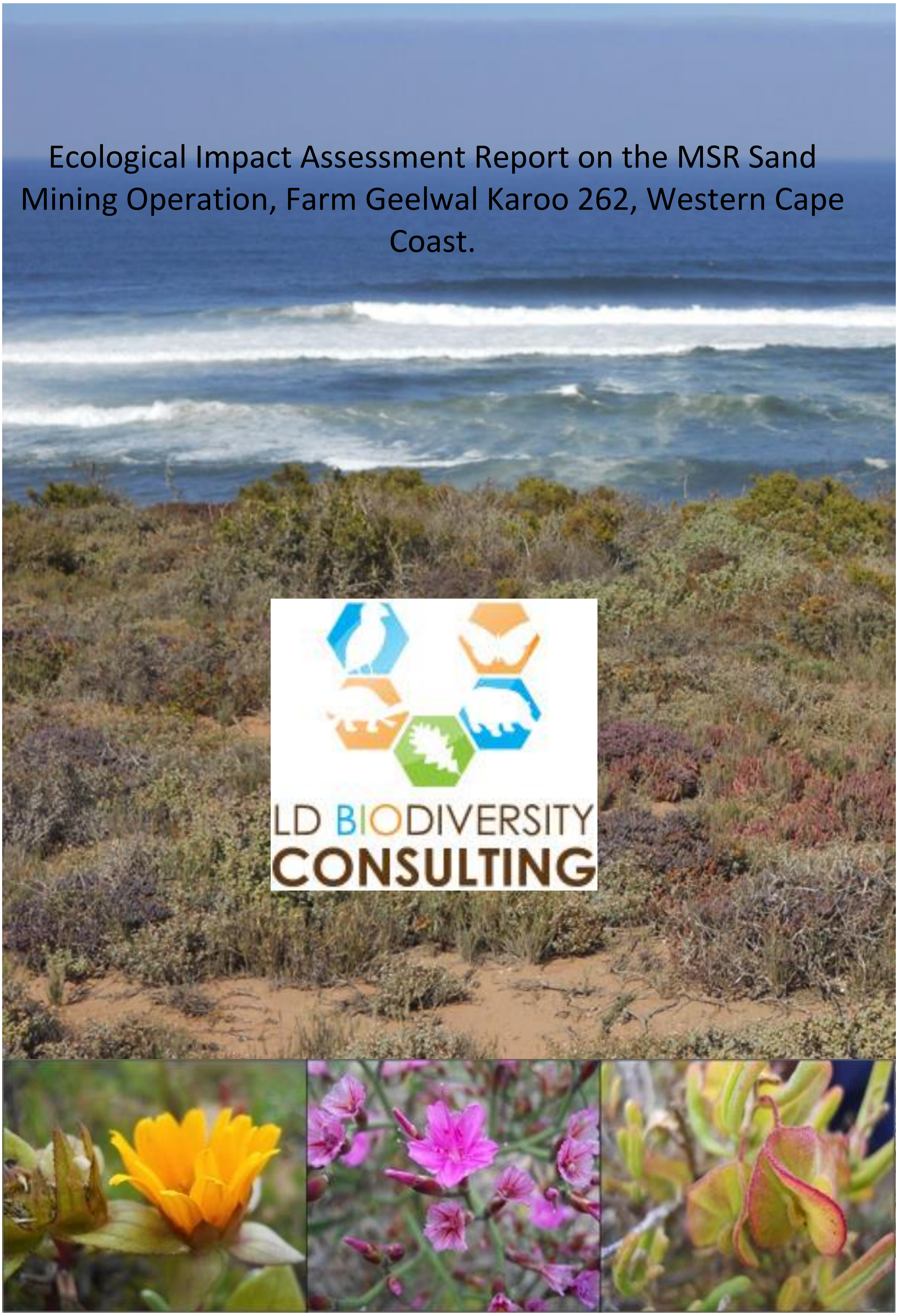
Ecological Impact Assessment Report on the MSR Sand Mining Operation, Farm Geelwal Karoo 262, Western Cape Coast.



Ecological Impact Assessment Report on the MSR Sand Mining Operation, Farm Geelwal Karoo 262, Western Cape Coast.

Prepared by

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(M.Sc., Pri. Sci. Nat)

For

MSR

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LD Biodiversity Consulting
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Appointment of Specialist
Leigh-Ann de Wet (LD Biodiversity Consulting) was commissioned by MSR to undertake an ecological impact assessment incorporating all previous ecological work for the MSR mining site in the Western Cape. Terms of reference were to review and summarize all available information from past ecological studies, as well as applying knowledge gained from a further brief site visit. Impacts, mitigation and management measures were required to be updated, along with the inclusion of additional background information where needed.

Details of Specialist
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Expertise of the specialist

- M.Sc. in Botany from Rhodes University, currently working on a PhD through Wits on Ecological Impact Assessment.
- Registered Professional Natural Scientist with the South African Council for Natural Scientific Professionals (Ecological Science).
- Registered with RSPO as a certified High Conservation Value Assessor (Plants).
- Founded LD Biodiversity Consulting in 2014.
- Ecological Consultant since 2009.
- Conducted, or have been involved in over 100 Ecological Impact Assessments, Baseline surveys, Biodiversity Action Plans and Offset Plans.
- Published four scientific papers, two popular articles and have three scientific papers in preparation.
- Presented 7 international conference presentations, and at two Botanical Society meetings.
- Lectured methods for specialist assessment for the Rhodes University short course on EIA.

Independence
Leigh-Ann de Wet and LD Biodiversity Consulting have no connection with MSR, and LD Biodiversity Consulting is not a subsidiary of any kind of MSR. The renumeration for services by MSR in relation to this report and associated studies is unrelated to approval by decision-making authorities responsible for authorization of any MSR activity. LD Biodiversity Consulting has no interest in secondary developments as a result of authorization of this proposed project. The percentage of work received directly or indirectly from MSR in the last twelve months is 0%.

Scope and Purpose of Report

The scope and purpose of the report is described in the section on Terms and Reference within this report.

Indemnity and Conditions Relating to this Report

The findings, results, observations, conclusions and recommendations given in this report are based on the author's best scientific and professional knowledge as well as available information. LD Biodiversity Consulting and its staff reserve the right to modify aspects of the report including the recommendations if and when new information may become available from ongoing research or further work in this field, pertaining to this investigation.

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Executive Summary

MSR plans to increase the footprint area of the plant site and road already existing in the Strandveld on the coastal plain of the west coast where they are mining the beach sand. The region has already been studied for the Environmental Impact Assessment submitted for the development, including the mining of the sand along the coast. This report serves as a summary of the ecological reports that have already been written for the area, as well as a brief update on those reports. Where possible, additional information has been added to enhance the theoretical framework for the ecological assessment.

The impacts of the MSR mining activities as well as the plant, roads and associated infrastructure are relatively small. The processing also has a low impact. Chemicals are not used in the processing of the material, water used in the process is recycled for continued use and tailings are returned to the beach to reconstitute the beach ecology.

Previously sheep have been grazing the area but these have been removed during the operation of the plant. Reduction in grazing has resulted in several positive impacts to the vegetation and habitats of this Strandveld. The vegetation is recovering from grazing and several species not recorded from grazing areas have started to recolonize and better stabilize the sand at the processing plant site. Some impacts are already occurring in the land earmarked for the expansion of the processing plant facility as a result of run-off of water used in processing. This run-off is causing some erosion and negative impacts to vegetation including inundation by loose sand carried by the run-off, and change in vegetation structure due to increased water and increased salinity. These impacts are negligible at this stage.

Sand mining itself has a low impact so long as beach access roads are stabilized to prevent collapse and subsequent impacts to the dune systems. Vehicles are the primary concern in terms of both faunal and floral losses and thus should be driven at low speed and within designated areas only. In order to reduce impacts of fauna using the beach, refugia in the form of conservation areas should be set up and areas not re-mined.

Few flora and fauna Species of Special Concern were recorded from the site. Permits will be required for the removal for some of these species (for the plant expansion or additional road building) and they will be valuable for the rehabilitation plan and associated nursery construction. Most ecological impacts are low to negligible and can be reduced to no impact with mitigation measures. Larger impacts include potential run-off from the processing plant site and the potential impacts of noise and disturbance to fauna, both of which can be reduced with mitigation.

Recommendations are made in the format of an Environmental Management Plan, which includes a Rehabilitation Plan, a Monitoring Plan and training of Environmental staff at the mine that much of the further work can be conducted by MSR.

There are large residual impacts from historical mining in the same locality, as well as the presence of at least two other companies operating within the same license area. MSR should not be held solely accountable for these impacts, and it is recommended that all the mining proponents along the stretch of coastline put a combined Management Plan into place, and all should be held responsible in relation to their impacts on the system.

Table of Contents

1. Introduction

MSR has a heavy minerals mine on the Western Cape coast, South Africa. MSR has already commissioned several ecological studies, which were done for the submission of the Environmental Impact Assessment (EIA) for the mine and associated infrastructure. MSR now plans to increase the footprint area of the plant site and road already existing in the Strandveld on the coastal plain of the west coast where they are mining the beach sand. An ecological impact assessment of the expanded footprint and roads was required. This is presented here, along with an updated impact assessment for the full development. This report serves as a full Ecological Impact Assessment for the entire development and takes into consideration information that did not exist previously as well as the information and findings of the previous reports.

The study area is situated to the north of the Olifants River mouth, with the planned mining taking place in a 50m wide strip between the low and high water marks on the farm Geelwal Karoo No 262 (ECOSUN 2007a). Figure 1.1 indicates the position of the MSR mining activities.

Figure 1.1: Locality map of the MSR mining licence area with the farm Geelwal Karoo 262 outlined in red and the approved coastal mining zone in purple. (This image has been taken directly from McDonald 2007b, pg 8).

1.1 Terms of Reference

The Terms of Reference for the study are as follows:

- Investigate the habitat in the planned plant and road expansion area;
- Classify the vegetation existing within the footprint;
- Indicate if any Species of Special Concern (fauna and flora) exist, or are likely to exist within the expanded footprint;
- Determine the impacts of the planned expansion of the plant site and haul road;
- Review previous studies and add the findings to the report;
- Add any additional pertinent information required;
- Recommend mitigation measures to reduce or eliminate negative impacts on the habitats and enhance positive impacts; and
- Recommend actions for an Environmental Management Plan (EMP) for the proposed development.

1.2 Assumptions and limitations

As in most studies there are some assumptions and limitations; these are outlined below:

- No mapping data were provided by MSR and thus the exact extent of the mining lease area was not known.
- All information made available by MSR has been included in this report, any omissions are due to the absence of previous reports.
- The site visit conducted by this specialist was limited and brief and occurred out of season for almost all flowering plants, but particularly the geophytes and thus was not able to record these.
- This reports serves only as a collation of previous studies and a brief impression of the study area at this stage and does not constitute a full baseline and impact assessment.

2. The Study Area in Context

2.1 The Succulent Karoo Biome

The study area occurs on the west coast of South Africa within the Succulent Karoo Biome, and here, within the Namaqualand Sandveld (Mucina & Rutherford 2006). The Succulent Karoo Biome extend from the West Coast of South Africa, northwards to Namibia and inland to Calvinia and almost as far as Port Elizabeth along the coast eastwards. The area is semidesert with a mostly unwavering mild climate. The majority of the area receives a unimodal pattern of winter rainfall. The geology of the region is complex, with a variety of metamorphic formations, along with sedimentary and igneous rock. Very little is known about the soil types of the region, with the information available being primarily reconnaissance level. In terms of diversity and endemism, the region forms the centre of endemism for groups such as Mole-rats, Lizards, Tortoises and various invertebrates. The area is incredibly diverse and rich botanically, containing 6356 plant species 26% of which are strict endemics and 14% near endemics. Of the species occurring within the biome, 17% are International red data species (Mucina & Rutherford 2006).

2.2 National Vegetation Map

Within the Namaqualand Sandveld, into which the study area falls, are several different vegetation types (Mucina & Rutherford 2006). Of these, the study area is located in only one: the Namaqualand Strandveld. This vegetation type occurs in the Northern and Western Cape Provinces, although it occurs primarily along the coast, separated by a band of Namaqualand Coastal Duneveld, this vegetation type sometimes extends inland up to 40kms. The Namaqualand Standveld occurs on primarily flat to slightly undulating land along the coastal peneplain. The vegetation comprises primarily low shrubland, which is species rich and comprised of succulent shrubs and climbers (*Cephalophyllum, Didelta, Othonna, Ruschia, Tetragonia, Tripteris, Zygophullum*) with a few non-succulents (*Eriocephalus, Lebekia, Pteronia, Salvia*) *as* well. The vegetation type occurs over deep sandy soils over marine sediments and in some areas, can occur on dunes. Mean annual rainfall for the area is 112mm, falling primarily between May and August. Frost does not often occur, with minimum temperatures reaching usually between 8 and 10 degrees Celsius, and a maximum of about 30^{o}C (Mucina & Rutherford 2006).

Endemic taxa of the Namaqualand Strandveld include the succulent shrubs *Lampranthus suavissimus, Tylecodon decipiens,* and *T. fragilis,* low shrubs include *Afrolimon* sp. nov. *,* *Gorteria* sp. nov.*,* and *Sutera multiramosa* with endemic geophytic herbs including *Lachenalia valeriae* and *Romulea sinispinosensis* (Mucina & Rutherford 2006). Identified as one of the most important threats to the region is the mining of heavy metals within this vegetation type. The conservation target for the vegetation type is 26%, with none statutorily conserved although several small private reserves do protect some of the area. 10% of the area has been transformed, with the most common land use grazing with few alien invasive species; although *Acacia* species may become problematic. This vegetation type has not been well studied, and it is likely that further work will result in the Namaqualand Strandveld being divided further into at least two different vegetation units (Mucina & Rutherford 2006).

2.3 Provincial Vegetation Mapping

The Western Cape Biodiversity Framework, developed in 2010 (Kirkwood *at al.* 2010), but updated this year (Pence & Genevieve 2014) maps the region in more detail as well as providing conservation goals along with other important biodiversity planning tools and categorizations. This assessment is recognized by the Department of Environmental Affairs and the South African National Biodiversity Institute (Pence & Genevieve 2014). Land use decisions can be made based on these tools. More detailed mapping has also been done in order to inform the Land Use Decision Tool (LUDS) which can be found on the SANBI website. This has involved the mapping of the vegetation of the region at a finer scale than the national vegetation map (Skowno *et al*. 2009). The vegetation was mapped at a scale between 5 000 and 50 000 from satellite imagery as well as google earth. This was done to a large extend as a result of more information available on the Sandveld. Some new vegetation types were identified, along with the remapping of some of the Mucina and Rutherford (2006) vegetation types (Skowno *et al*. 2009).

For the study area (roughly outlined, as containing an estimate of the license area length and including the vegetation mapped to the sea, as well as approximately 5km inland), the vegetation types defined include the following:

- Cape Seashore Vegetation (Mucina & Rutherford 2006);
- Namaqualand Heuweltjie Strandveld (Skowno *et al*. 2009);
- Namaqualand Inland Duneveld (Mucina & Rutherford 2006); and
- Olifants River Coastal Cliff Vegetation (undefined).

The vegetation type Namaqualand Heuweltjie Strandveld is described by Skowno *et al.* (2009) as a new vegetation type replacing some of the extent of the Namaqualand Strandveld described by Mucina and Rutherford (2006). Namaqualand Heuweltjie Standveld is the ecotone between (and therefore intermediate between) the Mucina and Rutherford (2006) vegetation types Namaqualand Strandveld and Namaqualand Heuweltjieveld (Skowno *et al*. 2009). This means that where previously the area has been mapped as only one vegetation type, it is now recognized as comprising four. One of which is a combination of two others. The Namaqualand Strandveld has been described in detail above; the remaining vegetation types are further described below.

Cape Seashore Vegetation

This vegetation type occurs in the Western and Eastern Cape Provinces. It is an azonal vegetation type and contains a number of elements including beaches, coastal dunes, dune slacks and coastal cliffs (Mucina & Rutherford 2006). The different vegetation types show the typical dynamic dune coastal systems and the disturbance of the system. Sandy sediments for the soils and geology of the coastal zone, the dunes and beaches of which are known as Strandveld. The water tends to be cold, and the rainfall low in the region, although it can vary greatly. This area has several endemic taxa, endemic dine and beach taxa include the low shrub *Psoralea repens*, the succulent shrub *Amphibolia laevis*, herbs *Amellus capensis, Gazania maritime, G. rigens* var. *leucolaena,* and *Silene crassifolia*, succulent herbs *Senecio litorosus, S. maritimus* and the graminoids *Thinopyrum distichum* and *Eragrostis sabulosa*. Endemics to the dune slacks include the herb *Vellereophyton vellereum*. Endemics to the cliffs include the succulent shrubs *Drosanthemum marinum, D. stokoei, Erepsia steytlerae* and *Prenia vanrensburgii*, the low shrub *Syncarpha sordescens* and the herbs *Limonium* sp. nov. and *Loberial boivinii.* This azonal vegetation type is considered Least Threatened by Mucina and Rutherford (2006) with a conservation target of 20%, which has been reached throughout the zone by both statutorily and privately protected areas. The biggest impact is caused by urban development (Mucina & Rutherford 2006).

Namaqualand Heuweltjieveld

This vegetation type occurs in the Northern Cape Province on the western foothills of the Namaqualand escarpment (Mucina & Rutherford 2006). The vegetation occurs on slightly undulating plains with a vegetation community mosaic on the slightly raised termite mounds known as heuweltijies. In between the termite mounds shrubland dominates, and is comprised mostly of low succulent shrubs. The vegetation type grows on deep red loamy soils, and has a unimodal winter rainfall pattern with a Mean Annual Precipitation of 115mm. Although Namaqualand endemics are biogeographically important taxa in this vegetation type, there are no endemics. Namaqualand Heuweltjieveld is considered Least Threatened and pressure is mainly from grazing and resultant veld degradation. The conservation target is 28% with approximately 11% statutorily conserved. A small area of the vegetation type has been transformed for cultivation, and *Acacia cyclops* is an invasive species to watch out for (Mucina & Rutherford 2006).

Namaqualand Inland Duneveld

This vegetation type occurs in the Northern Cape Province within the Namaqualand Sandveld where it occurs in isolated patches (Mucina & Rutherford 2006). It forms on the coastal peneplain and has mobile dunes, it is a tall shrubland dominated by non-succulent shrubs, some grasses and restioids. It grows on deep red and yellow sands forming dunes, within an arid winter rainfall regions with a Mean Annual Precipitation of 104mm. There are no biogeographically important taxa, nor endemic taxa within this vegetation type. Namaqualand Inland Duneveld is considered Least Threatened, with a conservation target of 26% and none statutorily conserved. Some grazing can result in land degradation although none has been transformed, and *Acacia cyclops* is a notable invasive species (Mucina & Rutherford 2006).

3. Previous Ecological Studies

ECOSUN (2007a) did a brief study on three different coastal zones in February 2007 within the mining lease area, they included the beach, associated dunes and extended approximately 500m inland. A summary of the methods used in the ECOSUN assessment was not given in that report. Additional botanic work was done on the coastal zone (McDonald 2007b) that included surveying areas on foot and collecting descriptions of vegetation and plant communities. A similar method was followed by a botanical study focusing on the plant area of the site (McDonald 2007a).

These previous assessments classified the vegetation of the study area; the two major vegetation types identified as occurring on the farm Geelwal Karoo included fragmented Namaqualand Seashore Vegetation along the coast and inland, the presence of Namaqualand Strandveld was confirmed (McDonald 2007b). Detailed fine-scale vegetation mapping was not done, nor were transects done from the high water mark to the climax vegetation inland (the usual method for describing successional vegetation (Lubke & de Moor 1998)). McDonald (2007a) describes in depth the different types of dunes present within the study area. These will be later reproduced in this report.

ECOSUN (2007b) also produced a faunal assessment of the area in September of 2006. The area from the tidal zone to about 500m from this was assessed during this time. The site was found to be poor in faunal species richness. Impacts to the isopod *Tylos granulatus* were considered to be the most severe and the possible increase in turbidity was considered to have an impact on bird species utilizing the area (ECOSUN 2007b). An additional desktop faunal assessment was conducted by Todd (2011) in order to include more detailed background information and to reassess the faunal impacts of the area. It was determined that some red data species are likely to occur in the site, however impacts to these species were considered low (Todd 2011).

4. Ecology of the Study Area

4.1 Dunes and Vegetation

The coastal zone of the sand mining area is dominated by very steep slopes and cliffs, which lead onto the beach. Erosion of the cliffs is natural, along with the development and destruction of dune systems and is typical of the dynamic ecology of the beach. The dune systems in the area are well described by McDonald (2007a) and the types are indicated in Figure 4.1 below. The dune systems are mainly comprised of three types (two of which were described by McDonald 2007a), which are presented in Table 4.1 below.

There are different zones within the dune ecology system; these are described by McDonald (2007ba) as follows:

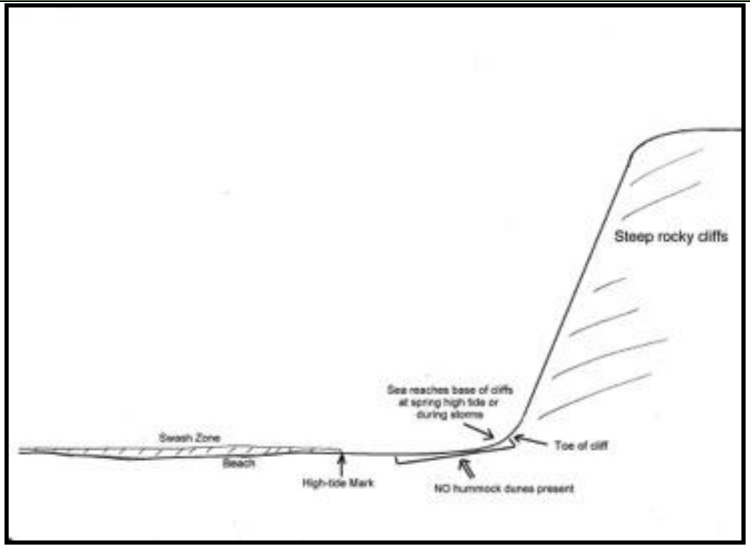
Beach: This zone is from the low tide mark to the drift line, which may form a natural berm or ridge.

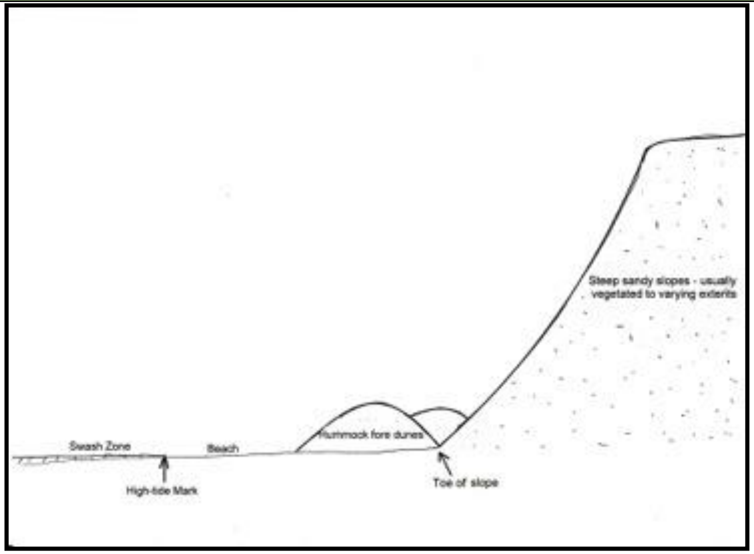
Dunes: This zone is the area from the highest drift line to the start of the coastal climax vegetation. It forms a dynamic system with the ocean influencing this zone and the vegetation within it, heavily.

Within the study area are a few zones which exhibit typical dune formation, which is the formation of embryo dunes, followed by hummock dunes as one proceeds inland. Behind the hummock dunes are the dune slacks, areas protected from wind and salt spray. Other much taller dunes can form behind these, resulting in the formation of climax coastal vegetation. In this case the coastal plain is high above most of the dune zones. If one were to look at the vegetation through a transect, however, it is likely that a very clear image of pioneer species leading to the formation of climax vegetation approximately 100m from the cliff edge. This application of dune ecology as a baseline has not, however been done in the past vegetation assessments and this one was conducted over a period of one morning and therefore insufficient time was available.

It is recommended that several transects be done as part of the baseline for the monitoring of the dune systems as required by the EMP for the MSR activities.

Table 4.1: Types of dune systems along the MSR mining license area.

Dune system type	Description	Diagram (taken from McDonald 2007b pg13)	Example
Steep slopes with no dune formation at the toe	These slopes are generally caused by the natural erosion of the slopes at the interface between the cliffs and the sea. Undermining of the rock by wave action then causes the cliffs to collapse. The resulted sand load is then washed back out to sea. This causes an abrupt change from the toe of the cliff to the flat shore, devoid of vegetation. Depending on sea level, dunes may form in these zones over an extended period of time.		 

Dune system type	Description	Diagram (taken from McDonald 2007b pg13)	Example
Steep slopes with dune formation at the toe	These steep slopes have collapsed in the past but the high tide line no longer reaches them. This has given the vegetation time to colonize slumped sand and embryo and hummock dunes are formed as a result of this succession process.		
Slopes with embryo and hummock dune formation at the base	There are some slopes which are still steep but do not have cliffs. In these areas a typical dune system is formed with embryo dunes forming closest to the high tide mark, hummock dunes and corresponding dune slacks created behind these. Vegetation then changes as the top of the slope and the coastal plain in reached where the climax vegetation becomes dominant.		

4.2 Dune Flora

The flora on the foredunes is not particularly species rich, especially when compared to the vegetation of the coastal plain (McDonald 2007b). Shrub species recorded as dominant on the foredunes included *Lycium tetrandum, and Salsola nollothensis*. Other species included *Arctotheca populifolia, Atriplex vestita, Cephalophyllum spronggiosum, Didelta carnosa, Oncosiphon suffruticosum, Psilocaulon dinteri, Stoeberia utilis* and *Zygophyllum cordifolium* (McDonald 2007b). Two of these species can be seen in Figure 4.1 below.

Figure 4.1: Common species on the foredunes within the study site. On the left is *Arctotheca populifolia* and on the right *Atriplex vestita* (From MacDonald 2007b pg 17).

In terms of the successional gradient of the area, from the foredunes the vegetation colonizes the cliffs and slopes that lead up to the climax vegetation on the coastal plain (McDonald 2007b). The cliffs and slopes are often not vegetated, but can be quite extensively vegetated. The vegetation on the slopes is Namaqualand Strandveld, with lower heights reached on sea-facing slopes. Species typical of the sandy slopes include *Drosanthemum luederitzii, Hypertelis angra-pequenae* and *Limonium* spp. (McDonald 2007b). One of the plants commonly found on the slopes is *Hypertelis angra-pequenae* shown below in Figure 4.2.

Figure 4.2: *Hypertelis angra-pequenae*, a common plant on steep slopes of the study site (From MacDonald 2007b pg 25).

4.3 Dune Fauna

The fauna of the area was not fully assessed in the original ECOSUN (2007a) report, and the subsequent report was restricted to a desktop analysis (Todd 2011). This study only served to outline possible habitats within the study area and did not sample the fauna. It is important that the fauna be properly assessed for the region and should be included in the baseline assessment for the monitoring of the MSR mining activities. The beach is defined as a habitat by ECOSUN (2007a) and is utilized by birds for foraging, rest or breeding as well as serving as habitat for the Cape Clawless Otter and the Black Backed Jackal (Todd 2011). The dunes above the beach have been identified as important habitat for reptiles and several species of importance are usually found within this habitat type, it is thus important that vehicular movement be restricted to the beach, rather than the dunes (Todd 2011).

4.4 Coastal Peneplain Vegetation

The vegetation at the study site is the same Namaqualand Strandveld described in previous botanical assessments of the area (ECOSUN 2007a, MacDonald 2007a). The area is dominated by low shrubs predominantly 50cm in height but ranging from 10cm to 1.5m. Most are succulent species typical of the region, with others plants known from the beach environment of the West Coast of South Africa. The vegetation community is one of bare sandy patches interspersed with shrubs and sparsely populated by grasses. The sides of the haul road comprise the same short vegetation, which has been negligibly impacted by dust and salt spray from use by haul trucks.

The study indicated that the vegetation changes from the edge of the current haul road close to the beach inland. This change is shown in both species composition as well as plant habit (Figure 4.3). Small (max 50cm) shrubs and Couch Grass (*Cynodon dactylon*) occur closer to the beach on the coastal plain, with much taller shrubs (up to 1.5m) occurring inland. The differentiation of plant communities is a clearly indicates that the coastal plain is part of the dune system of the coast, with climax dune vegetation occurring further inland than previous studies have suggested. This indicates that an approach using transects would be beneficial for the elucidation and mapping of the vegetation types effected by the mining and associated infrastructure and land use.

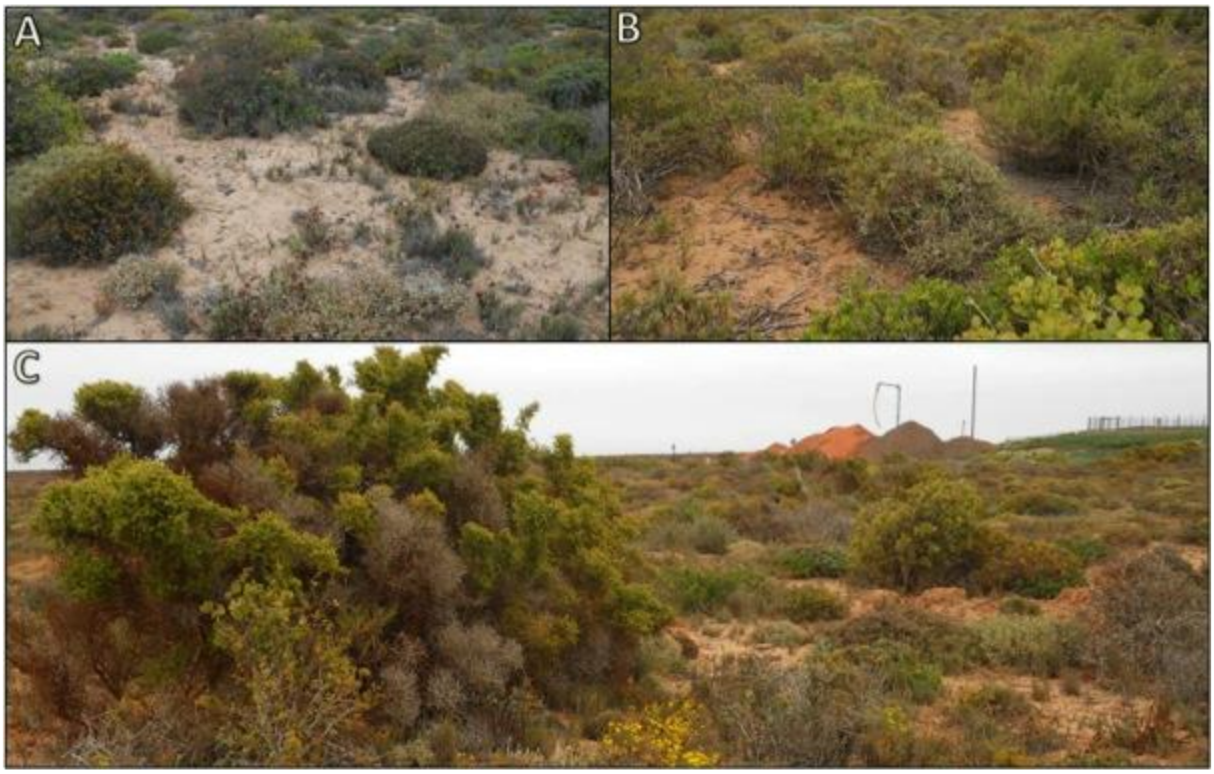


Figure 4.3: Vegetation differences at the MSR proposed plant expansion site. A: low vegetation closer to the coast, B: Taller vegetation inland, and C: The difference in height between the taller vegetation (left) and the shorter vegetation (right) in the ecotone zone.

4.5 Coastal Peneplain Flora

This section focuses on the Species of Special Concern (SSC) identified on site. This study has included those species listed on the following:

- International IUCN red data list;
- South Africa National Red list; and
- Endangered and Protected Plants on the Western Cape Provincial Conservation Ordinance (Act 19 of 1974).

It should be noted that the timing of this study (21st and 22nd of October 2014), as well as of previous botanical studies if the area (ECOSUN 2007a and MacDonald 2007a) did not coincide with the flowering season of the vegetation as a whole, but specifically of the geophytes, many of which are on red data lists or are protected. It is highly likely that a study timed in August and September would record a large number of geophytes as well as being able to better identify plants with flowers or fruits. Some plant species could not be identified for this study as available material was sterile.

No red-listed plants were recorded on the site (from the International IUCN red data list and the national red data list), but two families are protected provincially. These include blanket protection of all members of the Iris family (Iridaceae) as well as the mesemb family

(Mesembryanthemaceae). The majority of the succulents recorded from the site are mesembs. One species of Iridaceae was recorded though the state of the plants did not allow for identification to genus level (Figure 4.4). It is also likely that there will be more species.

The relevant permits are required to be obtained by the provincial authority in order to uproot (either to replant or remove) these species from the area. It is also recommended that a search and rescue of an additional species be done before construction commences. If time allows, this should be done when plants can be identified during the flowering season (August and September).

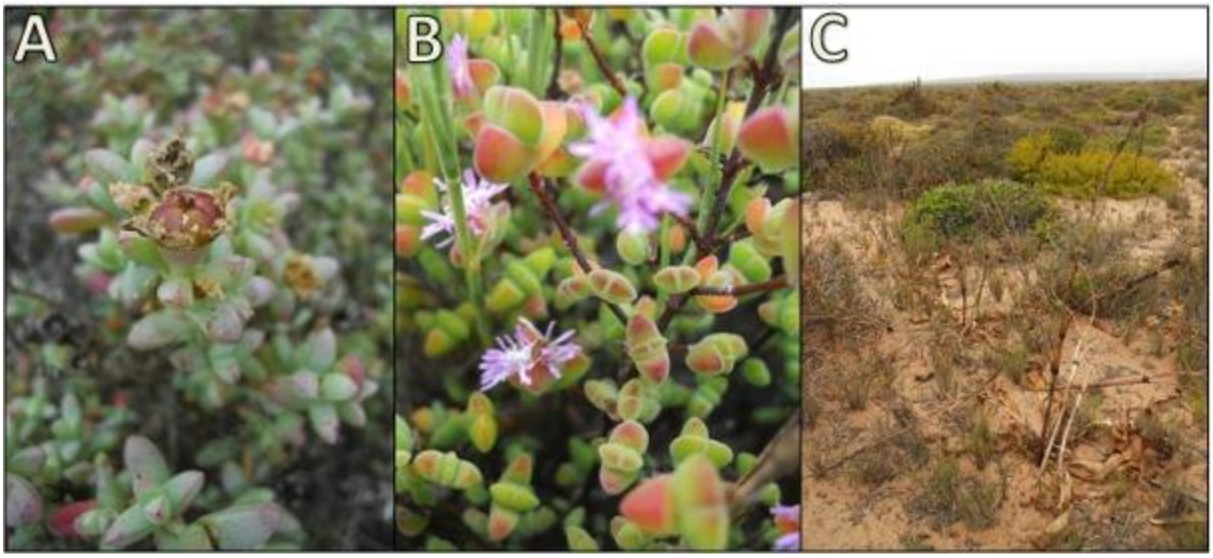


Figure 4.4: Some of the Species of Special Concern (SSC) recorded from the study area. A and B: Mesembryanthemaceae and C: Iridaceae (the dry plant in the foreground, having completed flowering and fruiting for the season).

4.6 Coastal Peneplain Fauna

The fauna of the area was not fully assessed in the original ECOSUN (2007a) report, and the subsequent report was restricted to a desktop analysis (Todd 2011). This study only served to outline possible habitats within the study area and did not sample the fauna. It is important that the fauna be properly assessed for the region and should be included in the baseline assessment for the monitoring of the MSR mining activities. The sea cliffs are determined to be an important habitat for reptiles, but the Strandveld area occurring on the peneplain is important habitat for a wide range of faunal species (Todd 2011). Species if concern for this area include Van Zyl's Golden Mole *Cryptochloris zyli* which is listed as Critically Endangered and Grant's Golden Mole *Eremitalpa granti* which is listed as Vulnerable (Todd 2011).

As the footprint area for the plant expansion and haul road is relatively small, and part of a widespread vegetation type, it can partially support macrofauna but does not form their only habitat. It is also highly likely that all macrofauna that may have existed in the area close the plant and road have since moved away due to current noise levels and vibrations. Animals living in the near vicinity would also be able to move away easily.

The survey showed no evidence of any large mammals present in the areas adjacent to the existing processing plant site. Evidence of large mammals was, however, present in other areas within the general mining area between the sea and about 500m inland. These large mammals are expected to be commonly occurring throughout the region wherever habitat exists.

The small and large bushes and bushclumps provide ideal habitat for small mammals such as mice and shrews, and their predators such as snakes and birds of prey. Avifauna was abundant and comprised both sea birds and birds commonly found in the region. All birds recorded were expected and most have been recorded in previous studies. Signs of moles were found in the proposed expansion site. These animals have clearly not moved away as several of the mole hills were evidently fresh. Some mice were seen but as time did not allow for trapping to be done, these could not be identified.

This section focuses on the Species of Special Concern (SSC) identified on site. This study has included those species listed on the following:

- International IUCN red data list;
- South Africa National Red list; and
- Endangered and Protected Animals on the Western Cape Provincial Conservation Ordinance (Act 19 of 1974).

Faunal species of special concern have been identified in previous studies; these species are likely to move away as construction takes place. However, it is required that animals be relocated if possible when construction commences. As clearing is done, it is recommended that all slow-moving animals are removed and placed outside the boundary of the plant or haul road site (animals such as tortoises). Construction should also take place slowly, to give animals such as small mice and shrews a chance to move outside the area.

Most animals are protected in the province including commonly occurring animals such as the Steenbok. Most notably, all amphibians and lizards, all tortoises and all birds are protected in the Western Cape. Important Protected Species include the Black-footed Cat (*Felis nigripes*), all shrews and all bats. Evidence of moles was found in the proposed footprint area (Figure 4.5). Although these are likely to be Mole-rats, rather than the Golden Moles, both groups have red-listed species (not all likely to occur on site) and it is recommended that the exact species be determined before any construction activity commences. Table 4.2 below indicates the species with distribution ranges that coincide with the development footprint, along with their likelihood of occurring.

Figure 4.5: Mole hills observed in the proposed processing plant expansion footprint. Although it is not known which species makes these hills, it is most likely either the Cape Dune Mole-rat (*Bathyergus suillus*) or the Cape Mole-rat (*Georychus capensis*), neither of which are red listed.

Table 4.2: Moles and Mole-rats likely to occur within the footprint of the proposed MSR plant area expansion (ref: Apps, 2000).

Species	**Habitat and signs**	**Red list status**	**Likelihood of occurrence**
Mole-rats			
Cape Dune Mole-rat (*Bathyergus suillus*)	Dunes and associated systems. Signs include burrows and mole hills.	None, but endemic	High (Although solitary, this species is known for high numbers of mole hills when active.)
Common Mole-rat (*Cryptomys hottentotus*)	Most soils. Signs include borrows and mole hills.	None	High
Cape Mole-rat (*Georychus capensis*)	Coastal dune systems and sand. Signs include burrows and mole hills.	None	Moderate (These Mole-rats are solitary and so do not produce an extensive network of mole hills as found on site.)
Golden Moles			
Cape Golden Mole (*Chrysochloris asiatica*)	Sandy soil on the West Coast. Signs include ridges formed when moles are foraging, and mole hills.	None, but endemic	Low (No ridges were observed on site.)
Grant's Golden Mole (*Eremitalpa granti*)	Namaqualand coastal plains loose soil. Signs include foraging ridges and mole hills.	Rare, and endemic	Low (No ridges were observed on site.)

5. Current ecological state of the proposed development area

The MSR footprint, including sand mining, roads, plant and associated infrastructure is incredibly small in relation to the distribution of the vegetation type on which it is situated. Chemicals are not used in the processing of the material, water used in the process is recycled for continued use and tailings are returned to the beach to reconstitute the beach ecology.

Currently, the land on which the processing plant is situated, as well as the area required for beach access is no longer used for sheep grazing. Sheep farming is the primary previous land use for the Strandveld of the area. As such, the entire area for which access to livestock is restricted, is currently recovering from grazing impacts. Reduction of grazing has resulted in several positive impacts to the vegetation and habitats of this Strandveld. The vegetation is recovering from grazing and several species not recorded from grazing areas have started to recolonize and better stabilize the sand at the processing plant site (Figure 5.1).

Figure 5.1: Strandveld surrounding the processing plant site showing the recovery, especially of grasses of the vegetation and associated increase in percentage cover.

Some impacts are already occurring in the land earmarked for the expansion of the processing plant facility as a result of run-off of water used in processing. This run-off is causing some erosion and negative impacts to vegetation including inundation by loose sand carried by the run-off, and change in vegetation structure due to increased water and increased salinity

(Figure 5.2). These impacts are negligible at this stage. Although these impacts will be eliminated if construction commences, they are likely to occur at the boundaries of the increased processing plant site. It is important that the area is correctly bunded and that run-off is collected and captured and re-used in the process as planned by MSR.

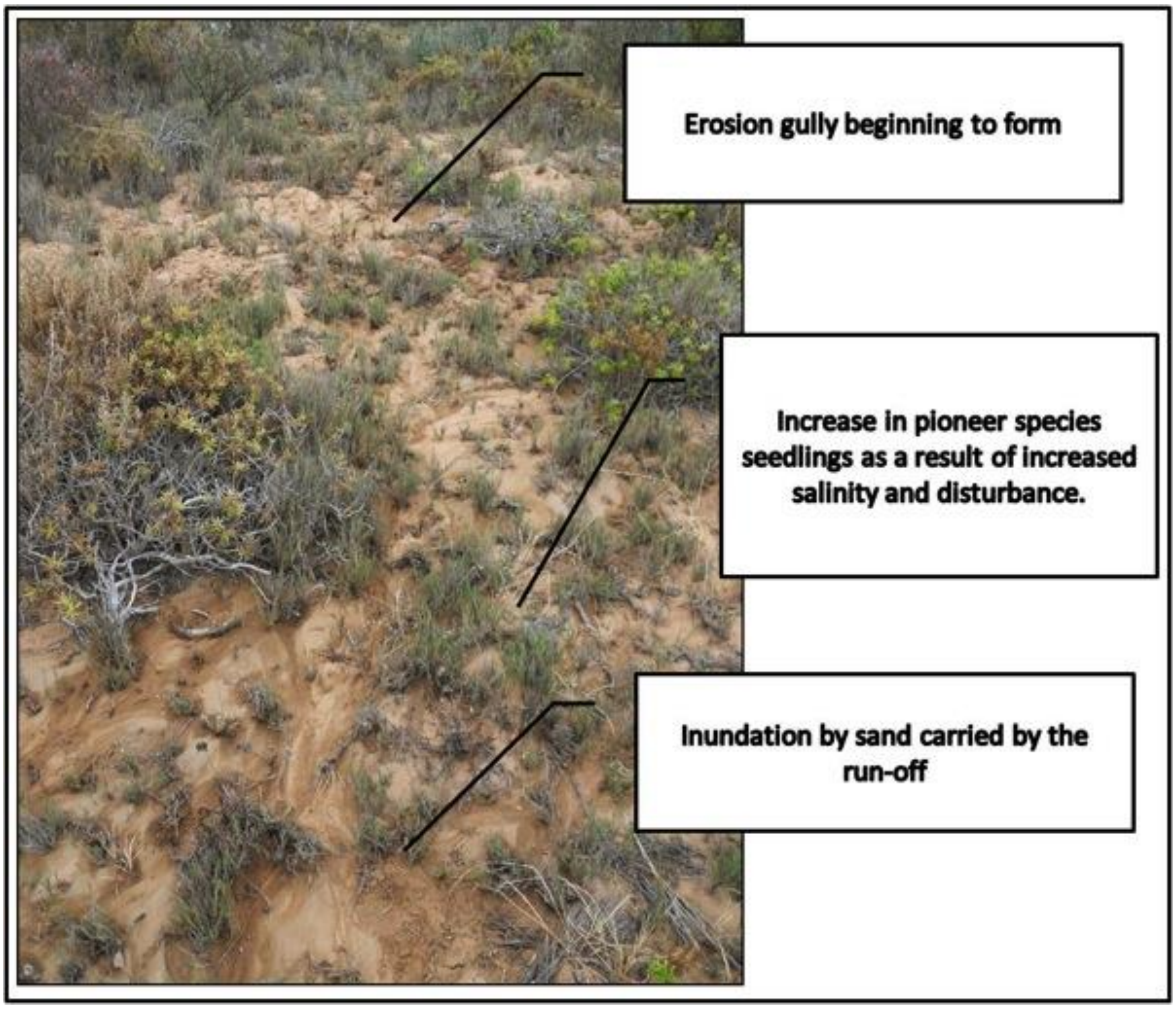


Figure 4.2: Negligible very low impacts associated with current run-off from the existing processing plant and associated infrastructure.

6. Impacts Identified and Assessed

The aim of this section is to present each of the impacts identified for the MSR activities. Each impact is presented, along with a brief explanation, a significance rating, recommended mitigation measure and post-mitigation significance rating. Impacts are presented in this manner in Table 6.1 for ease of reference.

Current MSR mining activities are restricted to the zone between the low tide mark and a 10m buffer from the last dune vegetation. Material is removed, processed and then returned to the beach and shaped by the waves. This results in an impact on wave function for a very brief period of time, as well as impacting on the organisms that live in the sand in this zone (such as crabs and isopods). No vegetation impacts exist and the fauna of the dune systems is unaffected. Shore birds and other animals tend to avoid areas where heavy machinery is present due to noise. Nonetheless, the footprint of the mining process should be kept as small as possible to make restructuring and recolonization of organisms as easy as possible. This should involve restricting vehicular movement to designated tracks on the beach, as well as maintaining a speed limit of 20km per hour on the beach itself to prevent collisions with wildlife.

Figure 6.1 below shows the obvious minerals in the sand that MSR are mining, as well as the operation between the 10m buffer zone and the low water mark.

Figure 6.1: MSR mining activities. A: Minerals within the sands of the beach are obvious. B: The mining activity takes place within a very small footprint at any one time and is restricted to the zone between the low tide mark and the 10m buffer zone from the dune vegetation.

Although the impacts on the beach are very small, MSR have constructed access roads to the beach. These have been constructed mainly over previously existing roads that past mining companies have used for beach access. The result is that both the historical impacts, as well as those caused by MSR on these beach access roads are one and the same. Figure 6.2 shows an example of the beach access roads. There is traffic along these roads in the sensitive vegetation zone between the shoreline and the climax vegetation, it is this important that these roads are managed correctly. Gabions should be constructed to prevent erosion and people must be prevented from walking down the slopes to access the beach. Compaction of the roads is unavoidable, and as many companies are busy mining the area, the roads are likely to be used in the future. The roads should be maintained by all users collectively.

Figure 6.2: Beach access roads used by MSR. A: a view of the proximity of the access road to the start of the steep slope. B: A beach access road situated on the slope between the cliff and associated dunes and the climax vegetation on the coastal plain.

The stretch of coastline (12 km) that will be mined by MSR over the life of mine (approximately 5 years) is also currently being mined by other companies, at least one of which is mining the same sand as MSR but for diamonds. There has also been a history of mining along the coastline from at least the 1950s. The result of all this activity is that not only are there residual impacts from past mining, but there are also existing impacts caused by mining companies other than MSR. The best solution from an ecological perspective would be the development of a cooperative management plan for all active mines along the same license area. The diamond mines mine the same sand as MSR, but the process looks for deeper sands and the resultant impacts are the same, if not higher, than those caused by MSR.

Existing issues for the coastal system are not only as a result of current and historical mining, but also a natural process for dune systems. These ecological systems are dynamic and constantly changing with a pristine baseline near impossible to determine. However, some issues of concern can be identified along the 12km mining license area, primarily due to historical mining. These are presented in Table 6.1 below, with examples shown in Figures 6.3, 6.4 and 6.5 below.

Table 6.1: Existing issues attributed to historical and current mining practices.

Issue	Description	Figure
Sand erosion on slopes	Where the high tide mark reaches the base of the sea cliffs, sand is eroded away from the slopes. This erosion is also present on shallower slopes where slumped sand has not revegetated due to recent slumping or lack of topsoil due to run-off. Responsibility held by MSR for this issue: none. However, this issue should not be exacerbated by MSR activities and a monitoring plan should be put into place to ensure no additional degradation occurs.	Figure 6.3

Issue	Description	Figure
Rock falls due to sea erosion of cliff bases	Where the high tide mark reaches the base of the sea cliffs, sand is eroded away from the slopes. This undermines the existing cliffs and the overlaying rock then collapses onto the beach. Depending on the type of rock, this may be eroded away by the sea, or form rocky outcrops with associated fauna and for a. Responsibility held by MSR for this issue: none. However, this issue should not be exacerbated by MSR activities and a monitoring plan should be put into place to ensure no additional degradation occurs.	Figure 6.4
Cliff erosion caused by diamond mining	Although a site visit to the existing diamond mining operation within the license area was not possible, this was seen from the top of the cliffs. It is clear that the impacts have affected the integrity of the existing coastal cliffs. Responsibility held by MSR for this issue: none. However, this issue should not be exacerbated by MSR activities and a monitoring plan should be put into place to ensure no additional degradation occurs.	Figure 6.5 A
Sand dumps failing to revegetate	Historical mining has left sand dumps along the coastline. Although the exact process that left these dumps is unknown at this stage, it is clear that they the sand has been dumped without an attempt at rehabilitation and the dumps retain no topsoil (evident through rock formations usually present within dunes, not t the surface). This is a risk as this could lead to slope slump which may affect MSR activity as well as dune ecology. Erosion is also a factor. Although the responsibility held by MSR for these dumps is zero, and integrated management and monitoring plan developed alongside other operations in the area could result in a best practice objective of leaving the environment in a better state than that prior to mining activities.	Figure 6.5 B
Erosion gullies forming on old beach access routes	Old beach access roads constructed by past mining or farming operations have not revegetated and run-off from the coastal plain has caused serious erosion along these routes. Responsibility held by MSR for this issue: none. This can be partially mitigated by the roads being upgraded for MSR use during mining operations, if this is not planned then the management and monitoring system mentioned above for the sand dumps should be considered.	Figure 6.5 C

Issue	Description	Figure
Sand erosion on old sand dumps	As with the sand dumps and old access roads, erosion has been caused resulting in the loss of topsoil and natural ability of the vegetation to regenerate. Responsibility held by MSR for this issue: none. As above, the management and monitoring system mentioned for the sand dumps should be considered.	Figure 6.5 D

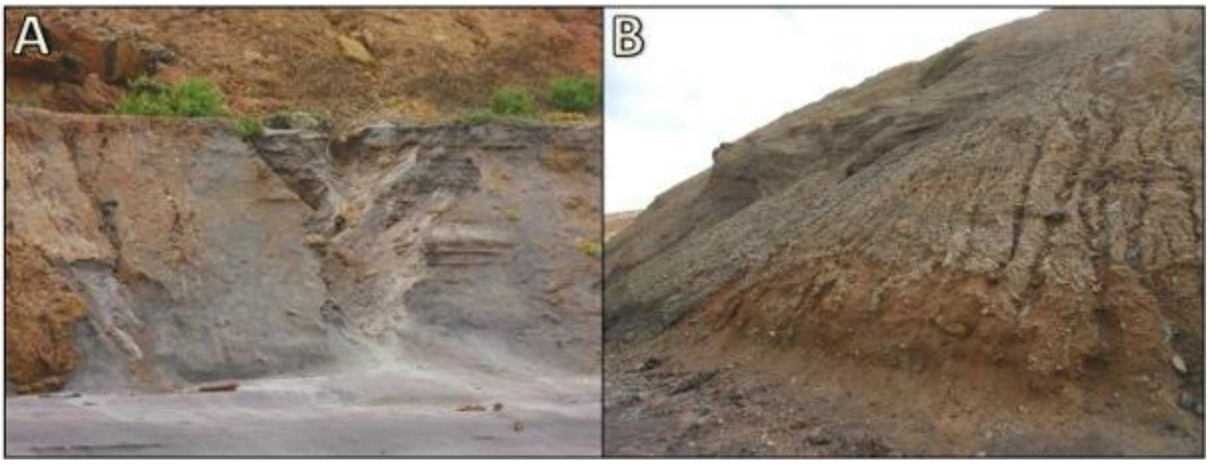


Figure 6.3 Sand erosion present in the study area. A: Sand erosion at the toe of the cliff. B: Sand erosion on slumped sand.

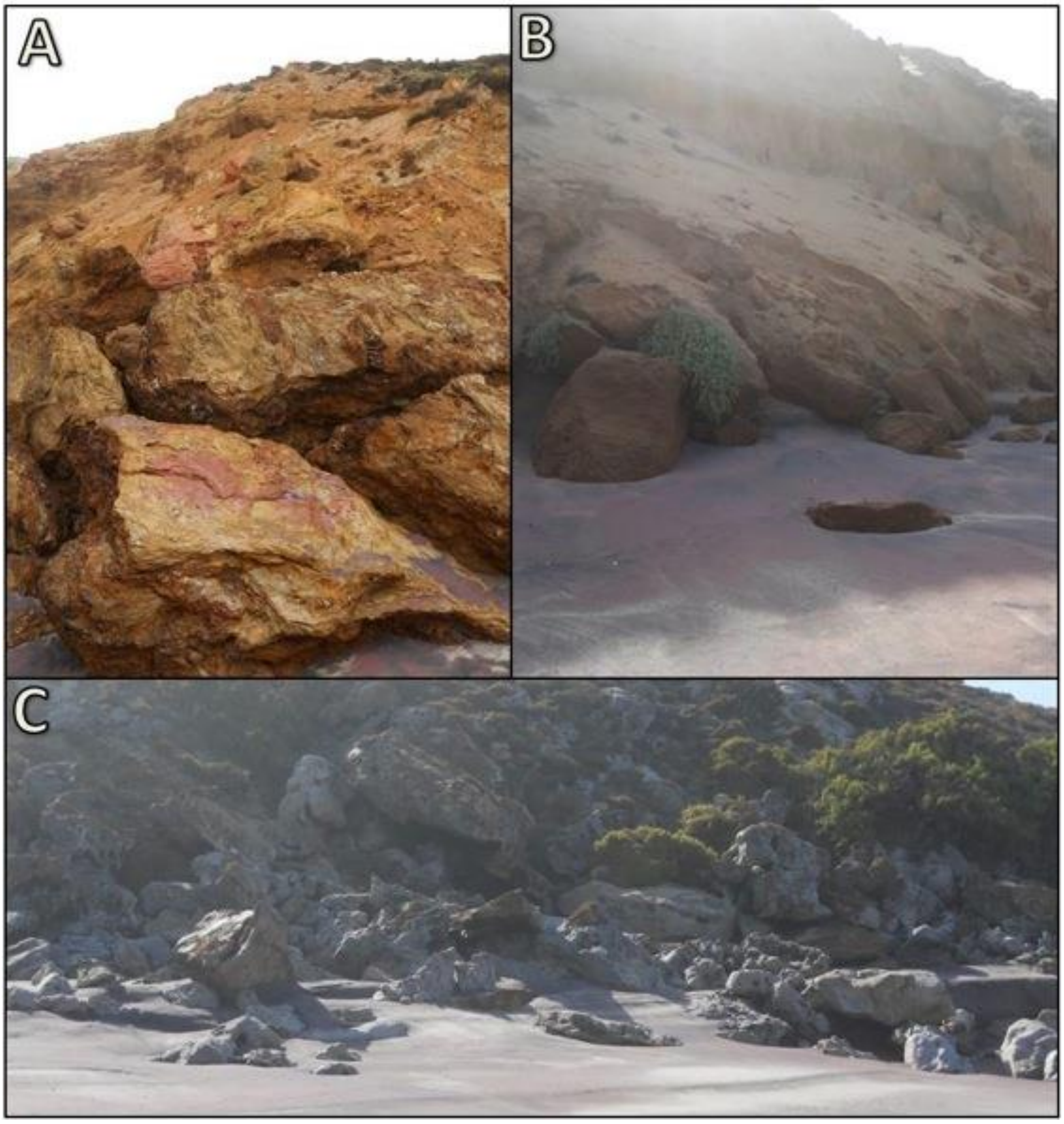


Figure 6.4: A, B and C: Rock falls resulting from cliff undermining by sea water and/or previous mining activities.

Figure 6.5: Historical impacts within the study area. A: Cliff erosion and destruction caused by current diamond mining operations. B: Old sand dumps that have failed to regenerate and have little to no topsoil. C: Erosion gully formed from an old beach access road. D: An erosion gully formed on an old sand dump.

Table 3.1: Impacts to, and Recommended Mitigation Measures for the Ecology of the footprint of the MSR mining and associated activities, Farm Geelwal Karoo 262, Western Cape, South Africa.

Impact	Description	Significance rating	Mitigation Measure	Significance Post-mitigation
Impacts associated with the strandveld				
Loss of vegetation and habitats	Removal of the vegetation will result in the loss of the vegetation and faunal habitats present.	Low negative	Mitigation measures should include rehabilitation of the plant footprint after decommissioning. As full restoration is unlikely to be attained within the 50 years following the rehabilitation of the site, a residual impact will exist. The road is a public road and is likely to be used in the future, thus requiring no rehabilitation. No personnel should be allowed within the natural areas surrounding the proposed plant site and roads.	Negligible impact
Loss of Biodiversity (General)	The expansion of the processing plant site and road will result in the loss of all of the vegetation and faunal habitat within the footprint area. This will result in the loss of individuals of each plant and animal species present and a very small area of the Namaqualand Strandveld vegetation type.	Negligible negative	Mitigation measures include the rehabilitation of the plant footprint area after decommissioning, considering the life of mine is five years, the impact will be short term. Any rehabilitation or restoration (to be established in a rehabilitation plan) should reach soil stability targets within 5 years from decommissioning. The road is a public road and is likely to be used in the future, thus requiring no rehabilitation. No personnel should be allowed within the natural areas surrounding the proposed plant site and roads.	No impact
Loss of Plant SSC	Loss of some species will be inevitable.	Low negative	Mitigation measures should include the search and rescue of any plant SSC which should then be placed in a nursery established for rehabilitation purposes.	No impact

Impact	Description	Significance rating	Mitigation Measure	Significance Post-mitigation
Loss of animal SSC	Loss of some species will occur.	Low negative	Mitigation measures should include a search and rescue to relocate any slow-moving animals and measures should be taken to relocate the moles present within the footprint. Initial clearing of the site should be done slowly (over the period of approximately three days) to allow for animals to move away from the construction activities. A speed limit of 40km per hour should apply to the roads on site to reduce the chance of road fatalities.	No impact
Fragmentation and edge effects	Usually loss of vegetation and associated habitats causes fragmentation of an ecosystem, interfering with the movement and dispersal of animals and plants. As this site is very small and the Namaqualand Strandveld relatively widespread, this impact is not expected to be large.	Negligible negative	Rehabilitation of the plant site should take place after decommissioning to restore connectivity of the ecosystem. The road is a public road and is likely to be used in the future, thus requiring no rehabilitation. No personnel should be allowed within the natural areas surrounding the proposed plant site.	No impact
Run-off associated change in vegetation composition.	As already noted, run-off, if not properly controlled from the processing plant site will have an impact on the vegetation surrounding the proposed processing plant expansion footprint. This increases the disturbance of the vegetation, as well as increasing sand deposited in top of the existing vegetation. This creates an environment which approximates beach conditions, resulting in a change from Strandveld to dune ecology. As this is likely to have a snowball effect, this impact is likely to be large over the long term.	Moderate negative	In order to mitigate this impact, the area on which salt water is used for processing should be bunded. The water should then be collected, passed through a settling pond to reduce sedimentation and then pumped into the collection ponds to be reused in the processing. Consistent monitoring should ensure no run-off occurs outside of the processing plant site.	No impact

Impact	Description	Significance rating	Mitigation Measure	Significance Post-mitigation
Salination of the soils within the footprint area.	Salination of the soils may occur through two ways, via the run-off of concentrated salt water used in the processing of the product, but also due to salt spray from the process itself. This is likely to change the soil salinity resulting in changes to the vegetation from the existing less salt-tolerant vegetation to the more tolerant dune vegetation.	Moderate negative	Mitigation measures should be as above, for run-off associated salination. Little can be done about salt spray, and the impacts of this on the vegetation surrouding the proposed plant site and road edges are likely to be small.	Negligible impact.
Impacts associated with the beach and dunes				
Loss of animal SSC	Loss of some species will occur, primarily due to vehicular movement on the beach.	Low negative	Vehicles on the beach should be restricted to a clearly demarcated area and drivers should be vigilant. A speed limit of 20km per hour should apply to the roads on site to reduce the chance of road fatalities.	No impact
Loss of vegetation and habitats	Removal of the vegetation will result in the loss of the vegetation and faunal habitats present. As not all faunal habitat is vegetated and includes the beach itself, this will be lost due to disturbance.	Moderate negative	Mitigation measures should include the avoidance of all vegetated systems in the area and the 10m buffer zone should be strictly adhered to. The loss of the beach faunal habitats is unavoidable but is short-term inn nature.	Low Negative
Loss of faunal biodiversity	This impact may result from both the increased human activity in the area, as well as the noise and potential disturbance from access roads and mining operations.	Moderate negative	Mitigation measures should include the restriction of mining activities to the mine plan and the maintenance of recovery areas for faunal species to use as refugia. No personnel should be allowed to wander around the site or leave their vehicles except at places of work. All personnel should attend an environmental induction which includes awareness raising around the illegal collection or fauna and flora (Todd 2011). This impact is short-term in nature.	Low negative

Impact	Description	Significance rating	Mitigation Measure	Significance Post-mitigation
Fragmentation and edge effects	Usually loss of vegetation and associated habitats causes fragmentation of an ecosystem, interfering with the movement and dispersal of animals and plants. This will occur along the beach and is unavoidable for both flora and fauna. Considering the already impacted state of this environment, this impact is comparatively low.	Moderate negative	It is essential that the buffer zone is maintained and vehicles are only allowed within designated areas. The mine plan should be followed and no remining of areas should be done. Dune systems should be monitored to ensure that they are not affected by mining activities. Refugia for fauna should be provided.	Low negative

7. Recommendations for an Environmental Management Plan

In this section, a draft Environmental Management Plan (EMP) is supplied for the ecology of the study site. It is based on the identified impacts or issues that have been described for the MSR mining and processing activities. The management measures are presented in this summary report in a table format (Table 7.1) for ease of reference and transcription into a general EMP for the MSR mine activities.

The table is designed to be used by the mine to check compliance, and the last column can be used to determine if compliance has been reached within the specified timeframe by the person responsible. This ensures a transparent and relatively simple system that can easily be applied to the mine activities. It should be noted that an EMP is a dynamic document that should be changed regularly depending on the current state of the mining operations. It should be used for adaptive management of environmental issues to ensure the mitigation measures for impacts applied. It should also be a transparent process that allows access to, and comments from, Interested and Affected Parties and the relevant governmental authorities.

As the MSR mine is one of several operating currently along the coastline, the EMP should not be solely the responsibility of that company. Furthermore, extensive existing impacts are present as a result of historical mining in the region. MSR is in a position to rectify these somewhat, but again should not be held responsible for residual impacts from past mining operations.

Table 4.1: Recommended Environmental Management Plan (EMP) Ecology for the MSR mining and associated activities on Farm Geelwal Karoo 262, Western Cape, South Africa.

Issue	Management Measure	Responsible person	Timescale	Compliance
Rehabilitation	**There are several steps required for rehabilitation of the plant site after decommissioning. As the life of mine is 5 years, these should be commenced as soon as possible.**			
	Rehabilitation plan (which will result in further EMP clarifications)	Biodiversity and Rehabilitation specialist commissioned by MSR.	This should be done by the **30th of November 2014**. If possible, the plan should be completed by 31st of October 2014 as it is likely that seed collection will be required and October is the best season. If not done at this time, the seed collection can only take place in September and October 2015.	Yes/No
	Establishment of a nursery	Environmental Officer trained and assisted by a Biodiversity and Rehabilitation specialist commissioned by MSR.	This will be informed by the rehabilitation plan, but seeds will need to be collected as soon as possible (by the **31st of October 2014**). A search and rescue operation will collect more plants prior to clearing of the site for construction.	Yes/No
	Rehabilitation trials	Environmental Officer trained and assisted by a Biodiversity and Rehabilitation specialist commissioned by MSR.	The setting up of these trials will be based on the outcomes of the rehabilitation plan. These should be set up **as soon as construction of the proposed processing plant site is completed.**	Yes/No
Search and rescue	**Search and rescue will need to be done after the applicable permits are obtained, this will ensure reduced loss of possible Species of Special Concern as well as supply the rehabilitation nursery with plants without having to dig these up from other areas on the farm.**			
	Search and rescue of plant SSC and additional plants for the rehabilitation nursery.	Environmental Officer trained and assisted by a biodiversity specialist commissioned by MSR.	This will need to be done **prior to the clearing** of the proposed site.	Yes/No
	Search and rescue of slow-moving animals.	Environmental Officer trained and assisted by a Biodiversity specialist commissioned by MSR.	This will need to be done **directly before the clearing of the site** to ensure that animals do not recolonize the area after being removed. Preferably this should be done during the clearing in front of the bulldozers.	Yes/No

Issue	Management Measure	Responsible person	Timescale	Compliance
Mole studies	**The presence of moles on site is of concern as these may be a red-listed species. The exact mole species should be determined and search and rescue and management measures put into place.**			
	Mole species determination.	Biodiversity specialist commissioned by MSR.	**Before commencement of construction**, at least before the 30th of November 2014.	Yes/No
	Mole management plan. This will be informed by the species of mole determined to occur on site and should outline means of relocation.	Biodiversity specialist commissioned by MSR.	**Before commencement of construction**, at least before the 30th of November 2014.	Yes/No
	Mole relocation.	Environmental Officer trained and assisted by a Biodiversity specialist commissioned by MSR.	**Before commencement of construction**, at least before the 30th of November 2014.	Yes/No
Monitoring	**Monitoring is needed to ensure that the management measures required for ecological impacts are working, or need to be adapted.**			

Issue	Management Measure	Responsible person	Timescale	Compliance
	Monitoring plan Which should include (but may not be limited to) monitoring of the following: • The impact of salt spray on vegetation; • The impact of run-off on vegetation; • Monitoring of any collisions of vehicles and wildlife; and • The success of the rehabilitation trials. Monitoring should also include monitoring of the dune system which should include (but not be limited to) monitoring of the following: • Dune formation including embryo and hummock dunes; • Erosion of cliffs and rock falls; • Monitoring of any collisions of vehicles and wildlife; and • Monitoring of old sand dump revegetation and erosion	Biodiversity specialist commissioned by MSR.	This needs to be done **before the operation of the proposed expanded plant site is commenced, but may be done post-construction**. It is recommended it be done by the 31st of December 2014.	Yes/No
	Monitoring according to the developed monitoring plan, and adapted according to field conditions	Environmental Officer trained and assisted by a Biodiversity and Rehabilitation specialist commissioned by MSR.	Ongoing, with the monitoring set up and baseline conditions recorded by the **31st of December 2014**.	Yes/No
General Management Measures	**General management measures are required to meet a best practice objective of leaving the site in a better state than that existing before the commencement of mining and should be achieved in partnership with other mining companies in the area.**			
	Construction of gabions along beach access roads to prevent erosion.	Construction crew overseen by the mine manager.	**Ongoing**, but should be done at completion of road construction before operation.	Yes/No

Issue	Management Measure	Responsible person	Timescale	Compliance
	Construction of gabions where required in existing erosion areas (such as old sand dumps)	Construction crew overseen by the mine manager.	A timescale should be determined through a meeting with other mining companies.	Yes/No
	Application of topsoil and shade cloth "walls" in areas failing to revegetate.	Construction crew overseen by the environmental control officer.	This should be done as soon as possible through a meeting with other mining companies. It is recommended that the "walls" remain up until at least a 60% cover is reached.	Yes/No
	Restriction of beach driving to specific tracks. These should be marked out for the monthly operations and adhered to.	Environmental Control Officer.	For current mining, this should be done by the **31st of October 2014**, and from then ongoing.	Yes/No
	Clearly marking the 10m buffer zone from the dune vegetation with stakes and danger tape.	Environmental Control Officer	This should be done **monthly** depending on the location of mining and to avoid the loss of markers due to wave action. As well as allowing for change in such a dynamic system.	Yes/No

8. Conclusions

The conclusions of this ecological assessment report are as follows:

- The MSR mining operation and associated infrastructure is located in a very small footprint when taken into context of the surrounding similar landscape. The result of this small footprint is that the ecological impacts are restricted and small.
- All impacts identified as likely to occur within the Standveld, will be reduced if the recommended mitigation measures are applied, most to no impact and the remaining to a negligible impact.
- Within the coastal plain zone in which the processing plant is situated, the previous land use (grazing of sheep) has been halted and as a result the vegetation is recovering from grazing pressure. The result is an overall positive impact to the Namaqualand Strandveld of the locality.
- Impacts of MSR to the dune system are restricted to the zone between a 10m buffer from the dune vegetation and the low water mark, as well as access roads to the beach.
- Mitigation measures for MSR activities are simple and require mainly the building of gabions to stabilize beach access roads and prevent erosion.
- Many impacts are already present due to historical mining activity and from current mining activities by other companies.
- An integrated management plan is recommended for the mining companies operating within the same area to manage collective impacts as well reach a best practice goal of leaving the ecology of the system in a better state than that prior to current mining (resulting in an overall positive ecological impact).
- A monitoring system should be set up to document baseline conditions as well as changing conditions throughout the life of mine.

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