portion of land (De Klipheuvel) shown in Figure 4.10 which includes data point 1.

5. CONSERVATION AND PLANNING TOOLS

Several conservation planning tools are available for the area. These tools allow for the determination of any sensitive and important areas from a vegetation point of view. They allow for the fine-tuning of plans with a view to reducing potential environmental impacts at the planning stage of the development.

5.1 PROTECTED AREAS

Protected areas are areas that are already conserved. Areas in close proximity to the proposed development may be affected by the development and thus must be taken into account. The northwestern corner of Roode Heuvel borders on the Namaqua National Park (refer to Figures 3.1 and 6.1), and in this regard it is important to note that areas within 10km of any National Park are regarded as "high biodiversity priority areas and have high risk for mining" according to the Biodiversity and Mining document recently published by DEA et al (2013). 90% of the Roode Heuvel property is within 10km of the Namaqua National Park boundary, and thus virtually this entire area can be regarded as a high biodiversity sensitivity area and high risk for mining. These buffer areas are defined in terms of Listing Notice 3 of the NEMA EIA Regulations (GN No. R546 of 2010).

5.2 PROTECTED AREAS EXPANSION STRATEGY

The objective of the Protected Areas Expansion Strategy (PAES) is to form an overarching strategic framework for a protected area network that 'conserves a comprehensive, representative and adequate sample of biodiversity and maintains key ecological processes across the landscape and seascape.' The areas earmarked by this study should be protected. The PAES does not appear to be relevant to this project as nearest areas earmarked for expansion are more than 5 km from the proposed mining area. This area is referred to as the "Namaqua" area, but it should be noted that the Namaqua National Park is still in its establishment and growth phase and may explore expansion into any adjacent areas of proven biodiversity value.

5.3 NAMAQUA NATIONAL PARK MANAGEMENT PLAN (NNPMP)

The Namaqua National Park was originally established to protect the diverse succulent and other flora of the region. The desired state was then developed in order to guide park management in facilitating protection and effective management of the Park. In order to achieve the vision of the Management plan a hierarchy of objectives has been established. These objectives aim to "manage the Namaqua National Park with stakeholder collaboration that enables the conservation and promotion of Namaqua's internationally significant biodiversity and cultural heritage while supporting sustainable livelihood options in the region" (NNPMP, 2012). The entire study area falls within the Priority Natural Area Buffer Zone (Figure 5.1), while the western part of Roode Heuvel as well as Leeuvlei is within the proposed expansion area of the Park (Figure 5.1). The Priority Natural Area zones are key areas required for the long term persistence of biodiversity in and around the park, in terms of pattern as well processes. This zone also includes the expansion footprint included for future park expansion (NNPMP, 2012). These areas are earmarked for developments that contribute to ensuring conservation friendly land-use, and activities should be restricted to already transformed areas and inappropriate development and negative land-use changes should be avoided.

Given the internationally recognized and unique biodiversity, land/seascape and potential social-economic importance, the expansion of the Namaqua National Park is a priority for SANParks. This expansion is also "in line with the National Biodiversity Strategy and Action Plan (NBSAP) objectives (DEAT 2005), namely: Strategic Objecive 5 (SO 5) - expanding the national protected area system towards 12% of the terrestrial area; and SO 3 - coordinated approach to the management of terrestrial & aquatic ecosystems" (NNPMP, 2012). These expansion areas were identified based on a number of studies, the most latest being the National Protected Areas Expansion Strategy (NPAES) (DEAT 2008).

The main objectives of the expansion strategy includes the improvement of conservation of ecological patterns and processes, biodiversity and the marine protected areas; the provision for wilderness areas, the avoidance of immediate and irreparable threats to biodiversity from the mining industry and the establishment of an economically sustainable park.

5.4 NAMAQUA DISTRICT BIODIVERSITY SECTOR PLAN

The purpose of the Namaqua District Biodiversity Sector Plan is to guide land-use planning, environmental assessments and authorisations and natural resource management to ensure that development in this region occurs in a sustainable manner, particularly within the identified Critical Biodiversity Areas (CBA) (Namaqua Bioregional Plan, 2008). CBAs are areas that have been identified as irreplaceable as well as key to the maintenance of ecosystem services.

The southern, north eastern and coastal sections overlap with the terrestrial corridor CBAs of the Namaqua District Biodiversity Sector Plan. In addition, slope CBAs occur in the north eastern section of the project area, amongst the foothills (Figure 5.2). Aquatic CBAs also occur within the project area.

5.5 SUCCULENT KAROO ECOSYSTEM PLAN (SKEP)

The Succulent Karoo biome extends from the south west through to the north west of South Africa and up into Namibia (Driver *et al.;* 2003). It is classified as one of the 25 internationally recognised biodiversity hotspots and is the world's only arid hotspot. It is remarkably diverse with 6 356 plant species, 40% of which are endemic and 17% of which are listed as Rare or Threatened in the Red List of South African Plants (Raimondo *et al*. 2009). Despite this rich diversity and high level of endemism, only 3.5% of the biome is formally conserved. As a result the biome's diversity is under pressure from human impacts, especially mining, agriculture, overgrazing and climate change.

The goal of SKEP is therefore to provide a framework to guide conservation efforts of this unique biome (Driver *et al.* 2003).

Five of the 15 vegetation types described by SKEP are found to occur in the project area (Figure 5.3):

- Sandveld
- Strandveld
- Lowland Succulent Karoo
- Mountain Succulent Karoo
- Fynbos

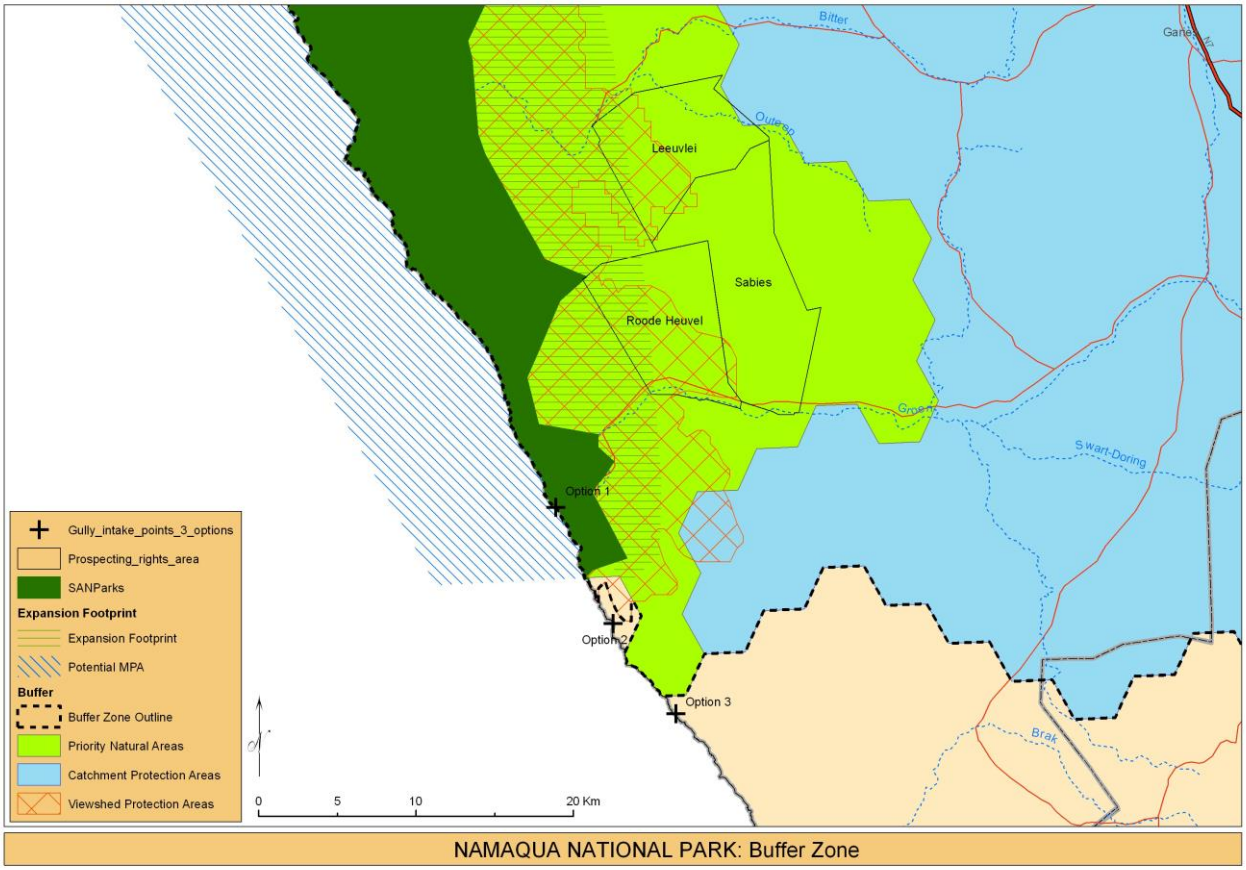


Figure 5.1: Namaqua National Park, Buffer zone

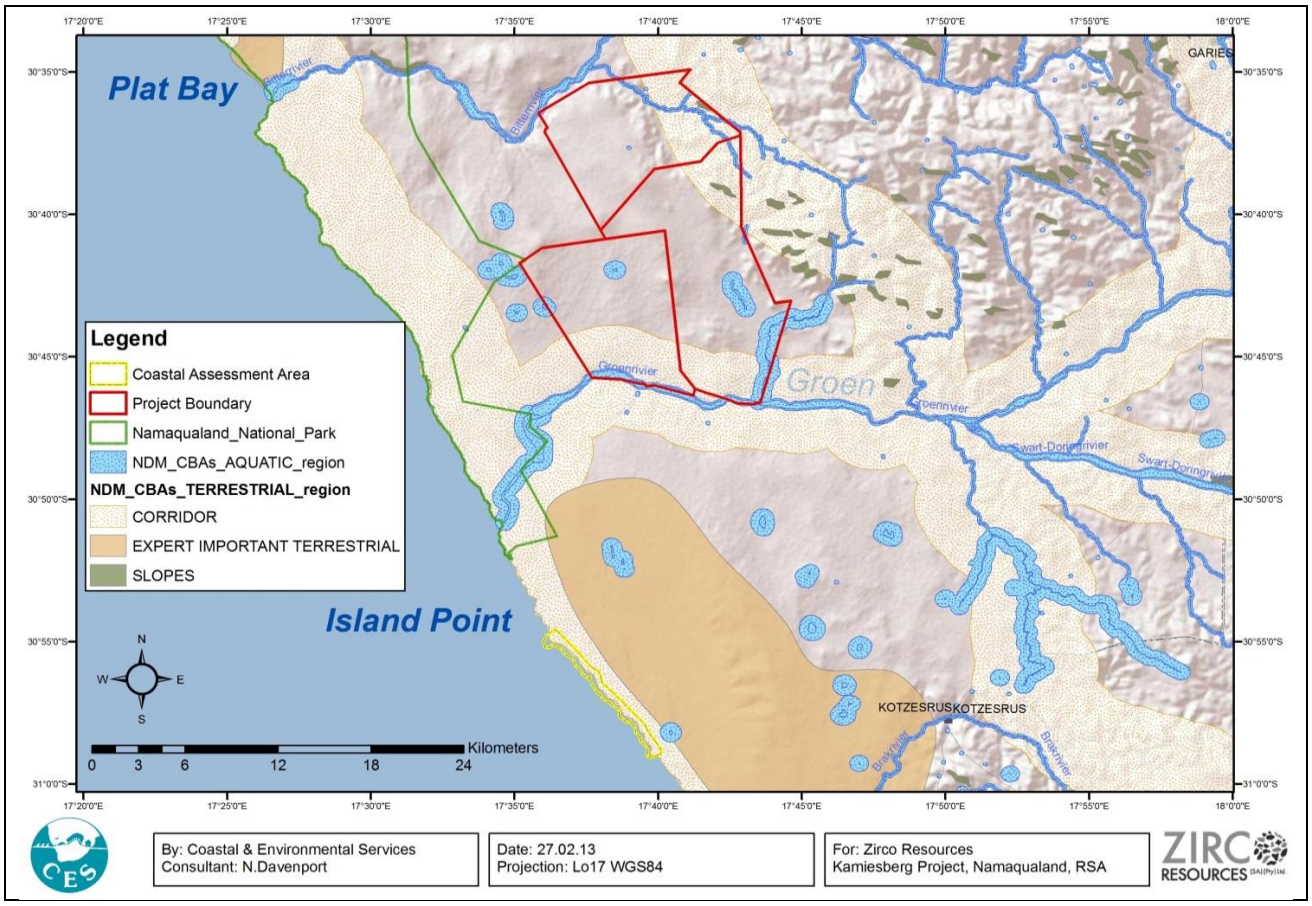


Figure 5.2: Namaqua District Municipality CBAs found within the project area

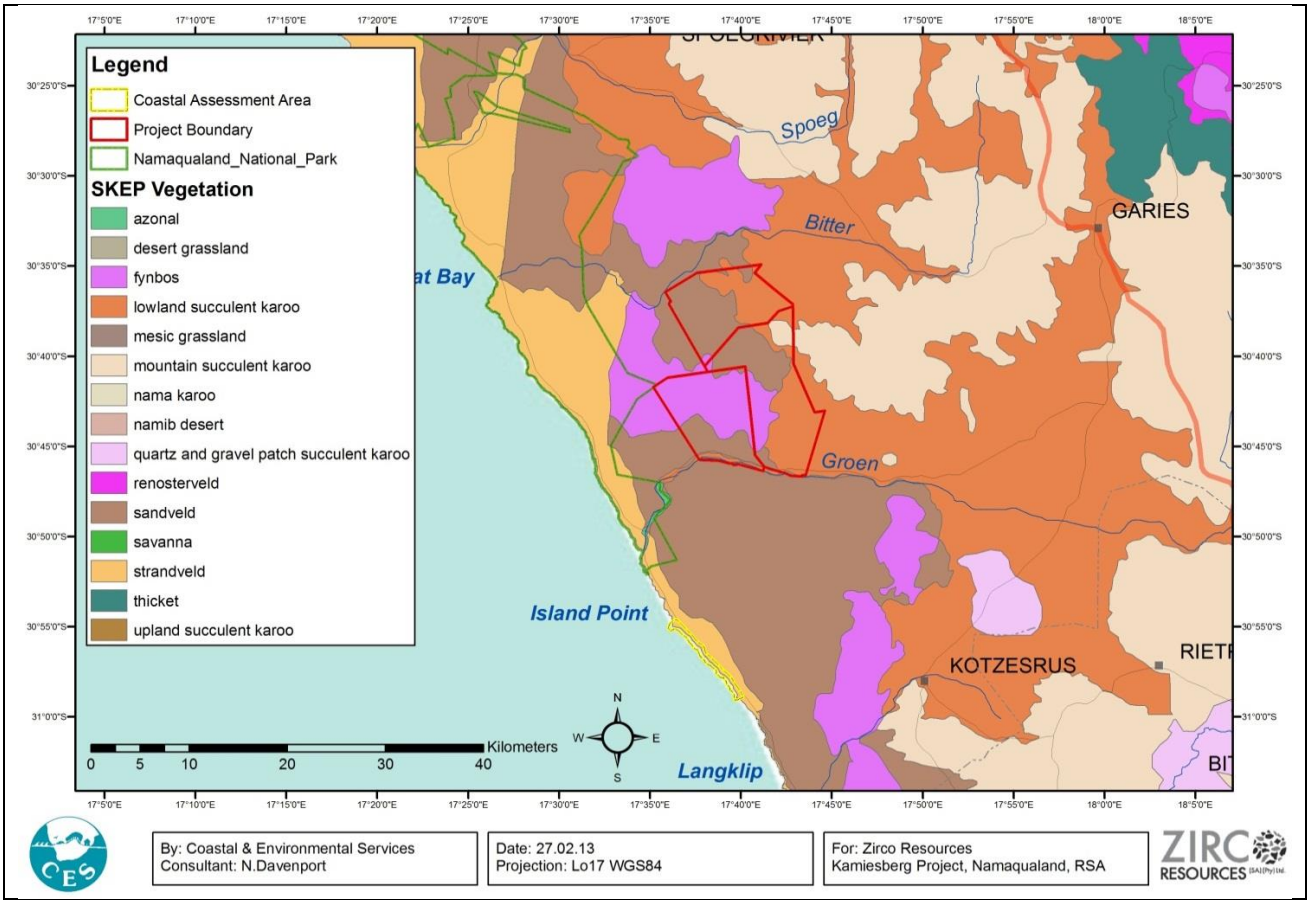


Figure 5.3: SKEP vegetation types found within the greater project area.

5.5.1 SKEP Priority Areas

SKEP has identified nine broad geographic priority areas for conservation in the Succulent Karoo biome. These areas were selected based on collections of high irreplaceability planning units, medium to high land-use pressures and the incorporation of spatial components of key ecological processes.

The majority of the project site falls within the Central Namaqualand Coast Priority Area (Figure 5.4 and 5.5). Furthermore, sand movement and river corridors overlap with the project area, particularly on Roode Heuvel.

5.5.2 Leslie Hill Succulent Karoo Trust Priority Areas

No part of the study area falls within any of the identified priorities for the Leslie Hill Succulent Karoo Trust, a private funding body set up to finance purchase of succulent plant conservation priority areas.

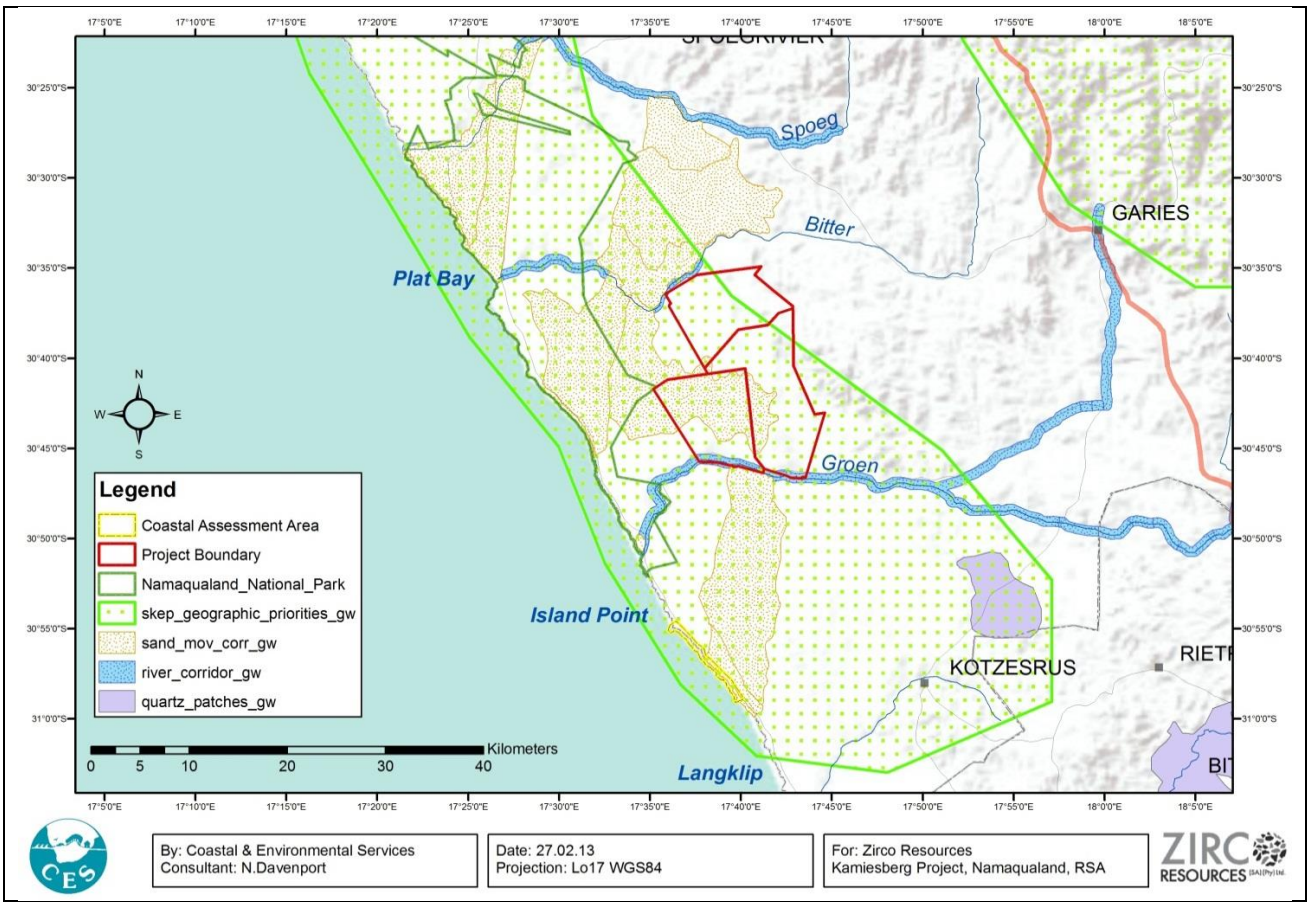


Figure 5.4: SKEP Geographic priority areas relevant to the project.

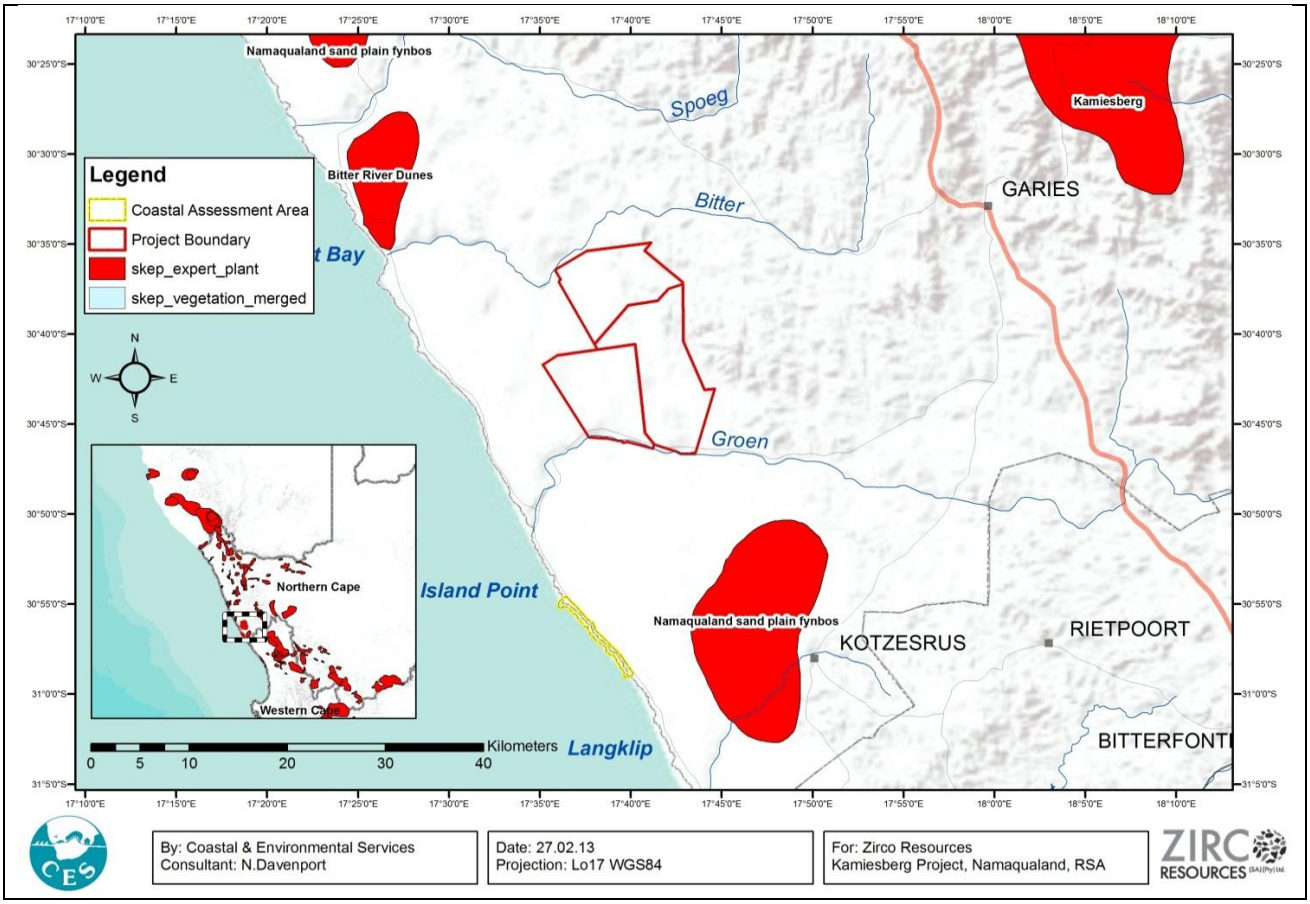


Figure 5.5: Botanical priority areas identified by SKEP

6. SENSITIVITY

6.1 REGIONAL DISTRIBUTION OF SCC AND ECOLOGICAL SENSITIVITY OF THE SITE

Five areas or features of particular conservation concern have been identified in the prospecting area (sensitivity of the coastal areas are discussed separately in Section 6.3 below). Every attempt should be made to avoid these areas during mining operations. These features are:

1. Wetlands and rivers
2. Steep slopes, rocky areas and areas with shallow soils, including the Soutfontein calcrete outcrops
3. The northern Sand Fynbos area
4. Outeep quartz patches
5. The main population of *Leucoptera nodosa*

It will be possible to avoid all of these areas, except for portions of the Northern Sand Fynbos.

Wetlands and rivers constitute features of conservation concern as they are process areas, and important in an arid area like this. They are essential for ecosystem functioning and process, and provide niche habitats for a variety of plants and animals. The areas have a VERY HIGH sensitivity.

The Groen River and Bitter River occur on either side of the project areas. These rivers are ephemeral in nature and support riparian vegetation which is important for several bird species. These river areas are identified as critical biodiversity areas and must be conserved and maintained as far as possible. As these water courses are not particularly close to the proposed footprint of the mine, they are not likely to be directly affected by it, and their functioning should remain relatively intact, provided that there is no abstraction from these catchments.

Some small drainage lines are present in the eastern section of Leeuvlei. These wetland areas also constitute process areas even though they are seasonal, often dry, and do not have specific wetland vegetation. These areas need to be avoided at all costs, and will require adequate buffers. It is important to note that these small drainage lines have been included in the proposed corridor as defined in Section 6.2 below and will not be impacted on (refer to Figure 6.1).

Steep slopes, rocky areas and areas with shallow soils also constitute important features of conservation concern as they are difficult to rehabilitate and are easily affected by changes in land use, with erosion being an important impact factor. In addition these areas support unique assemblages of dwarf succulents and bulbs, and are important reptile habitats. These areas exist throughout the eastern section of Leeuvlei in the Klipkoppe shrubland vegetation. It is recommended that these areas are excluded from the mining footprint in order to maintain niche habitats and plant biodiversity, which is likely to be tied to high insect and bird diversity, at least in the rainy season. The extensive calcrete outcrops south of Soutfontein are similarly important reptile habitats, and also support the rare *Dicrocaulon ramulosum* vygie (Plate 6.1). This is the only part of the study area in which this species occurs. Due to the sensitivity of this area the majority of the areas identified as Klipkop Shrubland (91 %) has been incorporated into an ecological corridor (Figure 6.1) and thus will not be impacted on by mining activities or the construction of associated infrastructure. Only a small portion of this vegetation type (9 %) will be impacted on by mining activities in the southern section of Leeuvlei.

Plate 6.1: Dicrocaulon ramulosum is a rare vygie only known from the Hondeklipbaai to Groen River area, and shown here on the Soutfontein calcretes (shallow soil habitat) just south of the Bitter River, the only place in the study area where it was found.

Significant concentrations of populations of plant SCC (>10 such species) are also considered to be indicative of areas of Very High sensitivity, and this is the primary reason for the identification of the **northern Sand Fynbos** as an area of Very High sensitivity. Sixty five percent (65% or 15 SCC) of the 23 SCC in the study area are found within the Namaqualand Sand Fynbos, which is also one of the primary target habitats for mining operations. All 15 SCC known from the Sand Fynbos are found within the northern Sand Fynbos, including all the most localised species, and the two undescribed species (*Elegia* and *Lachenalia*). All 15 SCC known from the Sand Fynbos in the study area are found within the proposed mining area, but none are restricted to this area, and all are present either in the northwestern or northeastern corners of Roode Heuwel - that are not part of the proposed mining area – and these areas should thus serve as critical offset conservation areas should mining proceed. Each of these “conservation corners” is about 900ha in extent, and the northwestern one is adjacent to the Namaqua National Park. It is important to note that of the 15 SCC that occur within this area, 10 species have a distribution of 5% or less of the known population within the prospecting area and thus it is suggested that the sensitivity of this area be reduced from VERY HIGH to HIGH. In addition to this, 54.5% of the northern Sand Fynbos has been incorporated into the proposed ecological corridor and thus will not be impacted upon.

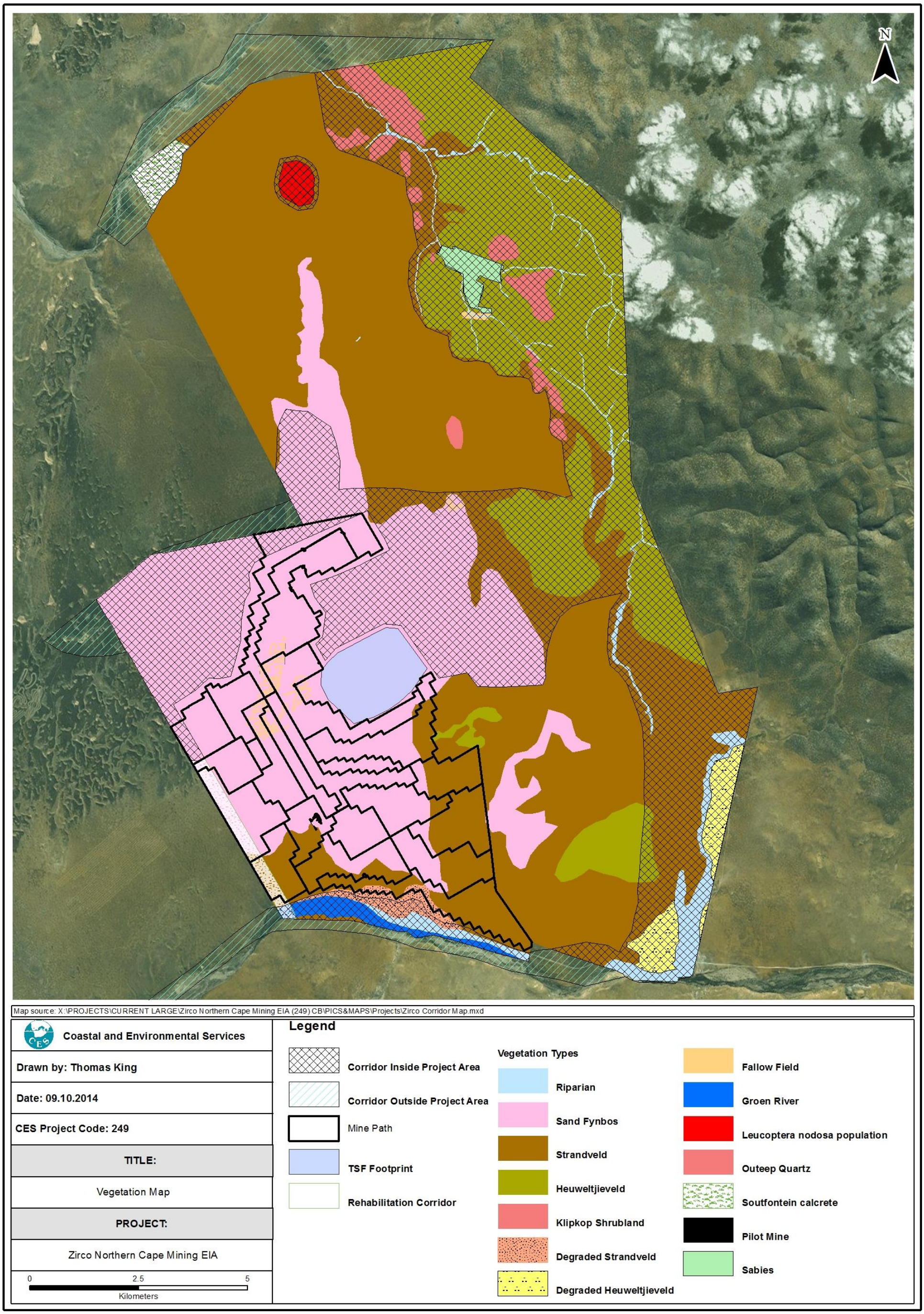


Figure 6.1: Vegetation map and ecological corridors

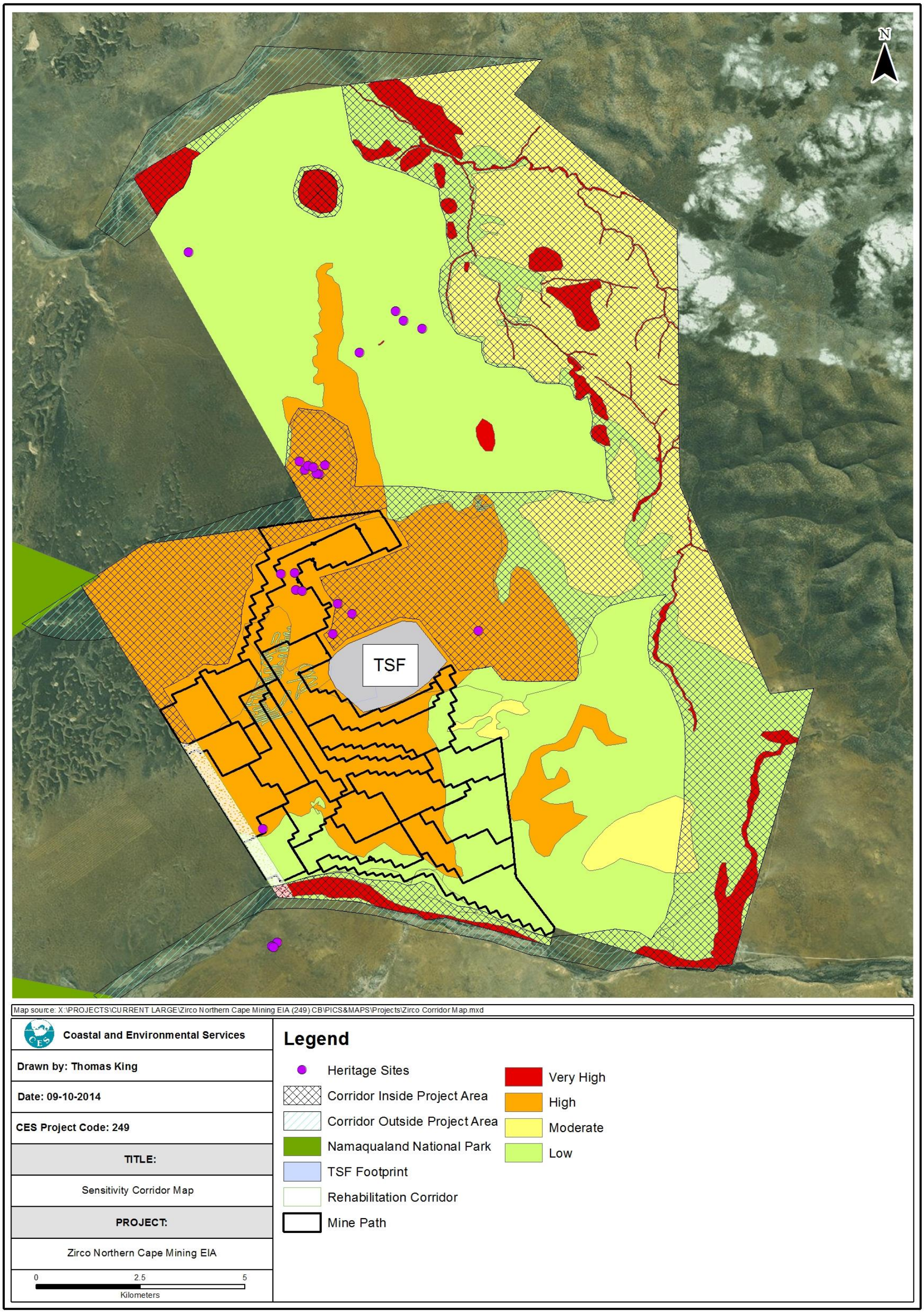


Figure 6.2: Sensitivity map and ecological corridors

Table 6.1 below shows the SSC that occur within this vegetation type and their percentage distribution within both the propecting area and the mine footprint.

Table 6.1 - List of plant species of conservation concern recorderd in the sand fynbos vegetation type, and the regional importance of the population in the study area.

	Red List Status	% of known population in proposed mining area	% of known population in project area (excl mine area)	Significance of mining area population	Significance of prospecting area population
1. Agathosma elata	**EN**	**10**	**2**	**MEDIUM**	**LOW**
2. Argyrolobium velutinum	EN	5	10	**LOW - MEDIUM**	**LOW - MEDIUM**
3. Aspalathus albens	VU	2	5	**LOW**	**LOW**
4. Caesia sabulosa	VU	2	2	**LOW**	**LOW**
5. Calobota lotononoides	NT	5	2	**LOW**	**LOW**
6. Elegia sp nov	**STBA**	**5**	**30**	**MEDIUM**	**HIGH**
7. Eriospermum arenosum	VU	3	2	**LOW - MEDIUM**	**LOW**
8. Hermannia sp nov	STBA	3	3	**LOW**	**LOW**
9. Lachenalia sp nov (arenicola)	**STBA**	**5**	**1**	**MEDIUM**	**LOW**
10. Lampranthus procumbens	**VU**	**20**	**10**	**HIGH**	**MEDIUM**
11. Leucoptera nodosa	**VU**	**1**	**20**	**LOW**	**HIGH**
12. Leucospermum rodolentum	VU	2	5	**LOW**	**MEDIUM**
13. Metalasia adunca	NT	2	2	**LOW**	**LOW**
14. Muraltia obovata	VU	5	5	**LOW - MEDIUM**	**LOW - MEDIUM**
15. Wahlenbergia asparagoides	VU	2	3	**LOW**	**LOW**

As can be seem from the table above, and based on additional surveys undertaken outside of the prospecting area, only 2 of the SCC (*Agathosma elata* and *Leucoptera nodosa)* have more than 10% of the known population located within the mining area. In addition to these two species, three other species, *Argyrolobium velutinum, Elegia sp nov* and *Lampranthus procumbens* have more than 10% of the known population located within the prospecting area. The following should however be noted from Figure 6.3 below:

- *Agathosma elata* - 10% of known population within the mining area. Figure 6.3 shows that the majority of this species (75%) have been incorporated into the proposed ecological corridors
- *Elegia* sp. Nov - 30% of known population occurs within the prospecting area. Figure 6.3 shows that the entire population has been included in the proposed ecological corridor.
- *Lampranthus procumbens* - 20% of known population occurs within the mining area and 10% within the prospecting area. Figure 6.3 shows that more than a third (35%) of this population has been included in the proposed corridor. This figure also shows that this species is widely spread outside of the prospecting area.
- *Leucoptera nodosa* - 20% of known population occurs within the prospecting area. Figure 6.1 shows that the main population of *Leucoptera nodosa*, and a buffer of 100m, have been incorporated into the proposed ecological corridors.
- *Argyrolobium velutinum* - 20% of known population occurs within the prospecting area. This species was found in all major areas surveyed in and outside the prospecting area, but typically widely scattered in Sand Fynbos.

Based on the above, it can be concluded that the majority of the populations of the SCC that are present within the prospecting area have been incorporated into an ecological corridor that will be protected from any development.

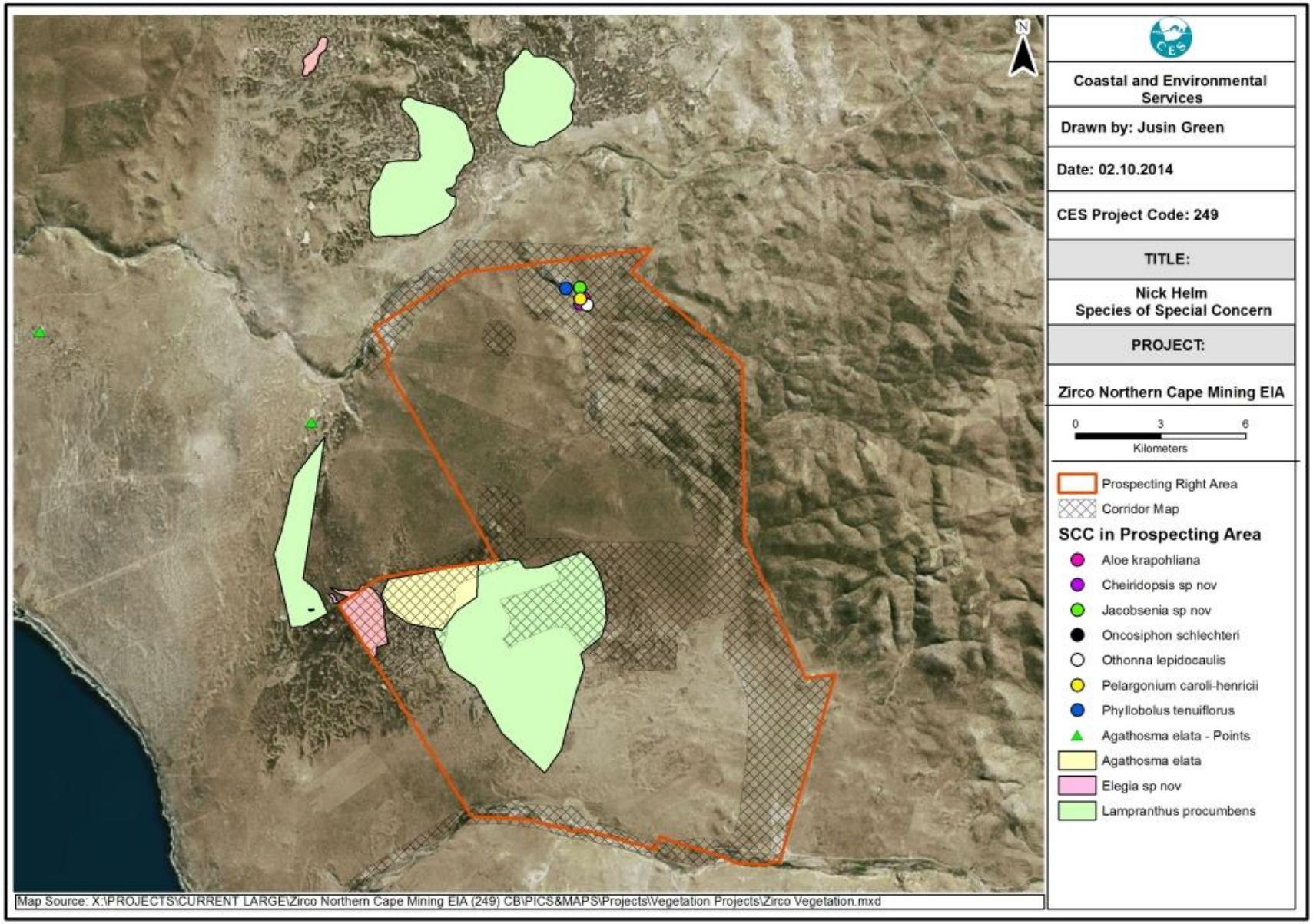


Figure 6.3: Distribution of SCC within the propecting area

Quartz patches usually harbour many interesting and unusual species (as they are stable and cooler), but the ones near the Outeep river (on Leeuvlei) proved to be exceptionally interesting. Two completely new vygie species were discovered here (see Plates 4.5 and 4.6), and these will be described by Dr C. Klak of the Bolus Herbarium. To date these species are only known from this single 5ha area (nearby quartz patches were checked), and may in fact occur nowhere else. In addition to these major finds there were three other SCC in this habitat, and there may also be others that were not found. This area thus clearly has a Very High conservation value and sensitivity and has accordingly been included into an ecological corridor (Figure 6.3).

To summarize, of the 23 SCC identified within the prospecting area, 6 occur within the area classified as hardeveld. These species are *Phyllobolus tenuiflorus, Pelargonium caroli-henrici, Othonna lepidocaulis, Jacobsenia sp nov, Cheiridopsis sp nov* and *Aloe krapohliana.* Two of these species, *Jacobsenia sp nov* and *Cheiridopsis sp nov,* are undescribed and 100% of the known population occurs within the prospecting area. The sensitivity of these species are thus rated as VERY HIGH (refer to Table 6.2). As shown in Figure 6.3 above these species are limited to the area identified as Outeep Quartz which have been incorporated (in its entirety) into the proposed ecological corridor and thus will not be impacted on by the proposed development.

Table 6.2: List of plant species of conservation concern recorderd in the Outeep Quartz vegetation type, and the regional importance of the population in the study area.

	Red List Status	% of known population in proposed mining area	% of known population in project area (excl mine area)	Significance of mining area population	Significance of prospecting area population
1. Aloe krapohliana	DDD	0	2	**LOW**	**LOW**
2. Cheiridopsis sp nov	**STBA**	**0**	**100**	**LOW**	**VERY HIGH**
3. Jacobsenia sp nov	**STBA**	**0**	**100**	**LOW**	**VERY HIGH**
4. Othonna lepidocaulis	**Rare**	**0**	**25**	**LOW**	**VERY HIGH**
5. Pelargonium caroli-henrici	Rare	0	10	**LOW**	**MEDIUM**
6. Phyllobolus tenuiflorus	VU	0	10	**LOW**	**MEDIUM**

The **main population of *Leucoptera nodosa***, and a buffer of 100m, has been given a Very High sensitivity as this area supports more than 50% of the total known population (>100 plants) of this Vulnerable and rare species. This population, including the buffer area have been incorporated into the proposed ecological corridor as depicted in Figure 6.1.

6.2 ECOLOGICAL CORRIDORS

Ecological corridors where formulated based on the ecological sensitivity and distribution of SCC described in Section 6.1 above.

The corridors proposed incorporate the following sensitive areas (please refer to Figures 6.1-6.2):

- 54% of the northern sand fynbos
- 100% of the Outeep Quartz
- 91% Klipkop Shrubland
- The Bitter River
- The Groen River (with the exception of the area where the pipeline and servitude crosses the Groen River)
- Small drainage lines are present in the eastern section of Leeuvlei
- The Outeep River (tributary of the Bitter River)
- 100% Soutfontein Calcrete
- 100% of the main population of *Leucoptera nodosa*

In addition to the above proposed corridor, a north-south corridor will also be required. This corridor is particularly important in the case of the primary target habitat – Namaqualand Sand Fynbos. This vegetation type has a north – south regional distribution, through the western half of the study area (mainly on Roode Heuwel), and it is part of a largely continuous strip of habitat that runs from northeast of Hondeklipbaai in the north to the Olifants River in the south. However, due to the progressive nature of the rehabilitation process, there will always be a corridor from north to south through the project area. This can be seen from the mine path depicted in Figure 6.3 below. Thus, for the first 5 years of mining, rehabilitation must focus on the years 1-4 area to ensure that at least one 300m wide north – south ecological corridor can be re-instated. This will necessitate leaving a portion of the year 20 mining area in an undisturbed state along the western edge of the project area, to ensure there is a north-south linkage. During the first 5 years of mining this corridor will be presented by years 6 to 19. Thus, based on the mine path provided a permanent corridor along the western edge of the project site is not required as long as there is always a link between the northern and southern borders of the project site. This link would, in any event, be provided by the portion of land to the west of Roode Heuvel, as it is highly unlikely any mining will take place in the next 5 years, since exploration and project development activities in this area have been limited, and 5 years is approximately how long it would take to get a project up and running from scratch.

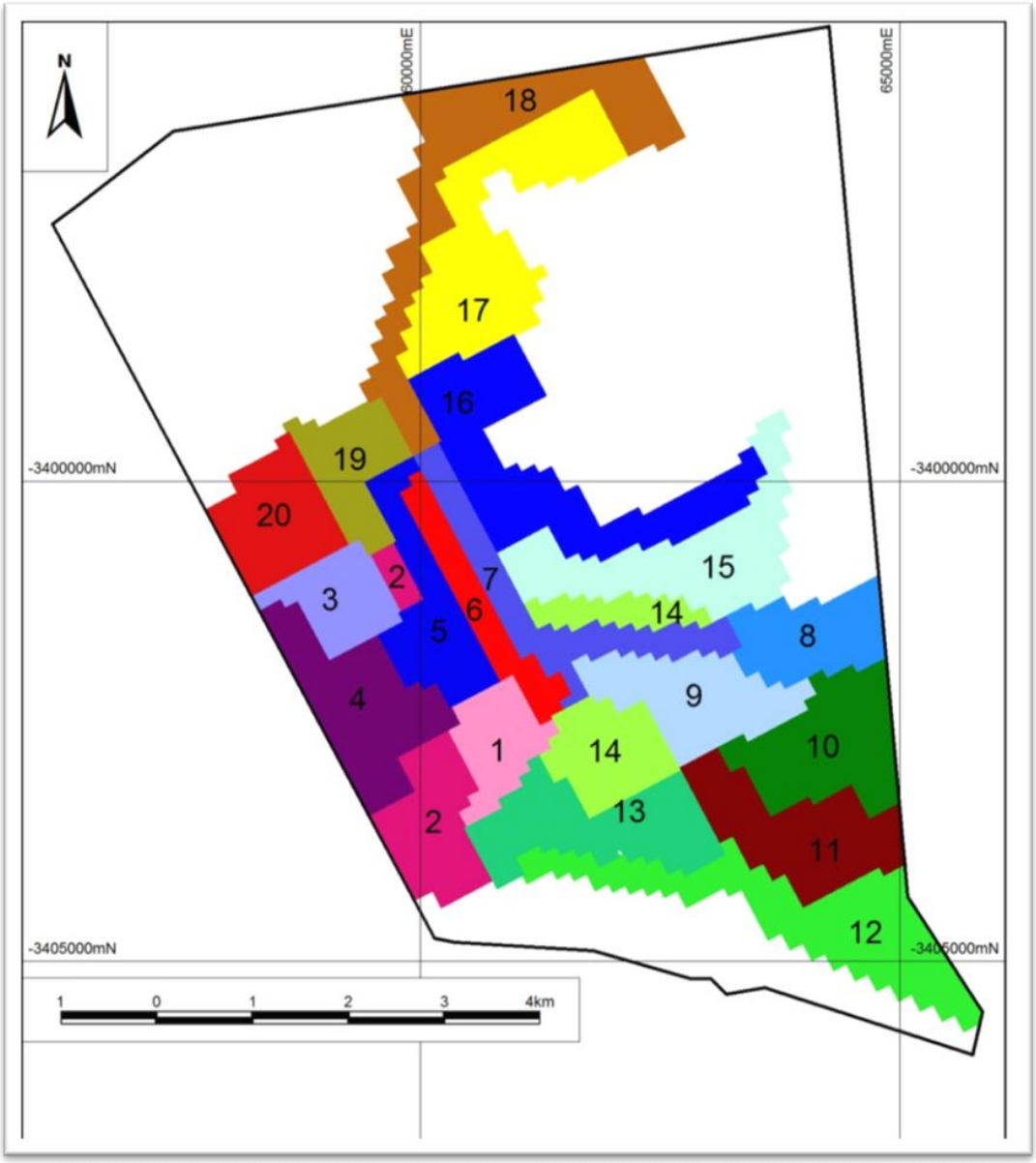


Figure 6.4: The mine path, indicating the years each parcel will be mined.

6.3 ECOLOGICAL SENSITIVITY OF THE COASTLINE

The **shelly coastal platform at Gulley Intake 3** is highly unusual, and seems to be either a very large midden, or a massive natural accumulation of old limpet shells. It is unusually close to the high water mark (HWM) for a midden (<20m), but this may be a function of its age and sea level change. The area thus has not only archaeological or geomorphological value, but also supports the only population of the perennial daisy *Oncosiphon schlechteri* found in the study area. This Endangered species is a poorly known Namaqualand coastal endemic, and its occurrence here means the area is of High sensitivity. This is reinforced by the presence of what appears to have been *Limonium decumbens* (unfortunately not collected or photographed), also a very poorly known Namaqualand coastal endemic Red Listed as Data Deficient.

The **dunes at Gulley Intakes 1 and 4** support the only study area populations of *Helichrysum dunense.* This Vulnerable species is locally common, but curiously patchy, and is not present in seemingly identical dune habitat nearby, making these areas of High sensitivity.

The prefered position of the gully intake is Gulley Intake 5 and thus it is not anticipated that the ecologically sensitive coastal areas will be impacted on by the proposed project. Figure 6.5 to Figure 6.8 shows the sensitive areas along the coastline.

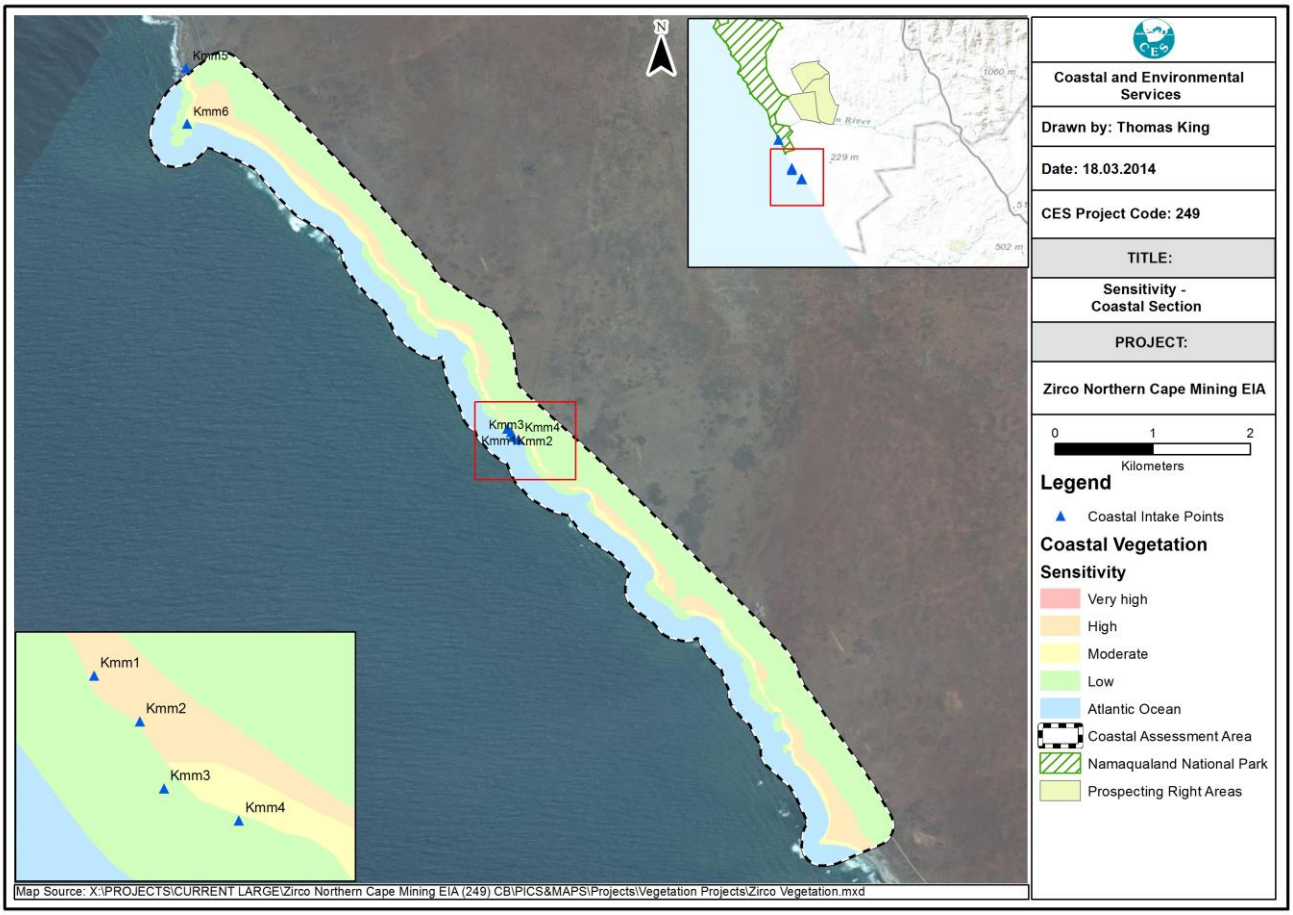


Figure 6.5: Sensitivity map of the coastal assessment area

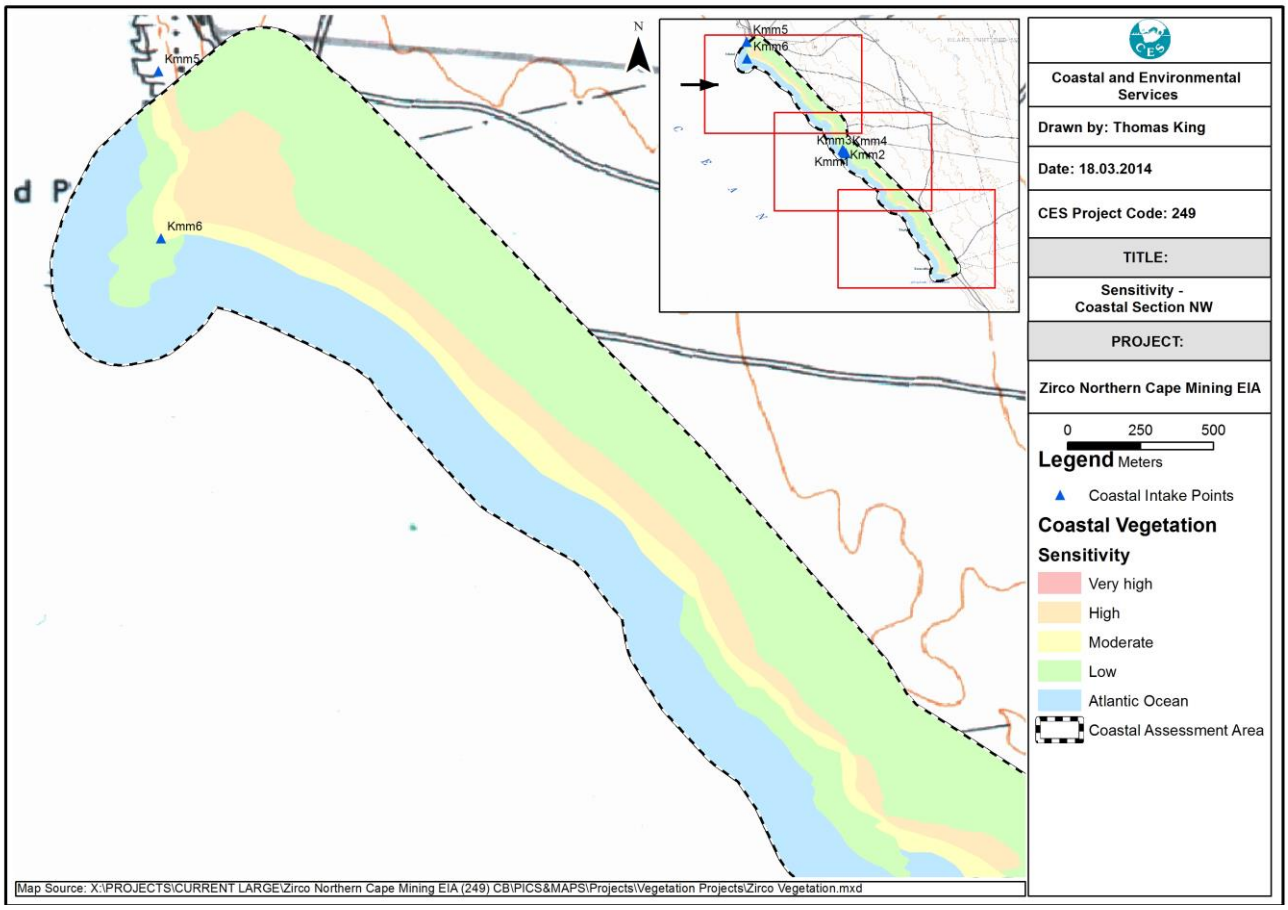


Figure 6.6: Sensitivity map of the coastal assessment area – north western section

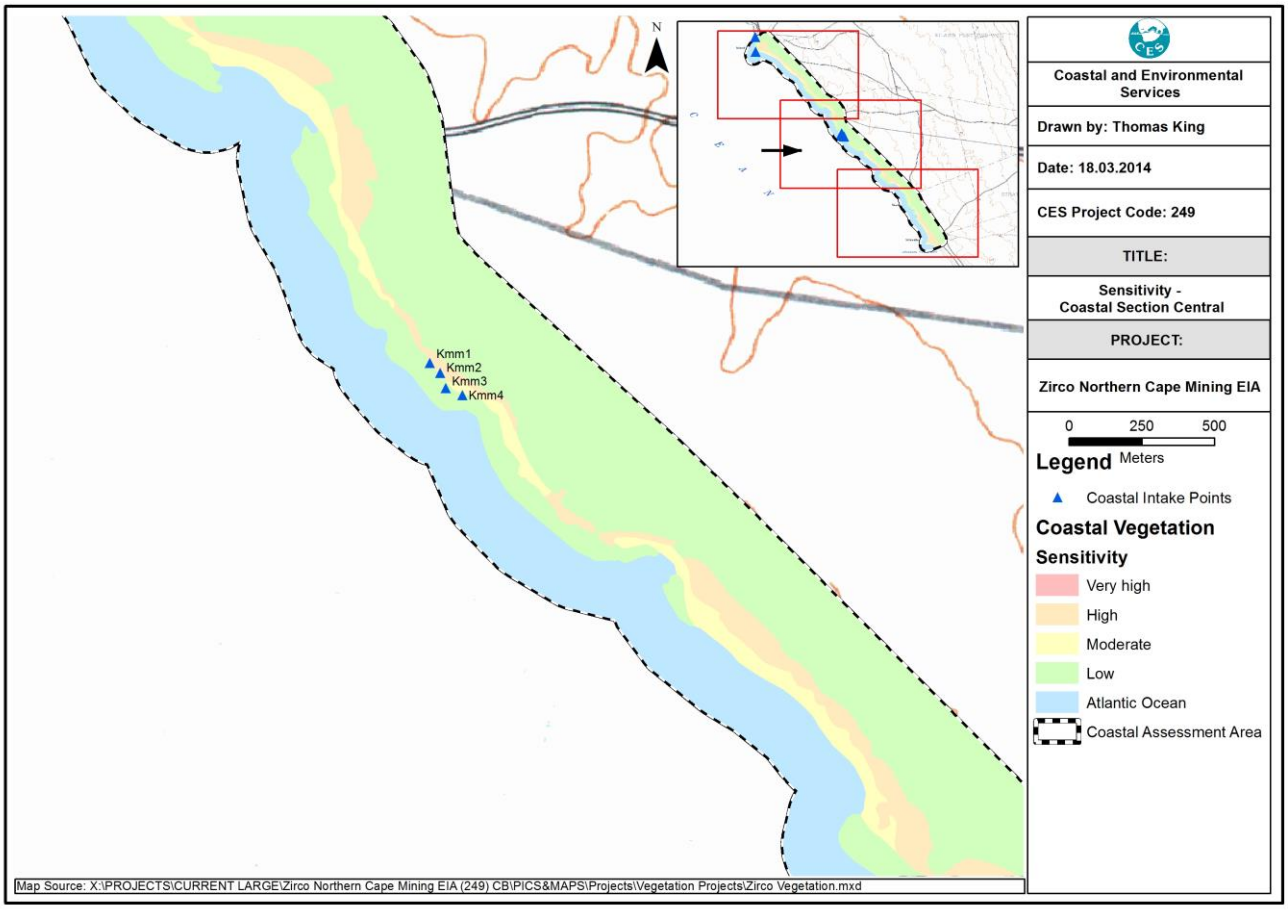


Figure 6.7: Sensitivity map of the coastal assessment area - central section

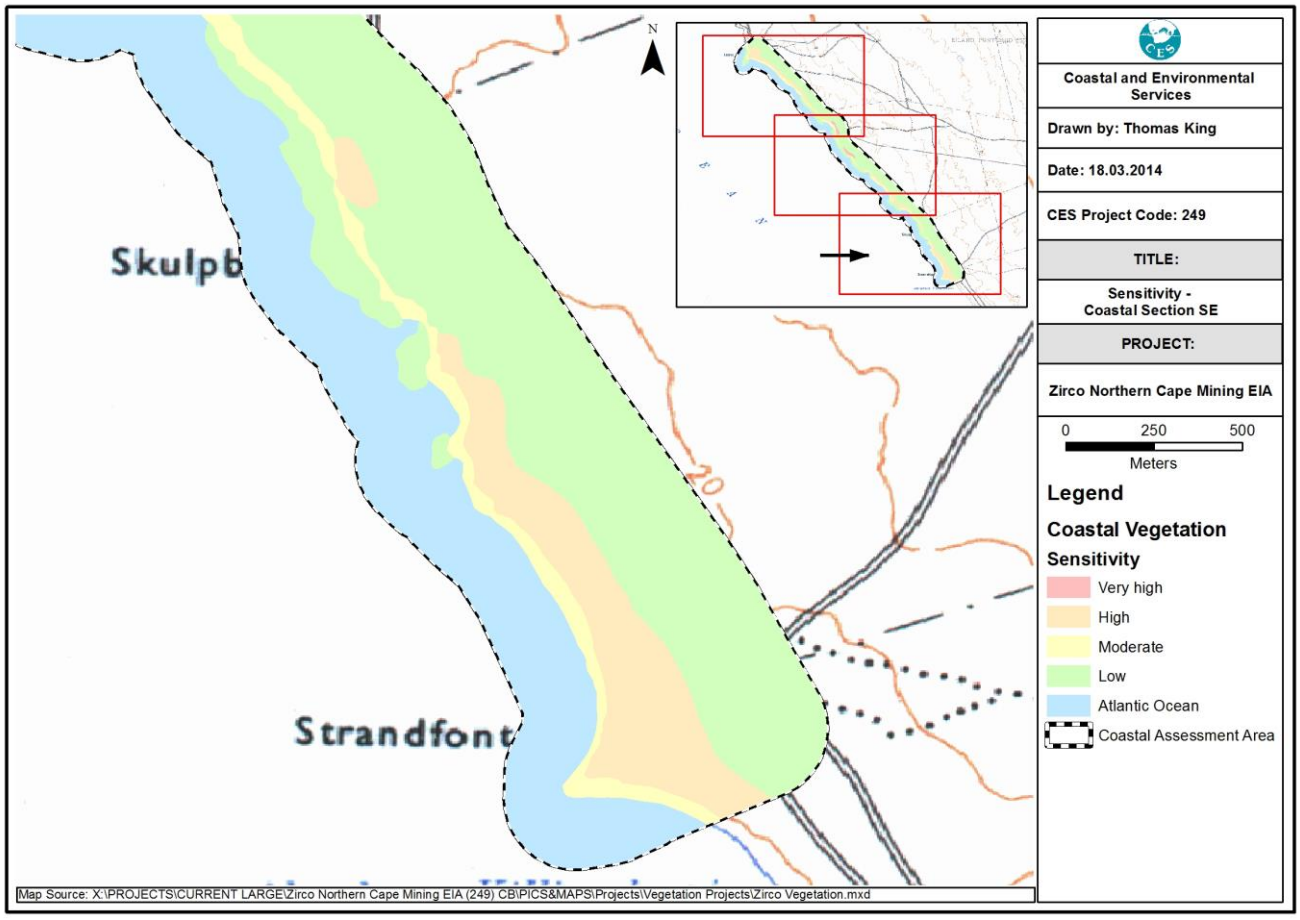


Figure 6.8: Sensitivity map of the coastal assessment area – south eastern section

7. ISSUES IDENTIFIED AND ASSESSED

The study that has been undertaken provides the necessary information to assess the impacts of the project on the vegetation and the flora at various relevant spatial and temporal scales.

The individual impacts have been grouped together as a series of key environmental issues. All of the issues relate to the loss of the existing vegetation cover in the mine path and the project area as a whole. At the spatial scale of the project area the impacts described below will definitely be considerable, but these need to be seen in the context of the project area as a whole or at a still larger spatial scale. The main issues identified with the existing impacts are discussed below:

7.1 ISSUE 1: LOSS OF NATURAL VEGETATION AND ASSOCIATED PLANT COMMUNITIES

Natural plant communities are dynamic ecosystems that provide habitats that support all forms of life. Different types of plant communities (and habitats) exist in the project area, and these occur within and around the project area. The total extent of the proposed mining and tailings infrastructure (TSF) is about 3815ha. The vegetation and habitat in the project area is generally in good condition, but the effects of stock and crop farming are evident in places, some land portions being significantly more overgrazed than others. In general the western parts are less heavily impact by grazing than the eastern parts, and areas with goats are more heavily impacted than areas without. Most of the coastal section is in good condition, apart from old diamond camps and diggings, numerous tracks, and some kelp harvesting stockpile areas.

7.2 ISSUE 2: LOSS OF BIODIVERSITY AND SPECIES OF CONSERVATION CONCERN

Removal of the vegetation during the mining process will result in the loss of existing populations of all plant species within the mine area and areas directly affected by infrastructure (e.g. the TSF and Process Plant). The project area as a whole has a high species diversity and a high number of Species of Conservation Concern (SCC). A total of 25 plant Species of Conservation Concern were recorded in the study area, including 6 species not yet formally named or described. At least 15 SCC occur within the proposed mining and TSF area of 3815ha. Large scale mining could thus have a significant negative impact on these species and the overall flora if adequate mitigation is not put in place.

The impacts at a larger spatial scale will only be important in the case of species that have a globally restricted range, or are otherwise in need of protection. In this case the mining process may significantly reduce the *area of occupancy* of the species. A reduction of the area of occupancy in turn may threaten the chances of survival for these plant SCC. However, the significance of the impact differs depending on the distribution and abundance of these plant species (and our knowledge thereof).

7.3 ISSUE 3: DISRUPTION OF ECOSYSTEM FUNCTION AND PROCESS

The habitats that exist in the project area, together with those of the surrounding area that are linked, form part of a functional ecosystem. An ecosystem provides more than simply a 'home' for a set of organisms, and is a functional system where biological and biophysical processes such as nutrient cycling, soil formation, reproduction, migration, competition, predation, succession, evolution and migration take place. Destruction or modification of habitats causes disruption of ecosystem function, and threatens the interplay of processes that ensure environmental health and the survival of individual species. This issue deals with a collection of complex ecological impacts that are almost impossible to predict with certainty, but which are nonetheless important.

7.4 THE CURRENT IMPACTS: THE "NO-GO" OR "WITHOUT PROJECT SCENARIO"

To contextualise the potential impacts of the proposed mining project the existing impacts (or status quo), associated with current ecological conditions need to be described in terms of

vegetation patterns, structure and composition. This baseline or status quo should be used as the comparison against which project impacts are assessed. The main issues associated with the likely impacts are discussed below:

7.4.1 Impacts Associated with Issue 1: Loss of Vegetation Type

Impact 1: Loss and Degradation of Strandveld (Namaqualand Strandveld)

Cause and comment:
Strandveld is the dominant vegetation unit in the study area (but is only 40% of the mining area) and occurs all along the Groen River basin in the southern sections of Roode Heuvel and Sabies areas. It is also found scattered throughout Sabies, and extends into Leeuvlei. Strandveld merges with Sand Fynbos all along the boundary between the two vegetation types, and in places it can be difficult to distinguish a clear boundary. Degraded Strandveld (181 ha) occurs along the southern section of Roode Heuvel. The cause of degradation is overgrazing, resulting from water points and livestock pens (kraals) which occur along the road, and incidentally along the Groen River.

Significance Statement:
The permanent loss of Strandveld *(i.e.* habitat transformation) is currently negligible, but there is ongoing degradation in places. The magnitude of this varies from place to place, and ranges from very low to moderate. Degradation is definitely occurring and has had a **low to moderate**, temporary to permanent impact (as removal of grazing pressure will often allow vegetation recovery). The environmental significance of this unmitigated impact is LOW NEGATIVE.

Current Impacts					
Impact	Effect			**Risk or Likelihood**	**Overall Significance**
	Temporal Scale	Spatial Scale	Severity of Impact		
Without Mitigation	Temporary to Permanent	Study Area	Low to Moderate	Definite	**LOW-**

Impact 2: Loss of Sand Fynbos (Namaqualand Sand Fynbos)

Cause and comment:
Sand Fynbos is the second largest vegetation unit in the project area, and it makes up about 60% of the mining area. It is the dominant vegetation on Roode Heuvel, but also extends into Sabies and Leeuvlei. Sand Fynbos occurs on slightly undulating plains and is often dominated by restios in the dune slacks (troughs), and asteraceous fynbos or restios on the dune ridges. The vegetation on the dune ridges often includes Strandveld elements.

Significance Statement:
The permanent loss of Sand Fynbos *(i.e.* habitat transformation) is currently negligible (although some has occurred in the past), but there is ongoing degradation in places. The magnitude of this varies from place to place, and ranges from very low to moderate. Degradation is definitely occurring and has had a **low to moderate**, temporary to permanent impact. The environmental significance of this unmitigated impact is LOW NEGATIVE.

Current Impacts					
Impact	Effect			**Risk or Likelihood**	**Overall Significance**
	Temporal Scale	Spatial Scale	Severity of Impact		
Without Mitigation	Temporary to Permanent	Study Area	Low - Moderate	Definite	**LOW-**

Impact 3: Loss of Heuweltjieveld (Namaqualand Heuweltjieveld)

Cause and comment:
Heuweltjieveld may be found all along the eastern extent of Leeuvlei, and a large part of north

eastern Sabies. It generally occurs on undulating topography of the Kamiesberg escarpment foothills, and comprises largely succulent dwarf shrubland communities amongst a mosaic of heuweltjie communities. Degraded Heuweltjieveld occurs in the south eastern sections of Sabies adjacent to alluvial corridors, where it has been both cultivated and heavily grazed. This vegetation type may be spectacular after good winter rains, when extensive displays of annuals, herbs and bulbs colour the landscape, and at that stage is capable of supporting a high diversity of insects, birds and other animals.

Significance Statement:
The permanent loss of Heuweltjieveld *(i.e.* habitat transformation) is currently negligible (although some has occurred in the past), but there is ongoing degradation in places. The magnitude of this varies from place to place, and ranges from very low to moderate. Degradation is definitely occurring and has had a **low to moderate**, temporary to permanent impact. The environmental significance of this unmitigated impact is LOW NEGATIVE.

Current Impacts					
Impact	Effect			**Risk or Likelihood**	**Overall Significance**
	Temporal Scale	Spatial Scale	Severity of Impact		
Without Mitigation	Temporary to Permanent	Study Area	Low to Moderate	Definite	**LOW-**

Impact 4: Loss of Riparian Vegetation (Namaqualand Riviere)

Cause and comment:
Riparian areas consist largely of alluvial corridors of the Groen River in the south and Bitter River in the north, but also includes tributary alluvial drainage lines scattered largely in the eastern sections of Leeuvlei and Sabies, commencing in the Kamiesberg escarpment foothills and draining down to the larger river basins. The vegetation varies from *Acacia* thicket to alluvial halophytic shrublands. These areas serve as important corridors for bird species and are classified as areas of high sensitivity.

Significance Statement:
The loss of the *riparian vegetation* has definitely occurred in the past, but does not appear to be ongoing, although degradation is ongoing (due to heavy grazing). Previous and current pressures have had a **Moderate to Severe**, temporary to permanent impact. The environmental significance of this unmitigated impact is MODERATE to HIGH NEGATIVE.

Current Impacts					
Impact	Effect			**Risk or Likelihood**	**Overall Significance**
	Temporal Scale	Spatial Scale	Severity of Impact		
Without Mitigation	Temporary to Permanent	Study Area	Moderate to Severe	Definite	**MODERATE to HIGH-**

Impact 5: Loss of Klipkop Shrubland (Namaqualand Klipkoppe Shrubland)

Cause and comment:
Klipkop Shrubland vegetation occurs as scattered communities surrounding rocky outcrops of the Kamiesberg escarpment foothills. These can be found in central Leeuvlei and northern Sabies. No SCC are likely to occur within the limited extent of this unit in the study area, but the unit was not surveyed extensively, and various SCC are known from this unit nearby.

Significance Statement:
No loss of the *Klipkop Shrubland* has occurred within the project area, but minor degradation (due to grazing) is ongoing. Most of this degradation is reversible, and is thus temporary. The environmental significance of this unmitigated impact is LOW NEGATIVE.

Current Impacts					
Impact	Effect			**Risk or Likelihood**	**Overall Significance**
	Temporal Scale	Spatial Scale	Severity of Impact		
Without Mitigation	Temporary	Study Area	Low	Definite	**LOW-**

Impact 6: Loss of Seashore Dunes

Cause and comment:

Seashore Dunes occur as a belt along the coastline, above the high tide water mark, and on the seaward side of the Coastal Duneveld. Essentially it consists of Namaqualand Seashore Vegetation, but also includes transition zones of seashore vegetation occurring on white dune sands, which have taller shrubs, but are not considered part of the Coastal Duneveld.

Significance Statement:
No loss of the *Seashore Dune* vegetation has occurred within the project area, but some localised degradation has occurred and is ongoing (due to kelp harvesting and offroad vehicle tracks). Most of this degradation is reversible, and is thus temporary. The environmental significance of this unmitigated impact is LOW NEGATIVE.

Current Impacts					
Impact	Effect			**Risk or Likelihood**	**Overall Significance**
	Temporal Scale	Spatial Scale	Severity of Impact		
Without Mitigation	Temporary	Study Area	Low	Definite	**LOW-**

Impact 7: Loss of Coastal Duneveld

Cause and comment:
Coastal Duneveld is situated on the inland side of the Seashore Dunes, and gradually merges with Strandveld further inland. No SCC were recorded in this unit.

Significance Statement:
There has been minor loss of the *Coastal Duneveld* (due to a few diamond exploration pits), but the unit does not appear to be experiencing any ongoing degradation. The severity of the impact is Low, and the environmental significance of this unmitigated impact is LOW NEGATIVE.

Current Impacts					
Impact	Effect			**Risk or Likelihood**	**Overall Significance**
	Temporal Scale	Spatial Scale	Severity of Impact		
Without Mitigation	Permanent	Study Area	Low	Definite	**LOW-**

7.4.2 Impacts Associated with Issue 2: Loss of Biodiversity and Species of Conservation Concern

Impact 8: Loss of Biodiversity (general)

Cause and comment:
The clearing of relatively small areas of land for agriculture and for large scale use of the area for livestock grazing has resulted in a loss of biodiversity in the area. Overall no species or habitats are likely to have been lost, although degradation in certain areas (around stock kraals) has been intense.

Significance Statement:
The current land use is probably having a **moderately severe,** Long Term impact on the *biodiversity* within the project area. The environmental significance of this unmitigated impact is MODERATE NEGATIVE.

Current Impacts					
Impact	Effect			**Risk or Likelihood**	**Overall Significance**
	Temporal Scale	Spatial Scale	Severity of Impact		
Without Mitigation	Long Term	Study Area	Moderately severe	Probable	**MODERATE-**

Impact 9: Loss of Species of Conservation Concern

Cause and comment:
The clearing of relatively small areas of land for agriculture and for large scale use of the area for livestock grazing is unlikely to have resulted in total loss of any plant SCC in the area. However, land use has undoubtedly impacted on the isolated populations of SCC, and reduced the total population numbers of about 5-10 SCC.

Significance Statement:
The current land use is probably having a **moderately severe**, Long Term impact on at least some of the SCC within the project area. The environmental significance of this unmitigated impact is MODERATE NEGATIVE.

Current Impacts					
Impact	Effect			**Risk or Likelihood**	**Overall Significance**
	Temporal Scale	Spatial Scale	Severity of Impact		
Without Mitigation	Long Term	Study Area	Moderatly severe	Probable	**MODERATE-**

Impact 10: Fragmentation of vegetation and edge effects

Cause and comment:
Habitat fragmentation is one of the most important impacts on vegetation, especially when this creates breaks in previously continuous vegetation, causing a reduction in the gene pool and a decrease in species richness and diversity. This impact usually occurs when large areas are cleared for agriculture, development or mining. Fragmentation results in the isolation of functional ecosystems, and results in reduced biodiversity and reduced movement due to the absence of ecological corridors.

Habitat fragmentation is currently not a major feature of the study area, as most cultivation consists of narrow strips (<30m wide) surrounded by natural vegetation. Most of the heavily disturbed areas are close to homesteads and livestock kraals, and are generally <10ha in extent.

Significance Statement:
Habitat fragmentation is fairly likely to be an issue within the project area, but it is of **Low** severity and has a Long Term impact. The environmental significance of this unmitigated impact is LOW NEGATIVE.

Current Impacts					
Impact	Effect			**Risk or Likelihood**	**Overall Significance**
	Temporal Scale	Spatial Scale	Severity of Impact		
Without Mitigation	Long term	Study Area	Low	Fairly likely	**LOW-**

7.5 IMPACTS ASSOCIATED WITH THE MINING PROJECT

7.5.1 Design and Planning Phase

Activities associated with the design and pre construction phase pertains mostly to exploration. As the project has an exploration license impacts associated with exploration and the mitigation of these impacts were included in the Exploration EMP compiled to obtain this license and will therefore not be repeated in this section. Other activities associated with the design and pre construction phase will not have impacts on the biophysical environment as this phase consists of planning and design of the proposed development, and is done at a desktop level. In some cases site visits need to take place but the impact of these visits is negligible, if any, e.g. photographs and field surveys, etc.

7.5.2 Construction Phase

This section assesses the impacts associated with the construction of the mine facilities and associated infrastructure, and does not include assessment of the actual mining, which falls within the operational phase.

Impacts Associated with Issue 1: Loss of Vegetation Type

Impact 1: Loss of Strandveld (Namaqualand Strandveld)

Cause and comment:
Strandveld is the dominant vegetation unit in the study area, but it occupies only about 40% of the proposed mining area (1500ha), and occurs all along the Groen River basin in the southern sections of Roode Heuvel and Sabies areas. It is also found scattered throughout Sabies, and extends into Leeuvlei. Strandveld merges with Sand Fynbos all along the boundary between the two vegetation types, and in places it can be difficult to distinguish a clear boundary. Degraded Strandveld occurs along the southern section of Roode Heuvel. Relatively few SCC are known to occur in true Strandveld, but nevertheless six SCC were recorded in this unit (24% of those in the total study area).

Strandveld is likely to be easier to rehabilitate than Sand Fynbos, as it is adapted to growing on slightly saline soils, whereas Sand Fynbos prefers more acid sands. The primary processing of the mineral sands will be undertaken with seawater, raising the salinity of the sands returned to site, and thus Strandveld is likely to benefit at the expense of Sand Fynbos.

Most of the Strandveld in the mining area has a High botanical sensitivity rating.

Significance Statement:
The loss and degradation of up to about 50ha of currently natural *Strandveld* will definitely occur and will have a **moderate,** permanent impact, as ecosystem functioning in these areas will be effectively lost and/or significantly altered, but the scale is relatively small. The unmitigated environmental significance of this impact is MODERATE NEGATIVE. This could be reduced to a LOW – MODERATE NEGATIVE with mitigation.

Loss of Strandveld					
Impact	Effect			**Risk or Likelihood**	**Overall Significance**
	Temporal Scale	Spatial Scale	Severity of Impact		
Without Mitigation	Permanent	Localised, within Study Area	Moderate	Definite	**MODERATE -**
With mitigation	Permanent	Localised, within Study Area	Moderate	Definite	**LOW – MODERATE -**

Mitigation and Management:
The following mitigation actions are required:

- Areas impacted by construction that are no longer required during the operational phase must be rehabilitated as soon as possible after cessation of disturbance;
- Topsoil of at last 300mm (0.3m) depth must be harvested from within all development footprints and used for rehabilitation purposes. This is regarded as the minimum depth required in order to include at least 60% of the bulbs (geophytes).
- Mine planning has been informed by the botanical sensitivity mapping to minimize what could otherwise be very significant negative botanical impacts, through the establishment of ecological corridors.
- Where possible associated infrastructure (not tied to any particular area) has been located in areas of lowest sensitivity.

Impact 2: Loss of Sand Fynbos (Namaqualand Sand Fynbos)

Cause and comment:
Sand Fynbos is the second largest vegetation unit in the study area, and makes up about 60% of the proposed mining area, and is consequently the most important vegetation type in terms of habitat loss to this project. It is the dominant vegetation on Roode Heuvel, but also extends into Sabies and Leeuvlei. Sand Fynbos occurs on slightly undulating plains, on fairly acid sands, and is often dominated by restios in the dune slacks (troughs), and asteraceous fynbos or restios on the dune ridges. The vegetation on the dune ridges often includes Strandveld elements. All Sand Fynbos on site has at least a High sensitivity, especially since all 15 plant SCC recorded from the Sand Fynbos are found in the Northern Sand Fynbos. Sand Fynbos is currently significantly underconserved on a national basis, and its rehabilitation potential is fairly low when compared to Strandveld.

Significance Statement:
The loss of the *Sand Fynbos* at the Construction Phase is likely to be relatively minor, as most infrastructure will be located south of the Sand Fynbos, in the Strandveld areas. Loss of up to 20ha will definitely occur and will have a **minor**, permanent impact. The environmental significance of this unmitigated impact will be LOW - MEDIUM NEGATIVE. This could be reduced to a LOW NEGATIVE with mitigation.

Loss of Sand Fynbos					
Impact	Effect			**Risk or Likelihood**	**Overall Significance**
	Temporal Scale	Spatial Scale	Severity of Impact		
Without Mitigation	Permanent	Localised, within Study Area	Fairly minor	Definite	**LOW – MEDIUM -**
With Mitigation	Permanent	Localised, within Study Area	Minor	Definite	**LOW -**

Mitigation and Management:
The following mitigation actions are required:

- Areas impacted by construction that are no longer required during the operational phase must be rehabilitated as soon as possible after cessation of disturbance;
- Topsoil of at last 300mm (0.3m) depth must be harvested from within all development footprints and used for rehabilitation purposes. This is regarded as the minimum depth required in order to include at least 60% of the bulbs (geophytes).
- Mine planning has been informed by the botanical sensitivity mapping to minimize what could otherwise be very significant negative botanical impacts, through the establishment of ecological corridors.
- Where possible associated infrastructure (not tied to any particular area) has been located in areas of lowest sensitivity.

Impact 3: Loss of Heuweltjieveld (Namaqualand Heuweltjieveld)

Cause and comment:
Heuweltjieveld may be found all along the eastern extent of Leeuvlei, and a large part of north-eastern Sabies. It generally occurs on undulating topography of the Kamiesberg escarpment foothills, and comprises largely succulent dwarf shrubland communities amongst a mosaic of heuweltjie communities. Degraded Heuweltjieveld occurs in the south eastern sections of Sabies adjacent to alluvial corridors. This vegetation type may be spectacular after good winter rains, when extensive displays of annuals, herbs and bulbs colour the landscape, and at that stage is capable of supporting a high diversity of insects, birds and other animals. The unit also supports isolated quartz patches, such as along the Outeep River, and these support many plant SCC, including at least two undescribed species new to science, which are not known to occur outside the study area.

The proposed mining footprint does not include any Heuweltjieveld. Prospecting and mining is unlikely to be undertaken to any great degree in this unit as it is not known to support any target minerals, but much of the anticipated impact is associated with possible prospecting in the few quartz patches.

Significance Statement:
The loss of significant areas of *Heuweltjieveld* is unlikely to occur at the construction phase and prospecting would have a low *temporary to permanent* impact. The environmental significance of this unmitigated impact will be LOW NEGATIVE. This could easily be reduced to LOW NEGATIVE with mitigation.

Loss of Heuweltjieveld					
Impact	Effect			**Risk or Likelihood**	**Overall Significance**
	Temporal Scale	Spatial Scale	Severity of Impact		
Without Mitigation	Temporary to Permanent	Study Area	Low	Definite	**LOW-**
With Mitigation	Temporary to Permanent	Study Area	Low	Definite	**LOW-**

Mitigation and Management:
No special mitigation proposed as this unit is unlikely to be impacted by the construction phase.

Impact 4: Loss of Riparian Vegetation (Namaqualand Riviere)

Cause and comment:
Riparian areas consist largely of alluvial corridors of the Groen River in the south and Bitter River in the north, but also includes tributary alluvial drainage lines scattered largely in the eastern sections of Leeuvlei and Sabies, commencing in the Kamiesberg escarpment foothills and draining down to the larger river basins. The vegetation varies from *Acacia* thicket to alluvial halophytic shrublands. These areas serve as important corridors for bird species and are classified as areas of high sensitivity. The only impact on this vegetation type will be due to the routing of the main aboveground seawater pipeline (and probably an associated service track) across the Groen River, but impacts are likely to be limited to less than 2ha.

Significance Statement:
Very minor loss of *riparian vegetation* is likely. The environmental significance of this impact will thus be LOW NEGATIVE, before and after mitigation.

Loss of Riparian Vegetation					
Impact	Effect			Risk or Likelihood	Overall Significance
	Temporal Scale	Spatial Scale	Severity of Impact		
Without Mitigation	Temporary	Study Area	Minor	Probable	**LOW-**
With Mitigation	Temporary	Study Area	Minor	Probable	**LOW-**

Mitigation and Management:
No specific mitigation required for this habitat in terms of mining, as it will not be impacted by mining.
The following mitigation actions are suggested:

- Locate the seawater pipeline in relatively disturbed parts of the Groen River crossing, and minimise impact to natural vegetation in this area.

Impact 5: Loss of Klipkop Shrubland (Namaqualand Klipkoppe Shrubland)

Cause and comment:
Klipkop Shrubland vegetation occurs as scattered communities surrounding rocky outcrops of the Kamiesberg escarpment foothills. These can be found in central Leeuvlei and northern Sabies. No SCC are likely to occur within the limited extent of this unit in the study area, but the unit was not surveyed extensively.

Significance Statement:
No loss of the *Klipkop Shrubland* is likely to occur. The environmental significance of this impact will thus be LOW NEGATIVE, before and after mitigation.

Loss of Klipkop Shrubland					
Impact	Effect			Risk or Likelihood	Overall Significance
	Temporal Scale	Spatial Scale	Severity of Impact		
Without Mitigation	Temporary	Study Area	Minor	Unlikely	**LOW-**
With Mitigation	Temporary	Study Area	Minor	Unlikely	**LOW-**

Impact 6: Loss of Seashore Dunes

Cause and comment:

Seashore Dunes occur as a belt along the coastline, above the high tide water mark, and on the seaward side of the Coastal Duneveld. Essentially it consists of Namaqualand Seashore Vegetation, but also includes transition zones of seashore vegetation occurring on white dune sands, which have taller shrubs, but are not considered part of the Coastal Duneveld. No mining will occur in this habitat, and loss would be caused by the installation of the seawater pump, pipe and associated facility, which would probably occupy less than 0.01ha.

Significance Statement:
The loss of *Seashore Dune* habitat will definitely occur and will have a **minor**, permanent impact. The environmental significance of this unmitigated impact will be LOW to MEDIUM NEGATIVE. With mitigation measures this can be reduced to LOW NEGATIVE.

Loss of Seashore Dunes					
Impact	Effect			**Risk or Likelihood**	**Overall Significance**
	Temporal Scale	Spatial Scale	Severity of Impact		
Without Mitigation	Permanent	Study Area	Moderate	Definite	**LOW to MEDIUM-**
With mitigation	Permanent	Study Area	Low	Definite	**LOW-**

Mitigation and Management:
The following mitigation actions are suggested:

- Locate the plant outside the identified areas of High dune sensitivity that cannot be easily rehabilitated.
- Minimise disturbance around pump infrastructure, and allow for natural rehabilitation of disturbed areas.

Impact 7: Loss of Coastal Duneveld

Cause and comment:
Coastal Duneveld is situated on the inland side of the Seashore Dunes, and gradually merges with Strandveld further inland. No SCC were recorded in this unit. The main seawater pipeline and associated access track will cross this habitat type, along with the Namaqualand Strandveld and the riverine habitat, but the routing thereof has not yet been finalised. Total habit loss is likely to be <5ha.

Significance Statement:
The loss of the *Coastal Duneveld* will definitely occur and will have a l**ow - moderate**, permanent impact. The environmental significance of this unmitigated impact will be LOW TO MODERATE NEGATIVE. With mitigation measures this can be reduced to LOW NEGATIVE.

Loss of Coastal Duneveld					
Impact	Effect			**Risk or Likelihood**	**Overall Significance**
	Temporal Scale	Spatial Scale	Severity of Impact		
Without Mitigation	Permanent	Study Area	Low - Moderate	Definite	**LOW - MODERATE-**
With mitigation	Permanent	Study Area	Low	Definite	**LOW-**

Mitigation and Management:
The following mitigation actions are suggested:

- Minimise impact to natural vegetation in this habitat, and allow for natural rehabilitation of disturbed areas.
- Ongoing, annual alien invasive vegetation management along the pipeline route.

7.5.3 Impacts Associated with Issue 2: Loss of Biodiversity and Species of Conservation Concern

Impact 8: Loss of Species of Conservation Concern

Cause and comment:
Although mining activities and the associated infrastructure will result in the loss of portions of the local subpopulations of at least 17 plant Species of Conservation Concern (SCC), as well as other species that are important to ecosystem functioning, no significant populations of any SCC are likely to be lost during the construction phase alone. It is possible that small portions of the local populations of up to 5 SCC may be impacted at the construction phase.

Statement:
The construction phase may result in the loss of portions of local subpopulations of up to 5 plant SCC and this will have a **moderate** permanent impact. The environmental significance of this unmitigated impact would be MODERATE NEGATIVE. Mitigation measures may reduce this to a LOW NEGATIVE impact.

Current Impacts					
Impact	Effect			**Risk or Likelihood**	**Overall Significance**
	Temporal Scale	Spatial Scale	Severity of Impact		
Without Mitigation	Permanent	Study Area	Moderate	Probable	MODERATE -
With Mitigation	Permanent	Study Area	Low - Moderate	Probable	LOW -

Mitigation and Management:
The following mitigation actions are suggested:

- All bulbs (geophytes) of Conservation Concern in the construction phase footprints (notably *Lachenalia* sp nov/*arenicola*) should be subject to Search and Rescue in the winter to spring season (June – September) preceding any mining. These plants should be located by suitably qualified staff or consultants who can identify the species. The plants should be immediately translocated to a similar, suitable receiving environment that will not be disturbed by mining activities at any stage in the future.
- All succulents of Conservation Concern in the construction phase footprints (notably *Lampranthus procumbens*) should be subject to Search and Rescue in the autumn (April – May) preceding any mining. These plants should be located by suitably qualified staff or consultants who can identify the species. The plants should be immediately translocated to a similar, suitable receiving environment that will not be disturbed by mining activities at any stage in the future.
- A nursery should be set up in the project area to propagate all possible SCC from within the mining and construction phase area, and the propagated plants should be returned to the post mining landscape about three years after initial rehabilitation has been completed. Planting out should take place after the first good winter rains, typically in May or June. Material for propagation should be sourced from the pre mining and construction phase areas.
- The applicant should set aside for conservation undisturbed habitat that conserves at least 30% of the project area populations of all SCC recorded from the project area.

Impact 9: Fragmentation of vegetation and edge effects

Cause and comment:
Habitat fragmentation is potentially one of the most important impacts on the vegetation, and this also has knock on effects on the associated fauna. Fragmentation occurs wherever previously continuous vegetation is lost or degraded, and results in a reduction in the total gene pool and a decrease in species richness and diversity. Fragmentation results in the isolation of functional ecosystems, and results in reduced biodiversity and reduced movement due to the absence of ecological corridors. The site is currently unfragmented in about 90% of the area, with partial fragmentation due to clearing of agricultural lands and heavy grazing in about 10% of the total area. Many of these agricultural lands have been fallow for over a decade and are now partly rehabilitated (although most are heavily grazed, which reduces their rehabilitation potential). Edge effects relate to the proximity of natural vegetation to disturbed or mined areas, and these edges are often invaded by alien species, and may also be impacted by windblown dust, etc.

Significance Statement:
The construction phase activities **may** result in minor habitat fragmentation and edge effects and this will have a **minor** permanent impact. The environmental significance of this unmitigated impact would be LOW NEGATIVE. This will remain a LOW NEGATIVE impact with mitigation measures

(which are mainly related to post mining rehabilitation).

Current Impacts					
Impact	Effect			Risk or Likelihood	Overall Significance
	Temporal Scale	Spatial Scale	Severity of Impact		
Without Mitigation	Permanent	Study Area	Minor	Probable	LOW-
With Mitigation	Permanent	Study Area	Minor	Probable	LOW-

Mitigation and Management:
The following mitigation actions are suggested:

- Ongoing alien invasive vegetation management in the project area for the duration of life of mine.
- Maintaining at least one 300m wide infrastructure free north – south ecological corridor along the entire western edge of the project area;
- Keeping vegetation clearing during construction to a minimum.
- Design and implement a Rehabilitation Management Plan which ensures that construction phase footprints are rehabilitated to acceptable standards (minimum of 60% of original plant species present) as soon as possible after the area is no longer in use.

7.5.4 Operational Phase

This section assesses the impacts associated with the operational phase of the mine, and includes the actual mining operations for the full life of mine.

Impacts Associated with Issue 1: Loss of Vegetation Type

Impact 1: Loss of Strandveld (Namaqualand Strandveld)

Cause and comment:
Strandveld is the dominant vegetation unit in the study area, but it occupies only about 40% of the proposed mining area (1500ha), and occurs all along the Groen River basin in the southern sections of Roode Heuvel and Sabies areas. It is also found scattered throughout Sabies, and extends into Leeuvlei. Strandveld merges with Sand Fynbos all along the boundary between the two vegetation types, and in places it can be difficult to distinguish a clear boundary. Degraded Strandveld occurs along the southern section of Roode Heuvel. Relatively few SCC are known to occur in true Strandveld, but nevertheless six SCC were recorded in this unit (24% of those in the total study area).

Strandveld is likely to be easier to rehabilitate than Sand Fynbos, as it is adapted to growing on slightly saline soils, whereas Sand Fynbos prefers more acid sands. The primary processing of the mineral sands will be undertaken with seawater, raising the salinity of the sands returned to site, and thus Strandveld is likely to benefit at the expense of Sand Fynbos.

Most of the Strandveld in the mining area has a High botanical sensitivity rating.

Significance Statement:
The loss and degradation of up to about 1500ha of currently natural *Strandveld* will definitely occur and will have a **severe,** permanent impact, as ecosystem functioning in these areas will be effectively lost and/or significantly altered. The environmental significance of this impact is HIGH NEGATIVE, before mitigation, and MEDIUM NEGATIVE after mitigation.

Loss of Strandveld					
Impact	Effect			Risk or Likelihood	Overall Significance
	Temporal Scale	Spatial Scale	Severity of Impact		
Without Mitigation	Permanent	Study Area	Severe	Definite	**HIGH -**
With mitigation	Permanent	Study Area	Moderate	Definite	**MODERATE -**

Mitigation and Management:
The following mitigation actions are required:

- Areas impacted by mining must be rehabilitated as soon as possible after cessation of disturbance;
- Topsoil of at last 300mm (0.3m) depth must be harvested from within all development footprints and used for rehabilitation purposes. This is regarded as the minimum depth required in order to include at least 60% of the bulbs (geophytes).
- There must be a north-south corridor at least 300 m wide through the project area at all times. This corridor will be along the eastern side of Roode Heuwel during years 1-5 of mining and along the western edge of the project site once rehabilitation has been completed, for the remainder of the mine life.
- Areas within the project area that are not required during mining should be demarcated as no-go areas and conserved. These areas provide important refugia for birds, reptiles, amphibians and mammals.
- All Very High sensitivity areas outside the approved mining area should be treated as conservation areas and should not be subject to invasive prospecting or mining;
- No livestock should be allowed to graze in the approved mining area nor within a 500m buffer area (if such an area is located within the permit area) from six months after any authorization up until the mine closure permit is granted. Removal of livestock from the area will significantly enhance seed set and hence rehabilitation.
- Design and implement a Rehabilitation Management Plan.
- Rehabilitation targets must include a measurable element of botanical diversity. In other words the rehabilitation target for Strandveld areas should be to return the mined areas to at least 60% of the pre-mining botanical diversity for this habitat.
- Ongoing, annual alien invasive vegetation management is required in the mined and rehabilitated areas until the mine closure permit is issued.
- East – west oriented wind fences will be required in the rehabilitation areas in order to minimise wind erosion, probably at an interval of every 5m, as at Namakwa Sands.

Impact 2: Loss of Sand Fynbos (Namaqualand Sand Fynbos)

Cause and comment:
Sand Fynbos is the second largest vegetation unit in the study area, and makes up about 60% of the proposed mining area (2290ha), and is consequently the most important vegetation type in terms of habitat loss to this project. It is the dominant vegetation on Roode Heuvel, but also extends into Sabies and Leeuvlei. Sand Fynbos occurs on slightly undulating plains, on fairly acid sands, and is often dominated by restios in the dune slacks (troughs), and asteraceous fynbos or restios on the dune ridges. The vegetation on the dune ridges often includes Strandveld elements. All Sand Fynbos on site has at least a High sensitivity, and due to the fact that all 15 plant SCC recorded from the Sand Fynbos are found in the Northern Sand Fynbos this area has been classified as VERY HIGH sensitivity. Sand Fynbos is currently significantly underconserved on a national basis, and its rehabilitation potential is fairly low when compared to Strandveld.

Significance Statement:
The loss of about 2290ha of *Sand Fynbos* will definitely occur and will have a **very severe**, permanent impact. The environmental significance of this unmitigated impact will be HIGH NEGATIVE. This could be reduced to a MODERATE to HIGH NEGATIVE with mitigation (but without a biodiversity offset). With a suitable offset this could be reduced to LOW NEGATIVE.

Loss of Sand Fynbos					
Impact	Effect			**Risk or Likelihood**	**Overall Significance**
	Temporal Scale	Spatial Scale	Severity of Impact		
Without Mitigation	Permanent	Study Area	Severe	Definite	**HIGH-**
With Mitigation	Permanent	Study Area	Moderate - Severe	Definite	**MODERATE - HIGH-**
With Mitigation & Biodiversity Offset	Permanent	Study Area	Slight	Definite	**LOW -**

Mitigation and Management:

The following mitigation actions are required:

- Areas impacted by construction that are no longer required during the operational phase must be rehabilitated as soon as possible after cessation of disturbance;
- Topsoil of at last 300mm (0.3m) depth must be harvested from within all development footprints and used for rehabilitation purposes. This is regarded as the minimum depth required in order to include at least 60% of the bulbs (geophytes).
- No livestock should be allowed to graze in the approved mining area nor within a 500m buffer area (if such an area is located within the permit area) from six months after any authorization up until the mine closure permit is granted. Removal of livestock from the area will significantly enhance seed set and hence rehabilitation.
- Design and implement a Rehabilitation Management Plan.
- Rehabilitation targets must include a measurable element of botanical diversity. In other words the rehabilitation target for Sand Fynbos areas should be to return the mined areas to at least 60% of the pre-mining botanical diversity for this habitat.
- Ongoing, annual alien invasive vegetation management is required in the mined and rehabilitated areas until the mine closure permit is issued.
- East – west oriented wind fences will be required in the rehabilitation areas in order to minimise wind erosion, probably at an interval of every 5m, as at Namakwa Sands.
- The majority of the northern Namaqualand Sand Fynbos in the project area (as depicted on the map showing the proposed corridors – Figure 6.1) (equating to > 2 000 ha) must be set aside as a formal conservation area and managed as such for the duration of the project. It is recommended that discussions are undertaken with the Namaqua National Park with regards to incorporating this section into the Park. This may however, not be a viable option as there are limited linkages between the Park and the proposed project area.
- No livestock should be allowed to graze in the area demarcated as ecological corridors within the Roode Heuwel property, which will be owned by Zirco. It is recognised that it will not be possible to prevent grazing in the ecological corridors of Leeuvlei and Sabies, as Zirco do not own the surface rights to this land. The Roode Heuwel corridor is a critical area as it includes a large amount of Namaqualand Sand Fynbos. It must be managed as a conservation area so that this portion of Sand Fynbos would make a contribution towards the conservation of this important vegetation type. A 4600ha biodiversity offset for this project has been recommended, and the ecological corridor would contribute approximately 2000 ha (43%) towards this target. The figure of 4,600ha has been arrived at by using a 2:1 ratio of conservation: development land, which is the quantum recommended for Least Threatened habitats in the Biodiversity Offsets Guideline (DEADP 2009).
- Suitable high quality areas of Namaqualand Sand Fynbos in the region, adjacent to the Namaqua National Park, have been identified. These could potentially be purchased by the applicant and donated to the appropriate national conservation authorities, or leased to them via contract. This would effectively be a biodiversity offset that would help reduce the significant residual botanical impacts remaining after all the above mitigation has been factored in (Moderate – High negative). Approximately 9000ha of suitable land has been identified, made up of 11 cadastres, in three main areas (see Figure 7-2). It is

recommended that 2500ha of this would be required to offset all biodiversity impacts to either moderate or low. It is recommended that consideration be given to purchasing suitable portions and donating them to the Park, within five years of project approval. Given that there are numerous factors that may impact on what land is actually purchased (including landowner willingness) no recommendation is made at this stage in terms of which portions have to be purchased, but it should be within either of these three target areas. If this quantum of land can be added to the National Park then the overall significance of the loss of Sand Fynbos for this project could be reduced to LOW negative.

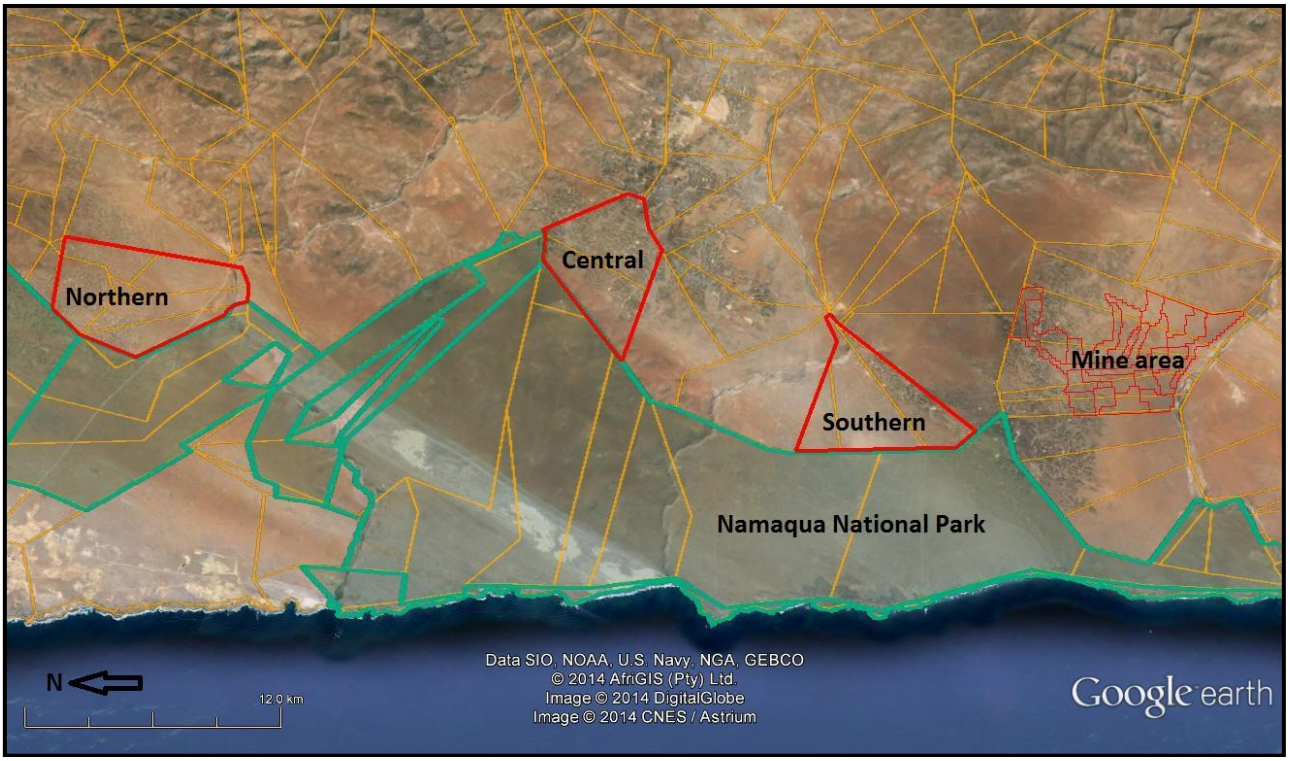


Figure 7.1: Map showing the three best proposed biodiversity offset options (red polygons) adjacent to the Namaqua National Park (green shaded area). Orange lines are cadastres.

Impact 3: Loss of Heuweltjieveld (Namaqualand Heuweltjieveld)

Cause and comment:
Heuweltjieveld may be found all along the eastern extent of Leeuvlei, and a large part of north-eastern Sabies. It generally occurs on undulating topography of the Kamiesberg escarpment foothills, and comprises largely succulent dwarf shrubland communities amongst a mosaic of heuweltjie communities. Degraded Heuweltjieveld occurs in the south eastern sections of Sabies adjacent to alluvial corridors. This vegetation type may be spectacular after good winter rains, when extensive displays of annuals, herbs and bulbs colour the landscape, and at that stage is capable of supporting a high diversity of insects, birds and other animals. The unit also supports isolated quartz patches, such as along the Outeep River, and these support many plant SCC, including at least two undescribed species new to science, which are not known to occur outside the study area.

The proposed mining footprint does not include any Heuweltjieveld. Prospecting and mining is unlikely to be undertaken to any great degree in this unit as it is not known to support any target minerals, but much of the anticipated impact is associated with possible prospecting in the few quartz patches.

Significance Statement:
The loss of significant areas of *Heuweltjieveld* is unlikely to occur and prospecting would have a medium *temporary to permanent* impact. The environmental significance of this unmitigated impact will be MEDIUM NEGATIVE. This could easily be reduced to LOW NEGATIVE with mitigation.

Loss of Heuweltjieveld					
Impact	Effect			Risk or Likelihood	Overall Significance
	Temporal Scale	Spatial Scale	Severity of Impact		
Without Mitigation	Temporary to Permanent	Study Area	Medium	Definite	**MEDIUM-**
With Mitigation	Temporary to Permanent	Study Area	Low	Definite	**LOW-**

Mitigation and Management:
The following mitigation actions are suggested:

- All Very High sensitivity areas (notably quartz patches) outside the proposed mining area should be treated as conservation areas and should not be subject to prospecting or mining.

Impact 4: Loss of Riparian Vegetation (Namaqualand Riviere)

Cause and comment:
Riparian areas consist largely of alluvial corridors of the Groen River in the south and Bitter River in the north, but also includes tributary alluvial drainage lines scattered largely in the eastern sections of Leeuvlei and Sabies, commencing in the Kamiesberg escarpment foothills and draining down to the larger river basins. The vegetation varies from *Acacia* thicket to alluvial halophytic shrublands. These areas serve as important corridors for bird species and are classified as areas of high sensitivity. The only impact on this vegetation type will be due to the routing of the main aboveground seawater pipeline (and probably an associated service track) across the Groen River, but impacts are likely to be limited to less than 2ha, and are covered under the construction phase impacts.

Significance Statement:
Very minor loss of *riparian vegetation* is likely (construction phase). The environmental significance of this impact will thus be LOW NEGATIVE, before and after mitigation.

Loss of Riparian Vegetation					
Impact	Effect			Risk or Likelihood	Overall Significance
	Temporal Scale	Spatial Scale	Severity of Impact		
Without Mitigation	Temporary	Study Area	Minor	Probable	**LOW-**
With Mitigation	Temporary	Study Area	Minor	Probable	**LOW-**

Mitigation and Management:
No specific mitigation required for this habitat in terms of mining, as it will not be impacted by mining.

Impact 5: Loss of Klipkop Shrubland (Namaqualand Klipkoppe Shrubland)

Cause and comment:
Klipkop Shrubland vegetation occurs as scattered communities surrounding rocky outcrops of the Kamiesberg escarpment foothills. These can be found in central Leeuvlei and northern Sabies. No SCC are likely to occur within the limited extent of this unit in the study area, but the unit was not surveyed extensively.

Significance Statement:
No loss of the *Klipkop Shrubland* is likely to occur. The environmental significance of this impact will thus be LOW NEGATIVE, before and after mitigation.

Loss of Klipkop Shrubland					
Impact	Effect			**Risk or Likelihood**	**Overall Significance**
	Temporal Scale	Spatial Scale	Severity of Impact		
Without Mitigation	Temporary	Study Area	Minor	Unlikely	**LOW-**
With Mitigation	Temporary	Study Area	Minor	Unlikely	**LOW-**

Mitigation and Management:
No specific mitigation required for this habitat in terms of the operational phase, as it will not be impacted by mining.

Impact 6: Loss of Seashore Dunes

Cause and comment:

Seashore Dunes occur as a belt along the coastline, above the high tide water mark, and on the seaward side of the Coastal Duneveld. Essentially it consists of Namaqualand Seashore Vegetation, but also includes transition zones of seashore vegetation occurring on white dune sands, which have taller shrubs, but are not considered part of the Coastal Duneveld. No mining will occur in this habitat, and loss would be caused by the installation of the seawater pump, pipe and associated facility, which would probably occupy less than 0.01ha. This is a construction phase impact and is covered under that section of the report.

Significance Statement:
The loss of *Seashore Dune* habitat will definitely occur and will have a **minor**, permanent impact. The environmental significance of this unmitigated impact will be LOW to MEDIUM NEGATIVE. With mitigation measures this can be reduced to LOW NEGATIVE.

Loss of Seashore Dunes					
Impact	Effect			**Risk or Likelihood**	**Overall Significance**
	Temporal Scale	Spatial Scale	Severity of Impact		
Without Mitigation	Permanent	Study Area	Moderate	Definite	**LOW to MEDIUM-**
With mitigation	Permanent	Study Area	Low	Definite	**LOW-**

Mitigation and Management:
No specific mitigation required for this habitat in terms of the operational phase, as it will not be impacted by mining (operational phase).

Impact 7: Loss of Coastal Duneveld

Cause and comment:
Coastal Duneveld is situated on the inland side of the Seashore Dunes, and gradually merges with Strandveld further inland. No SCC were recorded in this unit. The main seawater pipeline and associated access track will cross this habitat type, along with the Namaqualand Strandveld and the riverine habitat, but the routing thereof has not yet been finalised. Total habit loss is likely to be <5ha, but this will largely be at the construction phase. No mining (operational phase) will occur in this habitat.

Significance Statement:
The loss of the *Coastal Duneveld* will definitely occur and will have a l**ow - moderate**, permanent impact. The environmental significance of this unmitigated impact will be LOW TO MODERATE NEGATIVE. With mitigation measures this can be reduced to LOW NEGATIVE.

Loss of Coastal Duneveld					
Impact	Effect			**Risk or Likelihood**	**Overall Significance**
	Temporal Scale	Spatial Scale	Severity of Impact		
Without Mitigation	Permanent	Study Area	Low - Moderate	Definite	**LOW - MODERATE-**
With mitigation	Permanent	Study Area	Low	Definite	**LOW-**

Mitigation and Management:
No specific mitigation required for this habitat in terms of the operational phase, as it will not be impacted by mining.

7.5.5 Impacts Associated with Issue 2: Loss of Species of Conservation Concern

Impact 8: Loss of Species of Conservation Concern

Cause and comment:
Mining activities and the associated infrastructure will result in the loss of portions of the local subpopulations of at least 17 plant Species of Conservation Concern (SCC), as well as other species that are important to ecosystem functioning. Prospecting in the greater project area could potentially impact on a further six SCC, although the likelihood of this impact is much lower. Appendix 2 lists the SCC likely to be impacted by the proposed mining footprint, and in the possible prospecting areas, and the significance thereof for each species. Three species are of particular concern – *Lachenalia* sp nov (*arenicola* MS), *Agathosma elata* and *Lampranthus procumbens*.

Significance Statement:
The mining activities will definitely result in the loss of portions of local subpopulations of up to 17 plant SCC and this will have a **severe** permanent impact. The environmental significance of this unmitigated impact would be HIGH NEGATIVE. Standard mitigation measures may reduce this to a MODERATE - HIGH NEGATIVE impact, and if combined with the implementation of a suitable biodiversity offset this impact could be further reduced to LOW - MODERATE NEGATIVE.

Current Impacts					
Impact	Effect			**Risk or Likelihood**	**Overall Significance**
	Temporal Scale	Spatial Scale	Severity of Impact		
Without Mitigation	Permanent	Study Area	Severe	Definite	**HIGH-**
With Mitigation	Permanent	Study Area	Moderate	Probable	**MODERATE - HIGH-**
With Mitigation & Biodiversity Offset	Permanent	Study Area	Moderate	Probable	**LOW – MODERATE -**

Mitigation and Management:
The following mitigation actions are suggested:

- All bulbs (geophytes) of Conservation Concern in the mining area (notably *Lachenalia* sp nov/*arenicola*) should be subject to Search and Rescue in the winter to spring season (June – September) preceding any mining. These plants should be located by suitably qualified staff or consultants who can identify the species. The plants should be immediately translocated to a similar, suitable receiving environment that will not be disturbed by mining activities at any stage in the future.

- All succulents of Conservation Concern in the mining area (notably *Lampranthus procumbens*) should be subject to Search and Rescue in the autumn (April – May) preceding any mining. These plants should be located by suitably qualified staff or consultants who can identify the species. The plants should be immediately translocated to a similar, suitable receiving environment that will not be disturbed by mining activities at any stage in the future.
- A nursery should be set up in the project area to propagate all possible SCC from within the mining area, and the propagated plants should be returned to the post mining landscape about three years after initial rehabilitation has been completed. Planting out should take place after the first good winter rains, typically in May or June. Material for propagation should be sourced from the pre mining areas.
- The applicant should set aside undisturbed habitat that conserves at least 30% of the project area populations of all SCC recorded from the project area. Key areas in this regard include the ecological corridors (defined in Figure 6.2). These areas should be managed as conservation areas.
- A suitable biodiversity offset should be implemented within 5 years of any project approval, whereby at least 2500ha of natural habitat known to support the SCC is purchased by the applicant and added to the Namaqua National Park (either by donation or contract). The offset should be located within one of the three priority areas identified in Figure 7-2.

Impact 9: Fragmentation of vegetation and edge effects

Cause and comment:
Habitat fragmentation is potentially one of the most important impacts on the vegetation, and this also has knock on effects on the associated fauna. Fragmentation occurs wherever previously continuous vegetation is lost or degraded, and results in a reduction in the total gene pool and a decrease in species richness and diversity. Fragmentation results in the isolation of functional ecosystems, and results in reduced biodiversity and reduced movement due to the absence of ecological corridors. The site is currently unfragmented in about 90% of the area, with partial fragmentation due to clearing of agricultural lands and heavy grazing in about 10% of the total area. Many of these agricultural lands have been fallow for over a decade and are now partly rehabilitated (although most are heavily grazed, which reduces their rehabilitation potential). Edge effects relate to the proximity of natural vegetation to disturbed or mined areas, and these edges are often invaded by alien species, and may also be impacted by windblown dust, etc. It is acknowledged that less than 300ha will be mined at any one time, and that the remainder of the mining area blocks will either thus be undergoing rehabilitation or standing undisturbed, depending on the project phase, which will help reduce overall fragmentation of the site.

Significance Statement:
The mining activities will definitely result in habitat fragmentation and edge effects and this will have a **severe** permanent impact. The environmental significance of this unmitigated impact would be HIGH NEGATIVE. This will be reduced to MODERATE NEGATIVE with mitigation.

Current Impacts					
Impact	Effect			**Risk or Likelihood**	**Overall Significance**
	Temporal Scale	Spatial Scale	Severity of Impact		
Without Mitigation	Permanent	Study Area	Severe	Definite	**HIGH-**
With Mitigation	Permanent	Study Area	Moderate	Definite	**MODERATE-**

Mitigation and Management:
The following mitigation actions are suggested:

- Ongoing alien invasive vegetation management in the mining and project area for the duration of life of mine.

- Setting aside key representative portions of each vegetation type as conservation areas (as depicted in the proposed corridor map) within the project area.
- There must be a north-south corridor at least 300 m wide through the project area at all times. This corridor will be along the eastern side of Roode Heuwel during years 1-5 of mining and along the western edge of the project site once rehabilitation has been completed, for the remainder of the mine life.
- Best practise rehabilitation of mined areas as soon as feasible after cessation of mining of each block.
- Mining of only one block at a time (all blocks <300ha in extent), with concurrent rehabilitation of any previously mined blocks, and no disturbance of blocks that will only be mined in the future.

Impact 10: Increased dust levels on vegetation

Cause and comment:
Increased dust levels are common during construction and bush clearance and are also a major consequence of vehicular traffic, even on paved surfaces. Dust settling on adjacent vegetation can block plant photosynthesis, respiration and transpiration, in addition to causing physical injuries to plants (Farmer, 1993), but its most important impact probably relates to smothering of the anthers and stigmas of flowering plants and the consequent reduction in pollination success and seed set. Dust from road surfaces can also transport chemical pollutants to adjacent regions, thus affecting riparian ecosystems via impacts on water quality.

Significance Statement:
Dust levels will be raised during the construction and operation of the mine and will **definitely** have a **moderate,** long term impact. The environmental significance of this unmitigated impact would be MODERATE NEGATIVE. Mitigation measures will reduce the impact to a LOW NEGATIVE.

Current Impacts					
Impact	Effect			**Risk or Likelihood**	**Overall Significance**
	Temporal Scale	Spatial Scale	Severity of Impact		
Without Mitigation	Long Term	Study Area	Moderate	Definite	**MODERATE -**
With Mitigation	Short Term	Study Area	Slight	Probable	**LOW-**

Mitigation and Management:
The following mitigation actions are suggested:

- Haul roads and the heavy use areas around the main plant should be compacted and treated with dust inhibitors.
- Heavy vehicle speed limits on unpaved roads on site should be 40km/h.
- Wind fences should be erected at suitable intervals (probably every 5m) on all recently mined and rehabilitated areas.
- Only single blocks should be mined at any one time, with no block being bigger than 300ha.

Impact 11: Invasion of alien species

Cause and comment:
The removal of existing vegetation creates 'open' habitats that will inevitably be colonised by pioneer plant species. While this is part of a natural process of regeneration, which would ultimately lead to the re-establishment of a secondary vegetation cover, it also favours the establishment of undesirable species in the area. These species are introduced along transport lines, and by human and animal movements in the area. Once established, these species are typically very difficult to eradicate and may then invade, posing a threat to neighbouring habitats. The primary invasive alien species are likely to be *Atriplex lindleyi* ssp *inflata* (blasiebrak) and

Salsola kali (Russian tolbos), both already present in the area.

Significance Statement:
The mining activities will very probably result in the proliferation of alien invasive plants in the mining and project area, which will have a **moderate,** permanent impact. The environmental significance of this unmitigated impact would be MODERATE NEGATIVE. Mitigation measures could reduce the impact to a LOW NEGATIVE.

Current Impacts					
Impact	Effect			**Risk or Likelihood**	**Overall Significance**
	Temporal Scale	Spatial Scale	Severity of Impact		
Without Mitigation	Permanent	Study Area	Moderate	Very Probable	**MODERATE -**
With Mitigation	Permanent	Study Area	Slight	Probable	**LOW-**

Mitigation and Management:
The following mitigation actions are suggested:

- Prepare an Alien Management Plan, with ongoing, annual alien vegetation management throughout the project area, and in the mining area and along roads in particular.
- Eradicate alien invasive plants as they appear. Alien invasive plants should be stockpiled and burnt to destroy their seeds.
- Do not use any alien grasses (eg. *Lolium* - ryegrass) for rehabilitation purposes.
- Do not allow livestock on the mining site during the life of mine and for at least 10 years after mine closure, as livestock grazing will selectively remove the palatable species and leave the unpalatable species. The latter are typically the common, weedy species that dominate most disturbed areas, and once established are difficult to remove.
- Put in place environmentally acceptable procedures for waste management.
- Monitor the project area for any new invasive plant species, and remove them as they appear.

7.5.6 Decommissioning Phase

The decommissioning of the project could have a positive impact on the natural vegetation in the mining area, if the areas are restored to a near-natural state.

However, rehabilitating disturbed areas to a natural or near-natural condition may not meet the livelihood requirements of the project-affected communities, whose needs may be better served by allowing the area to be used for small stock grazing. In this case the decommissioning phase will probably result in a net loss of plant diversity, as natural vegetation will be altered by mining, followed by rehabilitation and grazing (further altering the natural species composition in favour of less palatable species), and thus this would be considered to be a negative ecological impact.

It is strongly recommended that livestock not be introduced into the mined and rehabilitated areas for at least ten years after initial rehabilitation has been completed on the last block to be mined. Removal of livestock will dramatically improve rehabilitation by allowing flowering and seed set for the more palatable species. It is recommended that the area be stocked with limited numbers of range appropriate game, and the possibility of tourist accommodation could be explored.

8. CONCLUSIONS AND RECOMMENDATIONS

8.1 CONCLUSIONS

The vegetation and habitat in the project area is generally in good condition, but the effects of stock and crop farming are evident in places, some land portions being significantly more overgrazed than others. In general the western parts are less heavily impacted by grazing than the eastern parts, and areas with goats are more heavily impacted than areas without. Most of the coastal section is in good condition, apart from old diamond camps and diggings, numerous tracks, and some kelp harvesting stockpile areas. Altogether some 25 plant Species of Conservation Concern (SCC) were recorded in the study area (17 in the mining area), including 6 species not yet formally named or described, and large scale mining could thus have a significant negative impact on some of these species and the overall flora if adequate mitigation is not put in place.

This report has:

1. Identified and mapped the main vegetation types and plant communities;
    - Five (5) key vegetation types occur on the Zirco prospecting area, namely:
        - **Strandveld** (Namaqualand Strandveld)
            - This unit often forms a complex mosaic with Sand Fynbos, and the ecotones (ecological transitions) may be very gradual. Six plant SCC were found in this unit, more than expected. The most significant was a very large population of *Leucoptera nodosa* (Vulnerable) comprising about 50% of the known population of this species (on Leeuvlei).
        - **Sand Fynbos** (Namaqualand Sand Fynbos)
            - This is the richest vegetation type in the study area in terms of number of threatened plant species, with no less than 15 SCC recorded, including two undescribed species, and a new record of the buchu *Agathosma elata* (Endangered), which was previously only known from the Vanrhynsdorp and Nardou area (150km to the southeast). The northern parts of this unit support all 15 SCC, whereas the southern parts have only 10 of the SCC in the unit. About 1100ha of the northern section of Sand Fynbos falls within the proposed mining footprint and about 2200ha of this vegetation unit in the project area lies outside the likely mining area (mainly to the northwest and northeast).
        - **Heuweltjieveld** (Namaqualand Heuweltjieveld)
            - The big surprise was a large quartz patch in this habitat near the Outeep river which yielded two undescribed vygie species, never previously recorded, and which appear to be restricted to this tiny area. This patch also yielded another four SCC, including some surprising range extensions.
        - **Riparian vegetation** (Namaqualand Riviere)
            - This unit is a seasonal wetland that varies from *Acacia* thicket to alluvial halophytic shrublands, and it provides an important corridors function for bird species. No plant SCC were found in this unit, and none are likely to occur here
        - **Klipkop Shrubland** (Namaqualand Klipkoppe Shrubland)
            - This unit provides important sites for local reptile populations, but no plant SCC were recorded in this vegetation unit, and none are likely to occur, mainly because it occupies only a very small part of the study area, and is very widespread outside the study area.
    - Two (2) key vegetation types occur within the coastal assessment area (Figures 4.3-4.6):
        - **Seashore Dunes**
            - Occurs as a belt along the coastline, above the high water mark, and on the seaward side of the Coastal Duneveld. Two SCC were recorded in this unit: *Helichrysum dunense* (Vulnerable) and *Oncosiphon schlechteri* (Endangered). The former occurs at proposed Gulley Intakes 1 and 4, and the latter at Gulley Intake 3.

- **Coastal Duneveld**
  - Is situated on the inland side of the Seashore Dunes, and eventually merges into Strandveld further inland. No SCC were recorded in this unit.

2. Identified and recorded the main plant species that occur within the concession area as well as the coastal assessment area;
   - A full list of plant species recorded in the area is presented in Appendix 1, and totals 270 species. Given the size of the study area, and the fact that only two site visits were undertaken, not all species are likely to have been recorded, but it is estimated that at least 80% of the species present have been recorded.

3. Identified plant SCC;
   - The area supports at least 25 plant SCC, a surprisingly high number, which includes at least 6 species not yet formally named or described. Two of these were previously unknown species that appear to be restricted to a very small part of the study area (near the Outeep river in the northeast, on Leeuvlei).

4. Described the likelihood of other SCC occurring in the vicinity;
   - There is a medium likelihood that a few (<5) additional SCC would be found in the study area if additional fieldwork was undertaken at different times of the year.

5. Assessed the extent of alien plant species over the site, and associated risks of alien invasion as a result of the mining project;
   - See section 4.3

6. Identified significant landscape features or rare or important vegetation/faunal associations such as seasonal wetlands, seeps or rocky areas that might support rare or important vegetation/faunal associations;
   - Various areas or features of particular conservation concern have been identified in the project area, all of which should ideally be avoided during mining operations. These features are:
   - Wetlands and rivers
   - Steep slopes, rocky areas and areas with shallow soils, including the Soutfontein calcrete outcrops (on Leeuvlei)
   - The northern Sand Fynbos area (mainly on Roode Heuvel)
   - Outeep quartz patches (on Leeuvlei)
   - Shelly coastal platform at Gulley Intake 3
   - Dunes at Gulley Intake 1
   - The main population of *Leucoptera nodosa* (on Leeuvlei)

It should be possible to avoid impacting these areas from mining, with the exception of about 1100ha of the northern Sand Fynbos area.

7. Placed the project area within the biodiversity context of the wider area;
   - See section 4.1, as well as sections 5.2-5.5.

8. Provided a sensitivity map of the concession and coastal assessment areas in order for the proponent to better place the layout of the project infrastructure.
   - Refer to Chapter 6.

8.2 RECOMMENDATIONS

1. Mine construction phase planning should, as far as possible, be informed by the botanical sensitivity mapping, so as to minimize what could otherwise be very significant negative botanical impacts. Where possible, discretionary facilities (those that are not tied to any particular area) should be located in areas of lowest sensitivity.

2. All Very High sensitivity areas shown in Figure 6.2, with the exception of the small portion of Klipkop Shrubland that may be impacted upon by mining activities in the southern section of Leeuvlei, should be treated and managed as conservation areas and should not be subject to prospecting or mining.

3. All High sensitivity areas that have been incorporated into the proposed ecological corridors, especially areas covered by northern Sand Fynbos, should be treated and managed as conservation areas and should not be subject to prospecting or mining.

4. All Very High and High sensitivity areas not subject to mining (specifically on the Roode Heuwel Prospecting Area) should be offered to the Namaqua National Park, presumably after mining has ceased, but the northwestern areas (adjacent to the Park) should be offered as soon as possible,. Areas of Very High and High sensitivity should also be offered to the NNP, if the land is acquired and mining proceeds at a later stage.

5. Provided that the Namaqualand Strandveld and Namaqualand Heuweltjieveld areas within the total project area are treated and managed as conservation areas for the full Life of Mine no additional offset is required for these habitats, as significantly more than double the habitat area (for these two vegetation types) likely to be impacted by mining will be conserved within the project area.

6. Suitable high quality areas of Namaqualand Sand Fynbos in the region, adjacent to the Namaqua National Park, have been identified. These could potentially be purchased by the applicant and donated to the appropriate national conservation authorities, or leased to them via contract. This would effectively be a biodiversity offset that would help reduce the significant residual botanical impacts remaining after all the above mitigation has been factored in (Moderate – High negative). Approximately 9000ha of suitable land has been identified, made up of 11 cadastres, in three main areas (see Figure 7-2). It is recommended that 2500ha of this would be required to offset all biodiversity impacts to either moderate or low. It is recommended that consideration be given to purchasing suitable portions and donating them to the Park, within five years of project approval. Given that there are numerous factors that may impact on what land is actually purchased (including landowner willingness) no recommendation is made at this stage in terms of which portions have to be purchased, but it should be within either of these three target areas. If this quantum of land can be added to the National Park then the overall significance of the loss of Sand Fynbos for this project could be reduced to LOW negative.

7. There must be a north-south corridor at least 300 m wide through the project area at all times. This corridor will be along the eastern side of Roode Heuvel during years 1-5 of mining and along the western edge of the project site once rehabilitation has been completed, for the remainder of the mine life. This corridor is particularly important in the case of the primary target habitat – Namaqualand Sand Fynbos. This vegetation type has a north – south regional distribution, through the western half of the study area (mainly on Roode Heuvel), and it is part of a largely continuous strip of habitat that runs from northeast of Hondeklipbaai in the north to the Olifants River in the south. Complete severance of this currently largely intact habitat through open cast mining across its width is not desirable from an ecological perspective (Desmet & Helme 2009). The corridors need to be of sufficient width to allow the potential natural movement of most faunal and plant species, and the wider the better in terms of functionality. The corridor will also function as a vital repository of rehabilitation material (seeds) for the post mining phase. This will significantly enhance rehabilitation success, and

will also help limit wind erosion. A large part of the Sand Fynbos in the area also occurs on the property to the west of Roode Heuvel, owned by and currently being prospected by Exxaro, which suggests that mining may take place here at some stage in the future, severely compromising the corridor potential in the region. It is thus essential that both operations take corridors into account on their own land in order to avoid total loss of the north – south link in this area. The position, shape and extent of the corridor/s are fairly flexible, but need to be worked into mine planning.

8. A significant buffer should be maintained along the part of the study area that borders the existing edge of the Namaqua National Park (northwestern corner of Roode Heuvel). Ideally this should be at least 5000m wide, and wider according to the Mining and Biodiversity Guidelines; but in reality this is not likely to be more than 3200m. This could serve a triple purpose as the main north – south ecological corridor, and would also conserve a large part of the northern Sand Fynbos area with at least 15 plant SCC.

9. Primary processing takes place on or near site and involves washing with seawater. This will lead to a significant increase in the salinity of the soil returned to the areas requiring rehabilitation. This will compromise the rehabilitation potential of Namaqualand Sand Fynbos (Desmet & Helme 2003), which prefers acidic soils. Studies at Namakwa Sands have found that high soil salinity poses a challenge during rehabilitation (reducing species diversity), especially if rainfall is below average (and natural leaching is thus reduced). It is therefore recommended that topsoil of at least 300mm depth (0.3m) be set aside for rehabilitation purposes, as this will then retain its original pH, and will also include the bulk of the soil stored seedbank (including most of the bulbs, which are more deeply buried than most of the seeds). Furthermore, the top 2 metres of tailings returned to the surface after mining must be sand tailings only, as any clay will assist in the retention of salt.

10. All livestock should be removed from the total authorized mining area and a 500m buffer area around it (except where this is not feasible due to land ownership) from six months after any initial authorisation, throughout the life of the mine, and for at least ten (10) years after primary rehabilitation is completed on any particular block. Livestock preferentially eat the most tender flowering parts (including seeds), and also target annuals, such as grasses and herbs. The latter are often pioneers, which would normally be the first to stabilize a disturbed area and provide habitat for the longer lived shrubs. Thus, by removing livestock one maximizes the available seed bank, and hence the rehabilitation potential. It is the cheapest and easiest way of enhancing rehabilitation success.

11. Livestock should, for the same reason, also be removed form the total project area (which will presumably be owned by the applicant) for the entire life of mine.

12. The coastal seawater intake should be located at either Gulley Intakes 2, 6 or 7, which are of the lowest sensitivity and do not support any plant SCC. If neither of these is suitable for any reason there are also many potentially suitable gulleys with low sensitivity adjacent vegetation just north of Island Point (Gulley Intake Kmm5), and the botanist can advise on these. Intake site Kmm4 does support a population of a single plant SCC, but the area has good rehabilitation potential and could be considered for development. Intake sites 1 and 3 contain high sensitivity botanical elements and should not be further considered.

13. The seawater pipeline should be an above ground pipeline if possible, as this entails significantly less disturbance than an underground pipeline. Frequent crossing zones should be incorporated to allow stock and wildlife movement. At this stage the exact route of the pipeline is not known and thus no further mitigation can be suggested.

14. Botanical input into the mine EMP is required, and specifically in terms of site rehabilitation and management of the surrounding areas that will not be developed.

15. All additional mitigation requirements (such as Search and Rescue for certain SCC, and alien invasive vegetation management) noted in Section 7 should be considered mandatory, as they are considered reasonable and feasible, and have been factored into the assessments.

9. REFERENCES

Apps, P. 2000. Smithers' Mammals of Southern Africa: A field guide. Struik Publishers

Barnes, K. N. (ed.) 2000. The Eskom Red Data Book of Birds of South Africa, Lesotho and Swaziland. Birdlife South Africa.

Barnes, K. N. Johnson, D. J., Anderson, M. D. and Taylor, P. B. 2001. South Africa. Pages 793-876 in L. D, C. Fishpool and M. I. Evans (Eds). Important bird areas in Africa and associated islands: priority sites for conservation. Pisces Publications and Birdlife International, Newbury and Cambridge, UK.

Bates, M.F., Branch, W.R., Bauer, A.M., Burger, M., Marais, J., Alexander, G.J. & de Villiers, M. (eds.). In Press. *Atlas and Red List of the Reptiles of South Africa, Lesotho and Swaziland*. South African National Biodiversity Institute, Pretoria.

BirdLife International. 2013. Country profile: South Africa. Available from: http://www.birdlife.org/datazone/country/south-africa. Checked: 2013-03-04

Blaustein, A. R. and D. B. Wake. 1990. Declining amphibian populations - a global phenomenon. Trends in Ecology & Evolution 5:203-204.

Böhm, M., Collen, B., Baillie, J.E.M., Bowles, P., et al. 2013. The conservation status of the world's reptiles. Biological Conservation 157: 372-385.

Branch, W.R. 1998. Field Guide to the Snakes and other Reptiles of Southern Africa. Rev. ed. Struik Publ., Cape Town, 399pp.

Channing, A. and Wahlberg, K. 2011. Distribution and conservation status of the desert rain frog Breviceps macrops , African Journal of Herpetology,DOI:10.1080/21564574.2011.608383

DEA. 2011. Threatened Terrestrial Ecosystems in South Africa. *Government Gazette* Vol. 1002: No. 34809. National Printer, Pretoria.

Department of Environmental Affairs, Department of Mineral Resources, Chamber of Mines, South African Mining and Biodiversity Forum, and South African National Biodiversity Institute. 2013. *Mining and Biodiversity Guideline: Mainstreaming biodiversity into the mining sector*. Pretoria.

Desmet, P. G. and N. Helme. 2003. Namakwa Sands: Description of the vegetation of the expanded Brand se Baai mine site. Unpublished baseline report for CCA, Cape Town. Nick Helme Botanical Surveys, Scarborough.

Desmet, P. G. and N. Helme. 2005. Impact Assessment of proposed EMPR amendment for Namakwa Sands, Brand se Baai: Vegetation. Unpublished report for Golder Associates, Johannesburg. Nick Helme Botanical Surveys, Scarborough.

Desmet, P.G. 2007. Namaqualand – A brief overview of the physical and floristic environment. Journal of Arid Environments: Volume 70, Issue 4, Pages 570 – 586.

Desmet, P.G., Turner, R. C. and Helme, N. A. 2009. Namaqua Sands Regional Context Vegetation Study. Report for Golder Associates Africa, Halfway House, South Africa.

de Wet, L., Phillipson, P., and Davenport, N. Toliara Sands Project - Madagascar: Botanical Specialist Report. Coastal & Environmental Services. August 2012 CES, Grahamstown.

Driver, A., Desmet, P.G., Rouget, M., Cowling, R.M. & Maze, K. 2003. Succulent Karoo Ecosystem

Plan: Biodiversity component Technical Report. Cape Conservation Unit Report No. CCU 1/03, Botanical Society of South Africa.

Du Preez, L.H. and Carruthers, V.C. 2009. A Complete Guide to the Frogs of Southern Africa. Struik Publ., Cape Town, 488pp

Fey, M. 2010. Soils of South Africa. Cambridge University Press, Cape Town.

Frost, Darrel R. 2013. Amphibian Species of the World: an Online Reference. Version 5.6 (9 January 2013). Electronic Database accessible at http://research.amnh.org/herpetology/amphibia/index.html. American Museum of Natural History, New York, USA.

Helgen, K. M. and Wilson, D. E. 2001. Additional Material of the Enigmatic Golden Mole Cryptochloris zyli, With Notes on the Genus Cryptochloris (Mammalia: Chrysochloridae). African Zoology, 36(1): 110-112.

Helme, N.A. & Raimondo, D. 2005. *Eriospermum arenosum* P.L.Perry. National Assessment: Red List of South African Plants version 2013.1. Accessed on 2013/03/12

Helme, N.A. & Raimondo, D. 2005. *Manulea cinerea* Hilliard. National Assessment: Red List of South African Plants version 2013.1. Accessed on 2013/03/11

Helme, N.A. & Raimondo, D. 2005. *Wahlenbergia asparagoides* (Adamson) Lammers. National Assessment: Red List of South African Plants version 2013.1. Accessed on 2013/03/12

Helme, N.A. & Raimondo, D. 2006. *Helichrysum dunense* Hilliard. National Assessment: Red List of South African Plants version 2013.1. Accessed on 2013/03/11

Helme, N.A., Boatwright, J.S. & Raimondo, D. 2008. *Calobota lotononoides* (Schltr.) Boatwr. & B.-E.van Wyk. National Assessment: Red List of South African Plants version 2013.1. Accessed on 2013/03/12

Helme, N.A., Raimondo, D. & von Staden, L. 2013. *Muraltia obovata* DC. National Assessment: Red List of South African Plants version 2013.1. Accessed on 2013/03/11

IUCN 2012. IUCN Red List of Threatened Species. Version 2012.2. <www.iucnredlist.org>. Downloaded on 04 March 2013.

Koopman, R. & von Staden, L. 2012. *Ferraria ornata* Goldblatt & J.C.Manning. National Assessment: Red List of South African Plants version 2013.1. Accessed on 2013/03/12

Lebert, T (2004) Municipal Commonage as a form of Land Redistribution: A case study of the new farms of Leliefontein, a communal reserve in Namaqualand, South Africa. Programme for Land and Agrarian Studies November 2004. Research Report No. 18

Measey, G. J. (ed.). 2011. Ensuring a future for South Africa's Frogs: A strategy for conservation research. *SANBI Biodiversity Series:* 19. South African National Biodiversity Institute, Pretoria.

Minter, L., M. Burger., J. Harrison, H. Braack, P. Bishop and D. Kloepfer (eds.) 2004. Atlas and Red Data Book of the Frogs of South Africa, Lesotho and Swaziland. *SI/MAB Series #9.* Smithsonian Institution, Washington, DC.

Mucina, L. & Rutherford, M.C. (eds) 2006. The vegetation of South Africa, Lesotho and Swaziland. Strelitzia 19. South African National Biodiversity Institute, Pretoria

Phillips, K., 1994. Tracking the vanishing frogs. Penguin Books, New York, 244.

Raimondo, D., Von Staden, L., Foden, W., Victor, J.E., Helme, N.A., Turner, R.C., Kamundi, D.A., and Manyama, P.A. (eds.) 2009. Red List of South African Plants 2009. *Strelitzia 25*. South African National Biodiversity Institute, Pretoria.

Rouget, M., Reyers, B., Jonas, Z., Desmet, P., Driver, A., Maze, K., Egoh, B. & Cowling, R.M. 2004. *South African National Spatial Biodiversity Assessment 2004: Technical Report. Volume 1: Terrestrial Component.* Pretoria: South African National Biodiversity Institute.

Sliwa, A. 2008. Felis nigripes. In: IUCN 2012. IUCN Red List of Threatened Species. Version 2012.2. <www.iucnredlist.org>. Downloaded on 04 March 2013.

Snijman, D.A (ed.). 2013. Plants of the Greater Cape Floristic Region 2: The Extra Cape Flora. *Strelitzia 30.* South African National Biodiversity Institute; Pretoria.

Victor, J.E. & Smith, G.F. 2004. *Aloe arenicola* Reynolds. National Assessment: Red List of South African Plants version 2013.1. Accessed on 2013/03/11

von Staden, L. 2008. *Aloe krapohliana* Marloth. National Assessment: Red List of South African Plants version 2013.1. Accessed on 2013/03/12

von Staden, L. 2008. *Aloe microstigma* Salm-Dyck subsp. *framesii* (L.Bolus) Glen & D.S.Hardy. National Assessment: Red List of South African Plants version 2013.1. Accessed on 2013/03/12

von Staden, L. 2012. *Ferraria flava* Goldblatt & J.C.Manning. National Assessment: Red List of South African Plants version 2013.1. Accessed on 2013/03/12

World Conservation Monitoring Centre. 1996. *Bitis schneideri*. In: IUCN 2006. *2006 IUCN Red List of Threatened Species.* URL: www.iucnredlist.org. Downloaded on 11 June 2007.

Zirco Resources (SA) Pty Ltd, 2012. Geological update on the Kamiesberg Heavy Minerals Sands project.

10. APPENDIX 1: LIST OF PLANT SPECIES RECORDED AT ROODE HEUWEL

Species	Namaqualand Sand Fynbos	Namaqualand Strandveld	Hardeveld	Coastal fringe	Only seen in proposed mining area	Red List Status
Acanthopsis carduifolia						
Adenogramma mollugo						
Agathosma elata						EN
Albuca grandis						
Albuca secunda						
Aloe krapohliana						DDD
Amphibolia laevis						
Amphiglossa tomentosa						
Antimima sp						
Arctotis decurrens						
Arctotis sp nov 1.(perennial, orange)						STBA
Arctotis sp nov 2 (rubrosabulosa MS)						
Argyrolobium velutinum						EN
Aspalathus albens						VU
Aspalathus cuspidata						
Aspalathus quinquefolius						
Aspalathus spinescens ssp lepida						
Asparagus aethiopicus						
Asparagus alopecurus						
Asparagus capensis						
Asparagus exuvialis						
Asparagus rubicundus						
Babiana brachystachys						
Babiana confusa						
Babiana grandiflora						
Babiana hirsuta						
Babiana sinuata						
Berkheya fruticosa						
Boophone haemanthoides						
Brassica tournefortii						

Species	Namaqualand Sand Fynbos	Namaqualand Strandveld	Hardeveld	Coastal fringe	Only seen in proposed mining area	Red List Status
Brownanthus sp						
Brunsvigia bosmaniae						
Calobota angustifolia						
Caesia sabulosa						VU
Calobota lotononoides						NT
Calobota sericea						
Cephallophyllum aff framesii						
Cheiridopsis sp nov						STBA
Chlorophytum viscosum						
Chrysocoma longifolia						
Chrysocoma ciliata						
Chrysocoma sp						
Cissampelos capensis						
Cladoraphis cyperoides						
Cleretum bellidiformis						
Cleretum rourkei						
Cliffortia juniperina						
Cliffortia teretifolia						
Clutia daphnoides						
Clutia aff polifolia						
Conicosia elongata						
Conicosia pugioniformis						
Conophytum pageae						
Corycium crispum						
Cotula thunbergii						
Cotyledon orbiculata						
Crassula deceptor						
Crassula expansa						
Crassula muscosa						
Crassula nudicaulis						
Cyanella orchidiformis						
Cytinus sanguineus						
Dicrocaulon ramulosum						

Species	Namaqualand Sand Fynbos	Namaqualand Strandveld	Hardeveld	Coastal fringe	Only seen in proposed mining area	Red List Status
Dicrocaulon sp 1						
Dicrocaulon sp 2						
Didelta carnosa						
Dimorpotheca pinnata						
Dimorpotheca pluvialis						
Dimorpotheca tragus						
Diosma ramosissima						
Diospyros austro-africana						
Dischisma spicata						
Drosanthemum sp						
Drosanthemum salicola						
Ehrharta barbinodis						
Ehrharta calycina						
Elegia sp nov						STBA
Elytropappus rhinocerotis						
Eriocephalus africanus var paniculatus						
Eriocephalus racemosus						
Eriospermum arenosum						VU
Eriospermum paradoxum						
Eriospermum sp						
Euclea tomentosa						
Euphorbia burmanii						
Euphorbia caputmedusae						
Euphorbia tenax						
Euphorbia tuberosa						
Euryops tenuissimus						
Felicia australis						
Felicia dregei						
Felicia filifolia						
Felicia hyssopifolia						
Ferraria flava						
Ficinia argyropa						
Ficinia deusta						

Species	Namaqualand Sand Fynbos	Namaqualand Strandveld	Hardeveld	Coastal fringe	Only seen in proposed mining area	Red List Status
Ficinia indica						
Frankenia pulverulenta						
Galenia africana						
Galenia fruticosa						
Galenia sarcophylla						
Galium capense						
Gazania tenuifolia						
Gethyllis britteniana						
Gethyllis ciliaris						
Gladiolus carinatus						
Gloveria integrifolia						
Gnidia clavata						
Grielum grandiflorum						
Grielum humifusum						
Gymnosporia buxifolia						
Hebebstreitia cordata						
Hebensreitia sp						
Helichrysum dunense						VU
Helichrysum tricostatum						NT
Helichrysum sp						
Heliophila cornuta						
Heliophila crithmifolia						
Heliophila juncea						
Heliophila sp						
Hermannia cuneifolia						
Hermannia heterophylla						
Hermannia scordifolia						
Hermannia sp nov						STBA
Hermannia trifurca						
Hessea pilosula						
Hirpicium alienatum						
Hoplophyllum spinosum						
Hyobanche glabrata						

Species	Namaqualand Sand Fynbos	Namaqualand Strandveld	Hardeveld	Coastal fringe	Only seen in proposed mining area	Red List Status
Hypertelis angrae pequenae						
Indigofera meyeriana						
Isolepis sp						
Jacobsenia sp nov						STBA
Jordaaniella cuprea						
Jordaaniella spongiosa						
Justicia cuneata						
Kedrostis psammophila						
Lachenalia anguinea						
Lachenalia mutabilis						
Lachenalia punctata						
Lachenalia splendida						
Lachenalia sp nov						STBA
Lachenalia undulata						
Lampranthus procumbens						VU
Lampranthus stipulaceus						
Lapeirousia arenicola						
Lebeckia ambigua						
Leucadendron brunioides ssp bruniodes						
Leucoptera nodosa						VU
Leucospermum rodolentum						VU
Limeum africanum						
Limeum fenestratum						
Limonium sp nov (dagmarae MS)						
Lobostemon cinereus						
Lotononis sp						
Lycium strandveldense						
Lyperia tristis						
Manulea altissima						
Melianthus elongatus						
Mesembryanthemum crystallinum						
Mesembryanthemum rapaceum						
Metalasia adunca						NT

Species	Namaqualand Sand Fynbos	Namaqualand Strandveld	Hardeveld	Coastal fringe	Only seen in proposed mining area	Red List Status
Metalasia densa						
Microloma sagittatum						
Mollugo cerviana						
Mollugo pusilla						
Monechma spartioides						
Monilaria chrysoleuca						
Monsonia spinosa						
Muraltia obovata						VU
Muraltia spinosa						
Nemesia anisocarpa						
Nemesia ligulata						
Nenax arenicola						
Nestlera biennis						
Odyssea paucinervis						
Oncosiphon schlechteri						EN
Oncosiphon suffruticosus						
Ornithogalum multifolium						
Ornithoglossum viride						
Osteospermum grandiflorum						
Osteospermum incanum						
Othonna aff. Hederifolia						
Othonna arbuscula						
Othonna coronopifolia						
Othonna cuneata						
Othonna cylindrica						
Othonna lepidocaulis						Rare
Othonna leptodactyla						
Othonna retrofracta						
Othonna sedifolia						
Othonna undulosa						
Oxalis flava						
Oxalis gracilis						
Oxalis hirta						

Species	Namaqualand Sand Fynbos	Namaqualand Strandveld	Hardeveld	Coastal fringe	Only seen in proposed mining area	Red List Status
Oxalis purpurea						
Pelargonium caroli-henrici						Rare
Pelargonium fulgidum						
Pelargonium gibbosum						
Pelargonium senecioides						
Pelargonium triste						
Pharnaceum lanatum						
Pharnaceum microphyllum						
Phylica sp						
Phyllobolus sp						
Phyllobolus tenuiflorus						VU
Phyllopodium pumilum						
Psammotropha quadrangularis						
Psilocaulon sp						
Pteronia divaricata						
Pteronia onobromoides						
Pteronia ovalifolia						
Pteronia pallens						
Restio macer						
Rhynchopsidium pumilum						
Romulea tabularis						
Ruschia fugitans						
Ruschia goodiae						
Ruschia small fls						
Ruschia subpaniculata						
Ruschiella lunulata						
Salvia africana lutea						
Salvia lanceolata						
Searsia leavigata						
Searsia longispina						
Selago						
Senecio alooides						
Senecio arenarius						

Species	Namaqualand Sand Fynbos	Namaqualand Strandveld	Hardeveld	Coastal fringe	Only seen in proposed mining area	Red List Status
Senecio bulbinifolia						
Senecio littoreus						
Senecio sarcoides						
Spergularia media						
Sporobolus virginicus						
Stipagrostis ciliata						
Stipagrostis obtusa						
Stipagrostis zeyheri						
Stoebe nervigera						
Stoeberia frutescens						
Stoeberia utilis						
Tetragonia echinata						
Tetragonia fruticosa						
Thamnochortus bachmanii						
Thesium elatior						
Thesium polycephalum						
Thesium spinosum						
Thesium strictum						
Trachyandra arenicola						
Trachyandra divaricata						
Trachyandra falcata						
Tribolium hispidum						
Trichogyne repens						
Tripteris clandestina						
Tripteris nordenstamii						
Tripteris oppositifolia						
Tripteris sp						
Tylecodon ventricosus						
Ursinia speciosa						
Wachendorfia multiflora						
Wahlenbergia asparagoides						VU
Watsonia meriana						
Wiborgia aff monoptera						

Species	Namaqualand Sand Fynbos	Namaqualand Strandveld	Hardeveld	Coastal fringe	Only seen in proposed mining area	Red List Status
Wiborgia obcordata						
Wiborgia fusca						
Willdenowia arescens						
Willdenowia incurvata						
Zaluzianskya affinis						
Zygophyllum cuneifolium						
Zygophyllum morgsana						
Zygophyllum cordifolium						
Zygophyllum spinosa						

11. APPENDIX 2: LIST OF PLANT SPECIES RECORDED IN THE PROJECT AREA AND THE REGIONAL SIGNIFICANCE

Species	Red List Status	% of known population in proposed mining area	% of known population in project area (excl mine area)	Significance of mining area population	Significance of prospecting area population
Agathosma elata	EN	10	2	MEDIUM	LOW
Aloe krapohliana	DDD	0	2	LOW	LOW
Arctotis sp nov (orange perennial)	STBA	5	0	LOW	LOW
Argyrolobium velutinum	EN	5	10	LOW - MEDIUM	LOW - MEDIUM
Aspalathus albens	VU	2	5	LOW	LOW
Caesia sabulosa	VU	2	2	LOW	LOW
Calobota lotononoides	NT	5	2	LOW	LOW
Cheiridopsis sp nov	STBA	0	100	LOW	VERY HIGH
Elegia sp nov	STBA	5	30	MEDIUM	HIGH
Eriospermum arenosum	VU	3	2	LOW - MEDIUM	LOW
Helichrysmum tricostatum	NT	2	2	LOW	LOW
Hermannia sp nov	STBA	3	3	LOW	LOW
Jacobsenia sp nov	STBA	0	100	LOW	VERY HIGH
Lachenalia sp nov (arenicola)	STBA	5	1	MEDIUM	LOW
Lampranthus procumbens	VU	20	10	HIGH	MEDIUM
Leucoptera nodosa	VU	1	20	LOW	HIGH
Leucospermum rodolentum	VU	2	5	LOW	MEDIUM
Metalasia adunca	NT	2	2	LOW	LOW
Muraltia obovata	VU	5	5	LOW - MEDIUM	LOW - MEDIUM
Othonna lepidocaulis	Rare	0	25	LOW	VERY HIGH
Pelargonium caroli-henrici	Rare	0	10	LOW	MEDIUM
Phyllobolus tenuiflorus	VU	0	10	LOW	MEDIUM
Wahlenbergia asparagoides	VU	2	3	LOW	LOW