DPR Ecologists & Environmental Services

# Ecological and Wetland Assessment for sand mining operations on a Portion of Portion 5 of the Farm Bezemfontein 213 near Laingsburg, Western Cape Province.

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**DECLARATION OF INDEPENDENCE**

**DPR Ecologists and Environmental Services is an independent company and has no financial, personal or other interest in the proposed project, apart from fair remuneration for work performed in the delivery of ecological services. There are no circumstances that compromise the objectivity of the study.**

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## Executive Summary

The site is situated at the foot of the Klein Swartberge on a Portion of Portion 5 of the Farm Bezemfontein 213 (Map 1). The site is situated approximately 50 km to the north east of Ladismith and approximately 70 km to the south east of Laingsburg and has an eextent of 4.99 hectares. The site is situated at the foot of the north facing slopes of the Klein Swartberg where sands eroding from the slopes are continuously deposited. The site does contain some transformation in the form of a large artificial impoundment and embankment but is still largely natural. Two prominent and largely natural stream system are also present on the site (Map 1). The proposed mining development will excavate sand from a low mound between the streams. The mining activities are not anticipated to utilise any processing plant and will remain at a very small scale.

From the description of the vegetation on the site it is clear that natural vegetation dominates the site though significant disturbance is also present. The ecological processes on the site are clearly defined and should allow for adequate management of mining operations and rehabilitation after cessation of mining activities. The site contains an elevated alluvial sand embankment which will be the main area of sand excavation (Map 1). This portion has a moderate species diversity, though sparse vegetation cover with a high proportion of protected species including five protected proteoid species, two Erica species and three Vygie species (Appendix B). None of these are however rare or endangered and they are all relatively widespread. However, the proposed mining area is of small extent and seeing as none of these species are rare, endangered or localised their loss is not anticipated to be high. Permits will however have to be acquired to remove these plants. Furthermore, provided that comprehensive rehabilitation and adequate management of topsoil is undertaken it is highly that several of these will be able to re-establish on the site after mining has ceased. This portion of the site is bordered to the north and south by two streams which are considered to have a high conservation value (Map 1). It is therefore recommended that these be excluded from the mining area and that the proposed access road avoid crossing these streams.

Wetland conditions can be confirmed to be present along these two small stream systems (Map 1). Obligate wetland vegetation could be easily utilised to provide an accurate border of wetland conditions. Along the northern stream system there is also an artificial crescent shaped channel and berm (Map 1). This furrow or channel diverts a portion of the flow in the stream although its intended function is unclear. It has however also manifested some wetland conditions due to continued inundation and saturated soil conditions. These wetland conditions are however artificial and do not perform any function which is important to the continued natural functioning of the stream. This channel and berm can therefore be included in the sand excavation operations without having a large impact on the functioning of the stream.

An Index of Habitat Integrity (IHI) was conducted for the two affected streams (Appendix D). The results of the IHI indicated that the study area has an Instream IHI of Category C: Moderately Modified and Riparian IHI of Category C: Moderately Modified. This can be mostly attributed to the modification of the streams brought about by the artificial impoundment.

The EI&S of the stream systems has been rated as being High: Floodplains that are considered to be ecologically important and sensitive. The biodiversity of these floodplains may be sensitive to flow and habitat modifications. They play a role in moderating the quantity and quality of water of major rivers.

A Risk Assessment for the proposed sand mine and affected stream systems has been undertaken according to the Department of Water & Sanitation's requirements for risk assessment and the provisional Risk Assessment Matrix for Section 21(c) & (i) water use (Appendix E).

The mining operations are anticipated to remain at a very small scale. This will significant decrease the risk on the streams. However, as indicated these streams must be regarded as highly sensitive. They should therefore be excluded from any mining activities and the necessary mitigation, mining methods and procedures implemented to minimise any impacts on them (Map 1). Should these be implemented the risk should remain moderate. Firstly, the excavation of sand should be restricted to the central embankment of alluvial sand, excluding the adjacent stream systems, treating these as no-go areas (Map 1). Sediments from the site should be prevented from entering the adjacent stream systems and it is recommended that berms be erected between the site and these streams. Secondly, the depth of sand excavation should not exceed the level of the banks of these streams (Figure 5). This should be feasible since adequate material is not present beyond this depth. In addition, the border between mined areas and adjacent natural areas should be faired in so that sheer drops or steps are avoided as these will cause significant erosion. Thirdly, the site will remain highly susceptible to erosion and comprehensive rehabilitation, including adequate management of topsoil, will be crucial. Extended monitoring and implementation of erosion measures will also be necessary.

The alluvial plain on the site is highly conducive to erosion and even when comprehensive erosion management measures are implemented it remains likely that sand mining will considerably increase the sediment load in downstream sections. However, the artificial impoundment essentially acts as a sediment trap and will prevent any mobilised sediments from entering the downstream sections. This will effectively contain impacts associated with sand mining in the immediate area.

The excavated sand will have to be transported from the site by trucks and heavy vehicles and will require an adequate access road which may affect the two stream systems. Crossing of these streams by such a road will have a significant impact on them and should be avoided. This can be achieved by utilising an existing small dirt track which can be upgraded and accessing the site via the dam shore which is already an artificial and degraded area and will prevent impacting on the stream systems (Map 1). Should this route be used the risk should remain low. It is however also subject to the upgrading of the existing track minimising erosion and its design allowing for adequate drainage of surface runoff without exacerbating erosion.

The impact significance has been determined and it is clear that the majority of impacts will be moderate although the impact on the adjacent streams are moderate-high. Through adequate mitigation this impact can also be decreased to moderate

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## Wetland and Ecological Assessment

## 1. Introduction

### 1.1 Background

Natural vegetation is an important component of ecosystems. Some of the vegetation units in a region can be more sensitive than others, usually as a result of a variety of environmental factors and species composition.

Though vegetation may seem to be uniform and low in diversity it may still contain species that are rare and endangered. The occurrence of such a species may render the development unviable. Should such a species be encountered the development should be moved to another location or cease altogether.

Some vegetation units perform vital functions in the larger ecosystem. These units are often associated with water bodies, water transferring bodies or moisture sinks. These systems are always connected to each other through a complex pattern. Degradation of a link in this larger system, e.g. tributary, pan, wetland, usually leads to the degradation of the larger system. Therefore, degradation of such a water related system should be prevented.

South Africa's water resources have become a major concern in recent times. As a water scarce country we need to manage our water resources sustainably in order to maintain a viable resource for the community as well as to preserve the biodiversity of the system. Thus, it should be clear that we need to protect our water resources so that we may be able to utilise this renewable resource sustainably. Areas that are regarded as crucial to maintain healthy water resources include wetlands, streams as well as the overall catchment of a river system.

In order to better manage our water resources several guidelines and research sources have been developed. Amongst these are the National Freshwater Ecosystem Priority Areas for South Africa 2011 (NFEPA).

It is well known that sand mining operations have several detrimental impacts on the environment. These impacts are numerous but the most pronounced impacts are associated with the excavation of large amounts of earth materials, the storage and disposal thereof and the sedimentation associated with it especially where mining takes places near watercourses. This usually causes degradation of waterways due to sedimentation as well as the transformation of the vegetation and ecosystem on the site.

For the above reasons it is necessary to conduct a wetland and ecological assessment of the area proposed for sand mining.

The site is situated at the foot of the Klein Swartberge on a Portion of Portion 5 of the Farm Bezemfontein 213 (Map 1). The site is situated approximately 50 km to the north east of Ladismith and approximately 70 km to the south east of Laingsburg and has an extent of 4.99 hectares. The site is situated at the foot of the north facing slopes of the Klein Swartberg where sands eroding from the slopes are continuously deposited. The site does contain some transformation in the form of a large artificial impoundment and embankment but is still largely natural. Two prominent and largely natural stream system are also present on the site (Map 1). The proposed mining development will excavate sand from a low mound between the streams.

The mining activities are not anticipated to utilise any processing plant and will remain at a very small scale.

A site survey was conducted on 30 October 2019. The entire footprint of the mining area was surveyed over the period of one day. The site survey was conducted during spring when most species are in flower and consequently species identification could be adequately done. The hydrological cycle was also active, allowing for accurate wetland delineation.

The report together with its recommendations and mitigation measures should be used to minimise the impact of the proposed mining activities.

### 1.2 The value of biodiversity

The diversity of life forms and their interaction with each other and the environment has made Earth a uniquely habitable place for humans. Biodiversity sustains human livelihoods and life itself. Although our dependence on biodiversity has become less tangible and apparent, it remains critically important.

The balancing of atmospheric gases through photosynthesis and carbon sequestration is reliant on biodiversity, while an estimated 40% of the global economy is based on biological products and processes (Johnson 2005).

Biodiversity is the basis of innumerable environmental services that keep us and the natural environment alive. These services range from the provision of clean water and watershed services to the recycling of nutrients and pollution. These ecosystem services include:

- Soil formation and maintenance of soil fertility.
- Primary production through photosynthesis as the supportive foundation for all life.
- Provision of food, fuel and fibre.
- Provision of shelter and building materials.
- Regulation of water flows and the maintenance of water quality.
- Regulation and purification of atmospheric gases.
- Moderation of climate and weather.
- Detoxification and decomposition of wastes.
- Pollination of plants, including many crops.
- Control of pests and diseases.
- Maintenance of genetic resources.

## 2. Scope and limitations

- To evaluate the present state of the vegetation and ecological functioning of the area proposed for the mining operations.
- To identify possible negative impacts that could be caused by the proposed mining operations.
- To evaluate the present state of the wetlands and riparian vegetation included within the study area. The importance of the ecological function and condition will also be assessed.
- Identify and delineate watercourses including rivers, streams, pans and wetlands and ascertain condition and status therefore and recommend mitigation.
- Determine the Present Ecological State (PES) and Ecological Importance & Sensitivity (EIS) for the watercourses in the study area.

### 2.1 Riparian Vegetation

Aspects of the riparian vegetation that will be assessed include:

- The vegetation types of the region with their relevance to the study area.
- The overall status of the riparian vegetation along the wetlands in the study area.
- Species composition with the emphasis on dominant-, rare- and endangered species.
- Boundary of wetlands using obligate wetland riparian species.

The amount of disturbance present on the study area assessed according to:

- The amount of grazing impacts.
- Disturbance caused by human impacts.
- Other disturbances.

### 2.2 Fauna

Aspects of the fauna that will be assessed include:

- A basic survey of the fauna occurring in the region using visual observations of species as well as evidence of their occurrence in the region (burrows, excavations, animal tracks, etc.).
- The overall condition of the habitat.

### 2.3 Wetlands and watercourses

Aspects of the wetlands that will be assessed include:

- Identification and delineation of watercourses including rivers, streams, pans and wetlands.
- Describe condition and status of watercourses and importance relative to the larger system.
- Conduct habitat integrity assessment of perennial systems to inform the condition and status of watercourses.

## 2.4 Limitations

Some geophytic or succulent species may have been overlooked due to a specific flowering time or cryptic nature. Several geophytic species may have finished flowering during autumn and would likely have been overlooked.
Although a comprehensive survey of the site was done it is still likely that several species were overlooked.
Smaller drainage lines may have been overlooked where a distinct channel or riparian vegetation is absent.
Due to time constraints, only limited soil sampling could be done.
Some animal species may not have been observed as a result of their nocturnal and/or shy habits.

## 3. Methodology

### 3.1 Several literature works were used for additional information.

Vegetation:
Red Data List (Raymondo *et al.* 2009).
Vegetation types (Mucina & Rutherford 2006).
Field guides used for riparian species identification (Bromilow 1995, 2010, Coates-Palgrave 2002, Fish *et al* 2015, Gerber *et al* 2004, Gibbs-Russell *et al* 1990, Grifiths & Picker 2015, Manning 2007 & 2009, Smith *et al* 1998, Van Ginkel *et al* 2011, Van Oudtshoorn 2004, Vlok & Schutte-Vlok 2010).

Terrestrial fauna:
Field guides for species identification (Smithers 1986a, Child *et al* 2016).

Wetland methodology, delineation and identification:
Department of Water Affairs and Forestry 2004, 2005, 2008, Collins 2006, Gerber *et al* 2004, Kleynhans 2000, Marnewecke & Kotze 1999, Macfarlane *at el* 2014, Nel *et al* 2011, SANBI 2009, Van Ginkel *et al* 2011.

### 3.2 Survey

The site was assessed by means of transects and sample plots.

- Noted species include rare and dominant species (Appendix B).
- The broad vegetation types present at the site were determined.
- The state of the environment was assessed in terms of condition, grazing impacts, disturbance by humans, erosion and presence of invader and exotic species.
- The state of the habitat was also assessed.

Animal species were also noted as well as the probability of other species occurring on or near the site according to their distribution areas and habitat requirements.
The state of the habitat was also assessed.

All rivers, streams, pans and wetlands were identified and surveyed where it occurred in the study area.

These systems were delineated by use of topography (land form and drainage pattern) and riparian vegetation with limited soil sampling (Appendix B & C).
The following guidelines and frameworks were used to determine and delineate the rivers, streams, pans and wetlands in the study area:

- Department of Water Affairs and Forestry. 2005. A practical field procedure for identification and delineation of wetlands and riparian areas. Edition 1. Department of Water Affairs and Forestry, Pretoria.
- Marnewecke & Kotze 1999. Appendix W6: Guidelines for delineation of wetland boundary and wetland zones. In: MacKay (Ed.), H. Resource directed measures for protection of water resources: wetland ecosystems. Department of Water Affairs and Forestry, Pretoria.

The following guidelines and frameworks were used to determine the sensitivity or importance of these identified watercourses in the study area:

- Nel *et al.* (2011). Technical Report for the National Freshwater Ecosystem Priority Areas project. WRC Report No. K5/1801.

- Government of South Africa. 2008. National Protected Area Expansion Strategy for South Africa 2008: Priorities for expanding the protected area network for ecological sustainability and climate change adaptation. Government of South Africa, Pretoria.

- Duthie, A. 1999. Appendix W5: IER (floodplain and wetlands) determining the Ecological Importance and Sensitivity (EIS) and Ecological Management Class (EMC). In: MacKay (Ed.), H. Resource directed measures for protection of water resources: wetland ecosystems. Department of Water Affairs and Forestry, Pretoria.

These guidelines provide the characteristics which can be utilised to determine if a wetland or watercourse is present and also aids in determining the boundary of these systems.

A Risk Assessment will be conducted for the mining operations in the study area in accordance with the Department of Water & Sanitation's requirements for risk assessment and the provisional Risk Assessment Matrix for Section 21(c) & (i) water use.

## 3.3 Criteria used to assess sites

Several criteria were used to assess the study area and determine the overall status of the environment.

### 3.3.1 Vegetation characteristics

Characteristics of the vegetation in its current state. The diversity of species, sensitivity of habitats and importance of the ecology as a whole.

Habitat diversity and species richness: normally a function of locality, habitat diversity and climatic conditions.
Scoring: Wide variety of species occupying a variety of niches – 1, Variety of species occupying a single nich – 2, Single species dominance over a large area containing a low diversity of species – 3.

Presence of rare and endangered species: The actual occurrence or potential occurrence of rare or endangered species.
Scoring: Occurrence actual or highly likely – 1, Occurrence possible – 2, Occurrence highly unlikely – 3.

Ecological function: All plant communities play a role in the ecosystem. The ecological importance of all areas though, can vary significantly e.g. wetlands, drainage lines, ecotones, etc.
Scoring: Ecological function critical for greater system – 1, Ecological function of medium importance – 2, No special ecological function (system will not fail if absent) – 3.

Degree of rarity/conservation value:
Scoring: Very rare and/or in pristine condition – 1, Fair to good condition and/or relatively rare – 2, Not rare, degraded and/or poorly conserved – 3.

### 3.3.2 Vegetation condition

The sites are compared to a benchmark site in a good to excellent condition. Vegetation management practises (e.g. grazing regime, fire, management, etc.) can have a marked impact on the condition of the vegetation.

Percentage ground cover: Ground cover is under normal and natural conditions a function of climate and biophysical characteristics. Under poor grazing management, ground cover is one of the first signs of vegetation degradation.
Scoring: Good to excellent – 1, Fair – 2, Poor – 3.

Vegetation structure: This is the ratio between tree, shrub, sub-shrubs and grass layers. The ratio could be affected by grazing and browsing by animals.
Scoring: All layers still intact and showing specimens of all age classes – 1, Sub-shrubs and/or grass layers highly grazed while tree layer still fairly intact (bush partly opened up) – 2, Mono-layered structure often dominated by a few unpalatable species (presence of barren patches notable) – 3.

Infestation with exotic weeds and invader plants or encroachers:
Scoring: No or very slight infestation levels by weeds and invaders – 1, Medium infestation by one or more species – 2, Several weed and invader species present and high occurrence of one or more species – 3.

Degree of grazing/browsing impact:
Scoring: No or very slight notable signs of browsing and/or grazing – 1, Some browse lines evident, shrubs shows signs of browsing, grass layer grazed though still intact – 2, Clear browse line on trees, shrubs heavily pruned and grass layer almost absent – 3.

Signs of erosion: The formation of erosion scars can often give an indication of the severity and/or duration of vegetation degradation.
Scoring: No or very little signs of soil erosion – 1, Small erosion gullies present and/or evidence of slight sheet erosion – 2, Gully erosion well developed (medium to large dongas) and/or sheet erosion removed the topsoil over large areas – 3.

### 3.3.3 Faunal characteristics

Presence of rare and endangered species: The actual occurrence or potential occurrence of rare or endangered species on a proposed site plays a large role on the feasibility of a development. Depending on the status and provincial conservation policy, presence of a Red Data species or very unique and sensitive habitats can potentially be a fatal flaw.
Scoring: Occurrence actual or highly likely – 1, Occurrence possible – 2, Occurrence highly unlikely.

### 3.4 Biodiversity sensitivity rating (BSR)

The total scores for the criteria discussed in section 3.3 were used to determine the biodiversity sensitivity ranking for the sites. On a scale of 0 – 30, five different classes are described to assess the biodiversity of the study area. The different classes are described in the Table 1:

Table 1: Biodiversity sensitivity ranking

| BSR | BSR general floral description | Floral score equating to BSR class |
|---|---|---|
| Ideal (5) | Vegetation is totally transformed or in a highly degraded state, generally has a low level of species diversity, no species of concern and/or has a high level of invasive plants. The area has lost its inherent ecological function. The area has no conservation value and potential for successful rehabilitation is very low. The site is ideal for the proposed development. | 29 – 30 |
| Preferred (4) | Vegetation is in an advanced state of degradation, has a low level of species diversity, no species of concern and/or has a high level of invasive plants. The area's ecological function is seriously hampered, has a very low conservation value and the potential for successful rehabilitation is low. The area is preferred for the proposed development. | 26 – 28 |
| Acceptable (3) | Vegetation is notably degraded, has a medium level of species diversity although no species of concern are present. Invasive plants are present but are still controllable. The area's ecological function is still intact but may be hampered by the current levels of degradation. Successful rehabilitation of the area is possible. The conservation value is regarded as low. The area is acceptable for the proposed development. | 21 – 25 |
| Not preferred (2) | The area is in a good condition although signs of disturbance are present. Species diversity is high and species of concern may be present. The ecological function is intact and very little rehabilitation is needed. The area is of medium conservation importance. The area is not preferred for the proposed development. | 11 – 20 |
| Sensitive (1) | The vegetation is in a pristine or near pristine condition. Very little signs of disturbance other than those needed for successful management are present. The species diversity is very high with several species of concern known to be present. Ecological functioning is intact and the conservation importance is high. The area is regarded as sensitive and not suitable for the proposed development. | 0 - 10 |

## 4. Ecological overview of the site

### 4.1 Overview of ecology and vegetation types

Refer to the list of species encountered on the site in Appendix B and Appendix A for maps and photos of the site and surroundings.

According to Mucina & Rutherford (2006) the area consists of Matjiesfontein Shale Renosterveld (FRs 6). This vegetation type is currently listed as being of Least Concern (LC) under the National List of Threatened Ecosystems (Notice 1477 of 2009) (National Environmental Management Biodiversity Act, 2004) (Map 2). It is not currently subjected to any pronounced transformation pressures and the conservation value of this vegetation type is therefore relatively low.

The Western Cape Biodiversity Spatial Plan (2017) has recently been published and has identified areas which are essential to meeting conservation targets for specific vegetation types, i.e. Critical Biodiversity Areas. The site in question is listed as being largely an Other Natural Area (ONA) although the southern stream system is also listed as being an Ecological Support Area 1 and 2 (Map 3). However, although this is not a Critical Biodiversity Area it still functions in ecological support of such surrounding areas and supports surrounding watercourses and wetlands. This functioning and support should therefore be retained as far as possible.

The site is situated at the foot of the Klein Swartberge on a Portion of Portion 5 of the Farm Bezemfontein 213 (Map 1). The site is situated approximately 50 km to the north east of Ladismith and approximately 70 km to the south east of Laingsburg and has an eextent of 4.99 hectares. The site is situated at the foot of the north facing slopes of the Klein Swartberg where sands eroding from the slopes are continuously deposited. The site does contain some transformation in the form of a large artificial impoundment and embankment but is still largely natural. Two prominent and largely natural stream system are also present on the site (Map 1). The proposed mining development will excavate sand from a low mound between the streams. The mining activities are not anticipated to utilise any processing plant and will remain at a very small scale.

The site survey was conducted in spring (October 2019) when most species are in flower and consequently species identification is considered adequate and accurate. Furthermore, the area burned about four years previously (*pers. comm.* J. Hunlun) and was not senescent at the time of survey and species diversity considered close to its climax. However, re-establishment of vegetation after the recent fire is evidently not high. This is considered most likely as a result of two-fold disturbance on the site. The site experiences a high natural disturbance regime as sands eroded from the slopes of the mountain is continuously deposited on the site and the sandy soils are also highly mobile, continuously shifting and is easily eroded. Secondly, the site is also affected by relatively high levels of trampling and overgrazing by domestic stock which also decreases the vegetation cover and increases erosion of the sandy soils. Other smaller impacts such as the culverts and drainage from the adjacent gravel road will also contribute to erosion.

In general, the site is considered to be largely natural, but as indicated above is subjected to significant disturbance, both natural and artificially induced. In addition, another large impact on the site and especially affecting the two small stream systems is a large artificial impoundment with an earthen embankment (Map 1). This inundates and transforms a significant portion of the natural vegetation but also modifies the flow and flooding regime of the two small stream systems significantly.

The habitat on the site is predominately formed by sands deposited by alluvial deposition. The site is situated at the foot of the north facing slope of the Klein Swartberg. The geology of this mountain range consists of the Table Mountain Sandstone Group which easily erodes into a fine sand. Rainfall along the peaks and steep slopes create runoff with a high velocity, which therefore cause erosion of these sandy soils down the slope to the foot of the mountain. Here the slope drastically and suddenly decreases to a flat plain with low ridges to the north. This essentially halts water flow which allows for the deposition of the sands and forms an alluvial plain. The low ridge to the north functions as a barrier and water flow therefore takes place in parallel to the mountain slope, i.e. west to east. Although water is slowed drastically at the foot of the mountain, large flow events or flooding has caused the formation of two prominent channels, incised into the sandy alluvial plain. These channels form two prominent streams, also associated with wetland conditions but will be discussed in more detail in the following sections (Map 1). The aim of the mining activities will be to excavate and remove the accumulated sands between these two streams.

Geologically the site is still dominated by the Table Mountain Sandstone Formation though shales of the Witteberg Group becomes evident along the northern border of the site. As a result, the site can also be regarded as forming an ecotone between the fynbos vegetation associated with the sandy soils derived from the sandstone and the renosterveld vegetation associated with the clayey soils derived from the adjacent shales. This is also reflected in the species composition on the site which contains elements of both the adjacent North Swartberg Sandstone Fynbos (FFs 23) as well as the Matjiesfontein Shale Rensoterveld (FRs 6) (Map 2).

Soils on the site is dominated by deep sands, although soils with a higher loam and clay content become more prominent along the northern border of the site as well as along the two streams which are deeply incised into the surrounding sands.

The mean annual rainfall for the region is 300 mm. However, as a result of the proximity to the Klein Swartberg which receives a considerably higher rainfall of up 580 mm, it is considered highly likely that the site will also receive a higher rainfall than the regional norm.

The vegetation structure in the majority of the site occurring on the central alluvial sand embankment is dominated by a very sparse shrub, grass and cape reed layer. The vegetation becomes much denser along the two streams where cape reeds, shrubs and grasses become dominant. The Rhinoceros Bush (*Elytropappus rhinocerotis*) is also prominent in most areas of the site but becomes especially abundant along the northern border of the site where shales are more prominent.

The vegetation in the central portion of the site is situated on the elevated alluvial sand embankment. The soils are fast draining with a low soil moisture content and vegetation here is better adapted to this. Several vegetation structural elements are present and will be listed separately. A very sparse grass layer is present represented by a few species adapted to arid environments. These include *Ehrharta calycina, Tribolium hispidum, Stipagrostis sp.* and *Pentameris airoides*. The cape reed layer is somewhat more prominent and represented by scattered clumps and include *Hypodiscus striatus, Restio gaudichaudianus* and *Willdenowia bolusii*. Low and dwarf shrubs are quite abundant and forms a significant component.

Prominent species include *Stoebe plumosa, Pteronia stricta, Metalasia densa, Erica quadrangularis, Chrysocoma ciliata, Rafnia racemosa* subsp. *racemosa, Erica cerinthoides* and *Euryops lateriflorus*. Associated with this layer is also several proteoid species which include *Leucadendron barkerae, L. eucalyptifolium, Protea eximia* and *P. repens*. A few herbaceous species are also present and include *Pelargonium ovale, Psammotropha anguina* and *Helichrysum acrophilum*. Another vegetation element which also substantiates that this portion is dominated by arid fynbos is several succulent species which include *Crassula cotyledonis, C. dependens, Antimima sp., Ruschia caroli* and *Lampranthus sp.* In conclusion, the vegetation on the high alluvial sand embankment consists of a moderately diverse species composition represented by several growth forms or structural elements although the vegetation layer is quite sparse. No species of high conservation significance or endangered, rare or Red Listed species are present and all species on the site are considered relatively widespread. However, a high proportion of the species are still protected with five protected proteoid species, two Erica species and three Vygie species occurring in this area. However, the proposed mining area is of small extent and seeing as none of these species are rare, endangered or localised their loss is not anticipated to be high. Permits will however have to be acquired to remove these plants. Furthermore, provided that comprehensive rehabilitation and adequate management of topsoil is undertaken it is highly likely that several of these will be able to re-establish on the site after mining has ceased. This will also be the portion of the site which will be most affected by sand excavation (Map 1).

The northern border of the site contains a much higher proportion of shale with loam/clayey soils and this alters the vegetation structure and species composition significantly. This portion is also somewhat degraded by the proximity of the gravel road. The low shrub, *Elytropappus rhinocerotis*, is dominant here although a few other dwarf shrubs such as *Eriocaphalus africanus, Chrysocoma ciliata* and *Pelargonium fruticosum* is also present. A few herbaceous species are also present with some of these also being indicative of disturbance, including *Gomphocarpus fruticosus, Berkheya sp.* and *Carpobrotus edulis*. This portion of the site is considered to have a low species diversity and consequently a low sensitivity and conservation value. It will however be least affected by the proposed sand excavation but will be affected by a proposed access road (Map 1).

The vegetation along the two stream systems are much the same and will be discussed together. Here the vegetation cover becomes much denser, though dominated by fewer species. The cape reed, *Elegia capensis*, forms dense stands along these streams and is also a reliable indicator of wetland areas. The riparian grass, *Pennisetum macrourum*, is also abundant, especially along the northern stream. The protected geophyte, *Watsonia angusta*, is also abundant along the streams. Other prominent though scattered shrubs occurring along the streams include *Psoralea arida* (*sp. nov*.), *Othonna parviflora, Anthopsermum aethiopicum, Helichrysum petiolare, Selago glomerata, Lobelia linearis* and *Erica discolor*. The above vegetation is most prominent along the banks of the streams whilst the narrow main channel contains a much shorter vegetation layer dominated by sedges, rushes and a few herbaceous species. This include the sedge, *Ficinia nodosa, Epischoenus sp.* and *Isolepis setacea*, the rush, *Juncus lomatophyllus*, the cape reed, *Hygrophilus rattrayi,* the herb, *Centella asiatica* and the geophyte, *Zantedeschia aethiopica*. Though not diverse or containing a high amount of protected species these streams are still considered to have a high conservation value. They perform important functions and will influence downstream sections. It is therefore recommended that these streams be excluded from the proposed mining operations (Map 1). The proposed access road should also endeavour not to cross these streams but rather follow the already transformed embankment of the artificial impoundment (Map 1). Furthermore, these streams are incised into the surrounding alluvial sands and the banks and channel is dominated by soils with a much higher clay content which would not be usable in the construction industry (Appendix C).

A note should also be made about *Protea convexa*. This species is currently listed as being Critically Endangered (CR) and has previously been recorded in this immediate vicinity (SANBI 2016). This is however a very distinctive species and can with certainty be regarded as being absent from the site. It is much more likely to occur on the low shale ridges to the north of the site.

The site is also located immediately north of the northern border of the Towerkop Nature Reserve (Approximately 120 meters) (Map 2 & 3). The site is however located downslope of the nature reserve and mining operations will therefore not be able to have any impact on it.

From the description of the vegetation on the site it is clear that natural vegetation dominates the site though significant disturbance is also present. The ecological processes on the site are clearly defined and should allow for adequate management of mining operations and rehabilitation after cessation of mining activities. The site contains an elevated alluvial sand embankment which will be the main area of sand excavation (Map 1). This portion has a moderate species diversity, though sparse vegetation cover with a high proportion of protected species. None of these are however rare or endangered and they are all relatively widespread. Consequently the conservation value of this portion is only considered moderate. However, should mining occur, the necessary permits will have to be obtained to remove the protected species in this portion. Comprehensive rehabilitation and adequate management of topsoil will also be important. This portion of the site is bordered to the north and south by two streams which are considered to have a high conservation value (Map 1). It is therefore recommended that these be excluded from the mining area and that the proposed access road avoid crossing these streams.

### 4.2 Overview of terrestrial fauna (actual & possible)

The site contains several signs and tracks of mammal species and it is considered likely that the mammal population on the site will be close to natural. Watercourses, especially perennial systems, contain a higher moisture regime compared to surrounding habitats and are therefore able to produce a much higher biomass with a higher diversity of habitat. As a result they often sustain a varied and significant mammal population. This will most likely also be the case on the site. The proximity of the gravel road and livestock farming will likely cause some modification to the natural mammal population but is not considered significant. It may therefore also be likely that the site may contain species of conservation significance. It is also likely that the site will also contain several other mammal species but these were not observed on the site.

Tracks and signs of mammals included the following:

Tunnels of one of the Golden Mole species occur along the shore of the artificial dam on the site. According to distribution data this can only be either the Cape Golden Mole (*Chrysochloris asiatica*) or the Fynbos Golden Mole (*Amblysomus corriae*). Of these the former is listed as being of Least Concern (LC) whilst the latter is listed as Near Threatened (NT). The proposed mining activities are anticipated to have an impact on this species since removal of sand will directly affect the habitat. The extent of operations is however small which therefore also limit the area of impact.

Dung of a small antelope were observed and is most likely a Common Duiker (*Sylvicapra grimmea*) or Steenbok (*Raphicerus campestris*). Although both are widespread and common their presence does indicate that the site is still able to sustain a significant population of mammals.

The impact that the proposed mining operations will have is mainly the loss of habitat which will decrease the available habitat for faunal species. The faunal population will vacate the site into adjacent natural areas which will put a strain on surrounding populations. However, the development will be of such low extent (approximately 5 hectares) that this impact cannot be considered as high.

It is recommended that any hunting, trapping or capturing be strictly prohibited. As mining activities commence they will vacate the area by their own accord. Provided that adequate rehabilitation is undertaken it is likely that the site will again be available as habitat to opportunistic species.

Mammals species likely to occur on the site has been determined by means of FitzPatrick Institute of African Ornithology (2019). Two Red Listed species has been noted to occur in this region though the proposed mining operations are not anticipated to have any direct impact on them.

Table 2: Red Listed mammals occurring or likely to occur in the study area (Child *et al* 2016).

| Common name | Scientific name | Status |
|---|---|---|
| Vaal Rhebok | *Pelea capreolus* | **Near Threatened (NT)** |
| Leopard | *Panthera pardus* | **Vulnerable (VU)** |

Table 3: Likely mammal species in the region.

| Family | Common name | Scientific name | Status |
|---|---|---|---|
| Bovidae | Klipspringer | *Oreotragus oreotragus* | |
| | Vaal Rhebok | *Pelea capreolus* | **Near Threatened (NT)** |
| | Cape Grysbok | *Raphicerus melanotis* | |
| | Bush Duiker | *Sylvicapra grimmia* | |
| | Greater Kudu | *Tragelaphus strepsiceros* | |
| Canidae | Black-backed Jackal | *Canis mesomelas* | |
| Cercopithecidae | Chacma Baboon | *Papio ursinus* | |
| Felidae | Caracal | *Caracal caracal* | |
| | Wildcat | *Felis silvestris* | |
| | Leopard | *Panthera pardus* | **Vulnerable (VU)** |
| Herpestidae | Marsh Mongoose | *Atilax paludinosus* | |
| | Yellow Mongoose | *Cynictis penicillata* | |
| | Egyptian Mongoose | *Herpestes ichneumon* | |
| | Cape Gray Mongoose | *Herpestes pulverulentus* | |

| | | | |
|---|---|---|---|
| Hyaenidae | Aardwolf | *Proteles cristata* | |
| Hystricidae | Porcupine | *Hystrix africaeaustralis* | |
| Leporidae | Smith's Red Rock Rabbit | *Pronolagus rupestris* | |
| Molossidae | Egyptian Free-tailed Bat | *Tadarida aegyptiaca* | |
| Muridae | Namaqua Rock Mouse | *Aethomys namaquensis* | |
| Mustelidae | Honey Badger | *Mellivora capensis* | |
| Orycteropodidae | Aardvark | *Orycteropus afer* | |
| Procaviidae | Cape Rock Hyrax | *Procavia capensis* | |
| Suidae | Red River Hog | *Potamochoerus porcus* | |
| Vespertilionidae | Melcks' Serotine | *Pipistrellus melckorum* | |
| Viverridae | Common Genet | *Genetta genetta* | |
| Viverridae | Cape Genet (Cape Large-spotted Genet) | *Genetta tigrina* | |

### 4.3 Wetland Assessment

The site consists of the sand mining area with extent of approximately 5 hectares and contains two small stream system bordering the site to the north and south (Map 1 & Appendix A). The proposed development will include excavation of sand from the alluvial floodplain and construction of an access road to remove the product from the site. The streams will be excluded from mining operations but may still be affected by it. These two systems will be discussed below.

The classification of stream orders from 1 to 3 can be illustrated by means of the Strahler 1952 classification:

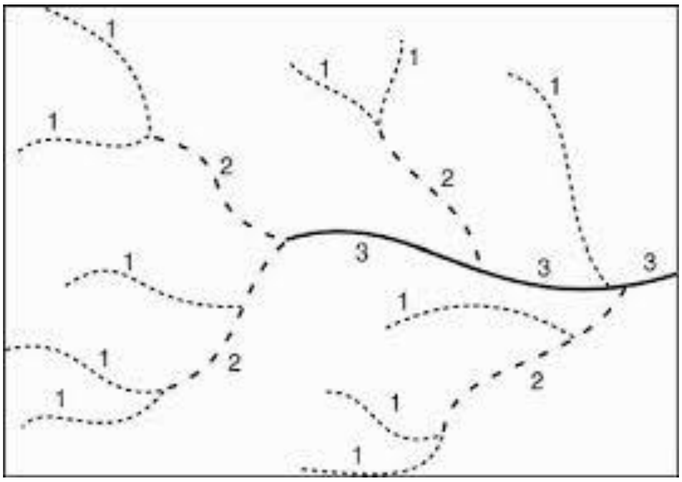


Figure 1: The classification of stream orders from 1 to 3 (Strahler 1952)

The term watercourse refers to a river, stream, wetland or pan. The National Water Act (NWA, 1998) includes rivers, streams, pans and wetlands in the definition of the term watercourse. This definition follows:

Watercourse means:

- A river or spring.
- A natural channel in which water flows regularly or intermittently.
- A wetland, lake or dam into which water flows.
- Any collection of water which the Minister may, by notice in the Gazette, declare to be a watercourse, and a reference to a watercourse includes, where relevant, its bed and banks.

Riparian habitat is an accepted indicator of watercourses used to delineate the extent of wetlands, rivers, streams and pans (Department of Water Affairs and Forestry 2005).

The streams and any associated wetland conditions were delineated by use of topography (land form and drainage pattern) and riparian vegetation with limited soil sampling (Appendix C). The following guidelines and frameworks were used to determine and delineate the watercourses and wetlands in the study area:

- Department of Water Affairs and Forestry. 2005. A practical field procedure for identification and delineation of wetlands and riparian areas. Edition 1. Department of Water Affairs and Forestry, Pretoria.
- Marnewecke & Kotze 1999. Appendix W6: Guidelines for delineation of wetland boundary and wetland zones. In: MacKay (Ed.), H. Resource directed measures for protection of water resources: wetland ecosystems. Department of Water Affairs and Forestry, Pretoria.
-

Where FW or OW is indicated it refers to Facultative or Obligate Wetland species. A facultative wetland species is often associated with wetlands but is also able to occur in non-wetland areas. Obligate wetland species are confined to wetlands and are only able to occur in wetlands. They are therefore reliable indicators of wetland conditions. Field observations over time as well as the following sources were used to determine Facultative Wetland (FW) and Obligate Wetland (OW) species:

- Marnewecke, G. & Kotze, D. 1999. Appendix W6: Guidelines for delineation of wetland boundary and wetland zones. In: MacKay (Ed.), H. Resource directed measures for protection of water resources: wetland ecosystems. Department of Water Affairs and Forestry, Pretoria.

- DWAF. 2008. Updated manual for the identification and delineation of wetlands and riparian areas, prepared by M.Rountree, A.L. Batchelor, J. MacKenzie and D. Hoare. Stream Flow Reduction Activities, Department of Water Affairs and Forestry, Pretoria, South Africa.

Obligate wetland vegetation was utilised to determine the presence and border of wetlands. Soil samples were used to determine the border and also to confirm the presence of wetland soils along the small streams on the site (Appendix C). Soil samples were investigated for the presence of anaerobic evidence which characterises wetland soils. Soil samples taken along the main channel of these streams contain clear signs of wetland conditions and is also indicative of a perennial zone of wetness. Wetland conditions can therefore be confirmed to be present along these two small stream systems. The boundary of the wetland conditions were not easily determined by means of soil sampling. However, obligate wetland vegetation could be easily utilised to provide an accurate border of wetland conditions. Obligate wetland species are only able to inhabit wetland areas and as a result where they occur wetland conditions can be assumed to occur. The obligate wetland cape reed (*Elegia capensis*), riparian grass (*Pennisetum macrourum*) and geophyte (*Watsonia angusta*) was utilised to provide a quite accurate boundary of wetland conditions and the floodplain of these streams (Map 1).

Along the northern stream system there is also an artificial crescent shaped channel and berm (Map 1). This furrow or channel diverts a portion of the flow in the stream although its intended function is unclear. It has however also manifested some wetland conditions due to continued inundation and saturated soil conditions. These wetland conditions are however artificial and do not perform any function which is important to the continued natural functioning of the stream. This channel and berm can therefore be included in the sand excavation operations without having a large impact on the functioning of the stream.

### 4.3.1 Classification of wetland systems

**The main channel and marginal zone can be characterised as a channel wetland system (SANBI 2009):**

"An open conduit with clearly defined margins that (i) continuously or periodically contains flowing water, or (ii) forms a connecting link between two water bodies. Dominant water sources include concentrated surface flow from upstream channels and tributaries, diffuse surface flow or interflow, and/or groundwater flow. Water moves through the system as concentrated flow and usually exits as such but can exit as diffuse surface flow because of a sudden change in gradient. Unidirectional channel-contained horizontal flow characterises the hydrodynamic nature of these units. Note that, for purposes of the classification system, channels generally refer to rivers or streams (including those that have been canalised) that are subject to concentrated flow on a continuous basis or periodically during flooding, as opposed to being characterised by diffuse flow (see unchanneled valley-bottom wetland). As a result of the erosive forces associated with concentrated flow, channels characteristically have relatively obvious active channel banks. An active channel is a channel that is inundated at sufficiently regular intervals to maintain channel form and keep the channel free of established terrestrial vegetation. These channels are typically filled to capacity during bankfull discharge (i.e. during the annual flood, except for intermittent rivers that do not flood annually)."

This accurately describes the two stream systems on the site. Wetland conditions are mostly confined to the main channel and decreases from the edge of the main channel (Map 1). However, the northern stream contains a portion with a lower gradient, a more diffuse flow regime and consequently also contains elements of an **unchanneled valley-bottom wetland (SANBI 2009)**. A description of this type of wetland is also provided to provide a more complete picture of the functioning of these systems on the site:

"a mostly flat valley-bottom wetland area without a major channel running through it, characterised by an absence of distinct channel banks and the prevalence of diffuse flows, even during and after high rainfall events. Water inputs are typically from an upstream channel, as the flow becomes dispersed, and from adjacent slopes (if present) or groundwater. Water generally moves through the wetland in the form of diffuse surface flow and/or interflow (with some temporary containment of water in depressional areas), but the outflow can be in the form of diffuse or concentrated surface flow. Infiltration and evaporation from unchannelled valley-bottom wetlands can be significant, particularly if there are a number of small depressions within the wetland area. Horizontal, unidirectional diffuse surface-flow tends to dominate in terms of the hydrodynamics."

However, both these stream systems flow into the artificial impoundment along the eastern border of the site (Map 1). In addition, where runoff from the steep mountain slopes to the south reaches the alluvial plain it is also likely that seepage areas may be present. These will however be located upstream of the mining area and not in close proximity and should therefore not be affected by mining operations and has therefore not been included in this assessment.

### 4.3.2 Description of the stream systems

River systems can be divided into different riparian zones within the lateral section of the system. These zones are as follows:

The marginal zone is the lowest zone and is always present in river systems while the other two zones may not always be present. The zone is situated from the water level at low flow, if present, up to the features that are hydrologically activated for the most of the year (Figure 2). Despite the small size of the streams on the site the lateral zones can still be quite accurately differentiated. The main channel of these streams are quite narrow and dominated by low sedges and semi-aquatic vegetation adapted to almost permanently saturated soils. The border between the marginal and lower zone can also be differentiated as a sudden increase in the slope which are quite steep along the banks of the streams. The marginal zone can also be regarded as mostly natural although trampling by cattle is evident in some areas.

The lower zone is characterised by seasonal features and extends from the marginal zone up to an area of marked elevation. This area may be accompanied by a change in species distribution patterns. The lower zone consists of geomorphic features that are activated on a seasonal basis (Figure 2). The lower zone along the banks of the streams are clearly defined and consists of a definite and steep slope. Obligate wetland vegetation is present and are dominated by cape reed (*Elegia capensis*), geophytes (*Watsonia angusta*) and riparian grass (*Pennisteum macrourum*). The vegetation may however also be much lower in density as a result of the steep slopes of the banks and significant erosion. Wetland conditions should therefore still be regarded as present, though only on a seasonal basis. The lower zone can be regarded as largely natural although significant erosion is present, this however also considered part of the natural cycle of these systems. It may be increased to some degree by trampling of domestic stock.

The upper zone is characterised by ephemeral features as well as the presence of both riparian and terrestrial species. The zone extends from the lower zone to the riparian corridor. The upper zone contains geomorphic features that are hydrologically activated on an ephemeral basis (Figure 2). The upper zone at the site is clearly visible as a decrease in slope and consists exclusively of terrestrial vegetation with wetland species absent. The zone is considered as the edge of these streams and indicate the absence of wetland conditions. It is also considered to be largely intact and unmodified.

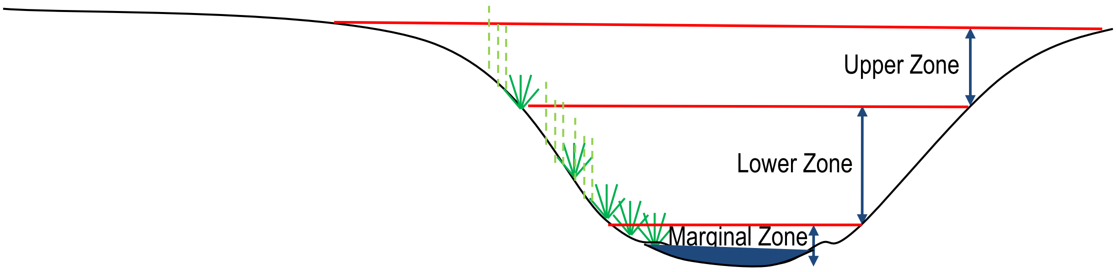


Figure 2: Illustration showing the different riparian zones along the two streams on the site.

#### 4.3.3 Condition and importance of the affected watercourses

The determination of the condition of the stream systems at the site will be based on an overall determination of the Index of Habitat Integrity (IHI) (Appendix D). This is considered to give a good representation of the condition of these systems. The IHI will be taken as representative of the Present Ecological State (PES) of the streams.

Table 2 refers to the determination and categorisation of the Present Ecological State (PES; health or integrity) of various biophysical attributes of rivers relative to the natural or close to the natural reference condition. The purpose of the Eco Classification process is to gain insights and understanding into the causes and sources of the deviation of the PES of biophysical attributes from the reference condition. This provides the information needed to derive desirable and attainable future ecological objectives for the river (Kleynhans & Louw 2007).

Table 3 refers to the Ecological Importance and Sensitivity (EIS) of wetlands. "Ecological importance" of a water resource is an expression of its importance to the maintenance of ecological diversity and functioning on local and wider scales. "Ecological sensitivity" refers to the system's ability to resist disturbance and its capability to recover from disturbance once it has occurred. The Ecological Importance and Sensitivity (EIS) provides a guideline for determination of the Ecological Management Class (EMC).

Table 2: Ecological categories for Present Ecological Status (PES).

| Ecological Category | Description |
|---|---|
| A | Unmodified, natural |
| B | Largely natural with few modifications. A small change in natural habitats and biota may have taken place but the ecosystem functions are essentially unchanged. |
| C | Moderately modified. Loss and change of natural habitat and biota have occurred, but the basic ecosystem functions are still predominately unchanged. |
| D | Largely modified. A large loss of natural habitat, biota and basic ecosystem function has occurred. |
| E | Seriously modified. The loss of natural habitat, biota and basic ecosystem functions is extensive. |
| F | Critically/Extremely modified. Modifications have reached a critical level and the system has been modified completely with an almost complete loss of natural habitat and biota. In the worst instances the basic ecosystem functions have been destroyed and the changes are irreversible. |

Table 3: Ecological importance and sensitivity categories.

| Ecological Importance and Sensitivity Category (EIS) | Range of Median | Recommended Ecological Management Class |
|---|---|---|
| Very High<br>Floodplains that are considered ecologically important and sensitive on a national or even international level. The biodiversity of these floodplains is usually very sensitive to flow and habitat modifications. They play a major role in moderating the quantity and quality of water of major rivers. | >3 and <=4 | A |
| High<br>Floodplains that are considered to be ecologically important and sensitive. The biodiversity of these floodplains may be sensitive to flow and habitat modifications. They play a role in moderating the quantity and quality of water of major rivers. | >2 and <=3 | B |
| Moderate<br>Floodplains that are considered to be ecologically important and sensitive on a provincial or local scale. The biodiversity of these floodplains is not usually sensitive to flow and habitat modifications. They play a small role in moderating the quantity and quality of water of major rivers. | >1 and <=2 | C |
| Low/marginal<br>Floodplains that are not ecologically important and sensitive at any scale. The biodiversity of these floodplains is ubiquitous and not sensitive to flow and habitat modifications. They play an insignificant role in moderating the quantity and quality of water of major rivers. | >0 and <=1 | D |

Due to the small size of the streams on the site they have not been included in any previous desktop estimates (Kleynhans 2000). Although largely natural the functioning of these streams has been modified by several significant impacts.

The two streams are considered to be mostly natural though some increased erosion due to trampling by domestic stock is likely (Appendix A). Trampling along the main channel is evident as well as heavy overgrazing of especially riparian grasses. This will decrease the vegetation, mobilise the sandy sediments and in so doing increase erosion and sedimentation of the streams.

The functioning of these streams is considered highly modified by the artificial impoundment along the eastern border of the site (Map 1). A small artificial channel and berm along the northern stream will likely also cause some modification to its functioning. The large impoundment will retain all surface flow and will considerably retard flooding events. This is also clearly evident in the downstream areas which have become choked by exotic trees as flooding events are no longer able to remove these. It is clear that this impoundment has heavily modified the natural flow and flooding regime of these streams. Furthermore, concentrated overflow is also clearly contributing to erosion. The small channel and berm will also divert a portion of flow and flooding events into the terrestrial interior portion of the site and will result in a further significant modification.

A gravel road occurs to the north of the site (Map 1). This road clearly causes some localised impacts. The most significant impact on the northern stream system are culverts underneath the road which contributes to concentrated runoff leading to some erosion. This will also contribute to the sediment load in the stream.

The following aerial photographs also illustrate impacts and changes on the site over time (Figure 3 – 4).

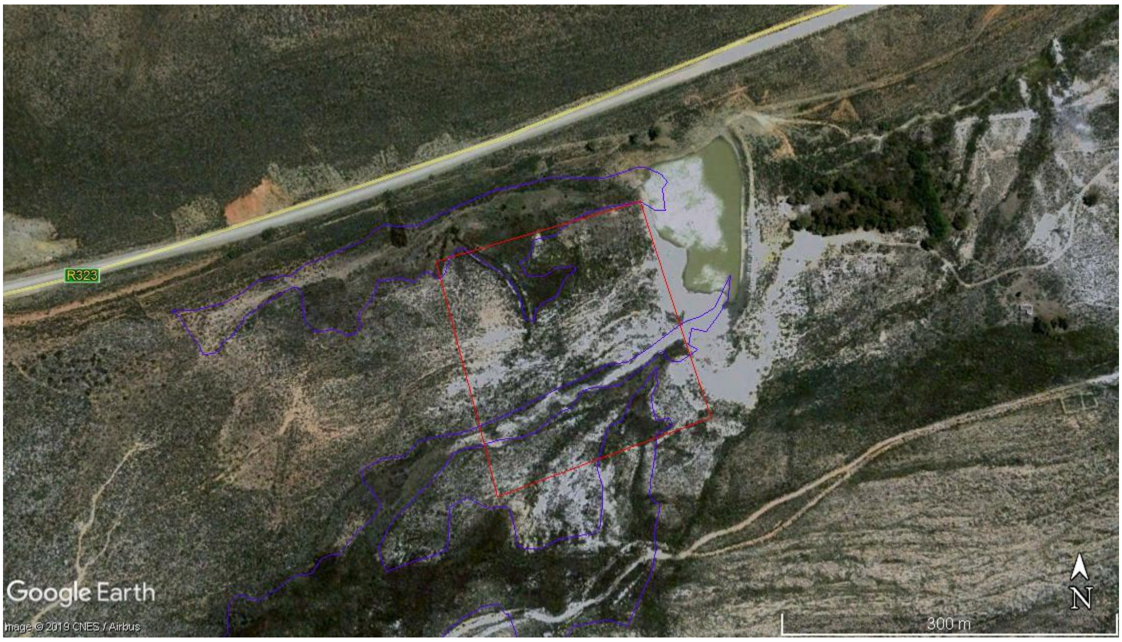


Figure 3: Aerial view of the site showing the site, the delineated borders of the two streams and the artificial impoundment (Google Earth 2006). Note also the small artificial channel and berm along the northern stream. Note also a significant vegetation cover is present although areas of sheet erosion is evident.


Figure 4: Aerial view of the site showing the site, the delineated borders of the two streams and the artificial impoundment (Google Earth 2018). Note that the border of the streams are much more easily discernible here and that the vegetation cover is considerably lower after the recent fire, *circa* 2016.

Diversity of plant species in the area is considered moderate with numerous protected species also being present. No rare or endangered species were encountered but this likelihood cannot be discounted. The site is clearly still natural to a large degree.

The two affected stream systems are both first order as they form the origin of this system. The quaternary catchment of the area is J24F. The streams are affected by a few significant impacts which largely modify the flow and flooding regime. An Index of Habitat Integrity (IHI) was conducted for the two affected streams (Appendix D). The results of the IHI indicated that the study area has an Instream IHI of Category C: Moderately Modified and Riparian IHI of Category C: Moderately Modified. This can be mostly attributed to the modification of the streams brought about by the artificial impoundment.

The EI&S of the stream systems has been rated as being High: Floodplains that are considered to be ecologically important and sensitive. The biodiversity of these floodplains may be sensitive to flow and habitat modifications. They play a role in moderating the quantity and quality of water of major rivers.

### 4.3.4 Risk Assessment

A Risk Assessment for the proposed sand mine and affected stream systems has been undertaken according to the Department of Water & Sanitation's requirements for risk assessment and the provisional Risk Assessment Matrix for Section 21(c) & (i) water use (Appendix E). Activities which will be implemented by the sand mining operations and which may affect the streams include the excavation of sand from the alluvial embankment between them and an access road to this embankment for the removal of excavated sand.

The mining operations are anticipated to remain at a very small scale, consisting only of a temporary excavator as the need dictates and without storage of any hazardous materials or wastes. This will significant decrease the risk on the streams. However, as indicated these streams must be regarded as highly sensitive. They should therefore be excluded from any mining activities and the necessary mitigation, mining methods and procedures implemented to minimise any impacts on them (Map 1). Should these be implemented the risk should remain moderate. Firstly, the excavation of sand should be restricted to the central embankment of alluvial sand (Map 1). Secondly, the depth of sand excavation should not exceed the level of the banks of these streams. This should be feasible since adequate material is not present beyond this depth. In addition, the border between mined areas and adjacent natural areas should be faired in so that sheer drops or steps are avoided as these will cause significant erosion. Thirdly, the site will remain highly susceptible to erosion and comprehensive rehabilitation, including adequate management of topsoil, will be crucial. Extended monitoring and implementation of erosion measures will also be necessary.

The alluvial plain on the site is highly conducive to erosion and even when comprehensive erosion management measures are implemented it remains likely that sand mining will considerably increase the sediment load in downstream sections. However, the artificial impoundment essentially acts as a sediment trap and will prevent any mobilised sediments from entering the downstream sections. This will effectively contain impacts associated with sand mining in the immediate area.

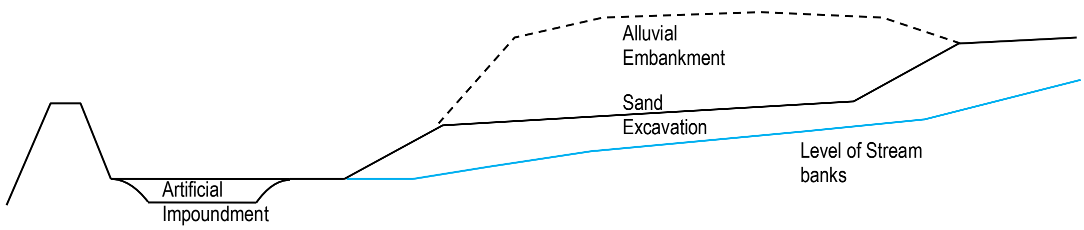


Figure 5: Lateral view of the sand mining of the alluvial embankment which illustrates that the depth of sand excavation should not exceed the depth of the banks of the stream systems, should retain gradual slopes and no sheer drops.

The excavated sand will have to be transported from the site by trucks and heavy vehicles and will require an adequate access road which may affect the two stream systems. Crossing of these streams by such a road will have a significant impact on them and should be avoided. This can be achieved by utilising an existing small dirt track which can be upgraded and accessing the site via the dam shore which is already an artificial and degraded area and will prevent impacting on the stream systems (Map 1). Should this route be used the risk should remain low. It is however also subject to the upgrading of the existing track minimising erosion and its design allowing for adequate drainage of surface runoff without exacerbating erosion.

Moderate Risks: Risk and impact on watercourses are notable and require mitigation measures on a higher level.

Low Risks: Acceptable as is or consider requirement for mitigation. Impact to watercourses and resource quality small and easily mitigated.

For the complete risk assessment please refer to Appendix E.

| No. | Phases | Activity | Aspect | Impact | Risk Rating | Confidence level | Control measures |
|---|---|---|---|---|---|---|---|
| 1 | Mostly Operational Phase but also limited during rehabilitation | Sand mining operations | Extraction of sand from the alluvial sand embankment between the two stream systems. | Sand will be extracted from the alluvial sand embankment between the stream systems which may increase sedimentation, promote erosion and alter the functioning and geomorphology of the adjacent stream systems. | **M** | **4** | The extraction of sand will be confined to the central alluvial embankment and the stream systems themselves will be excluded from mining activities. However, due to the close proximity and erosive sandy soils the streams are still likely to be affected by sand excavations. This will mostly be in the form of erosion, sedimentation and modification of the riparian habitat of the streams.<br><br>These impacts can be mitigated by limiting the depth of sand excavation to the level of the banks of these streams. Furthermore, comprehensive rehabilitation will be necessary, adequate topsoil management and monitoring and remediation of erosion. |
| | Mostly Operational Phase but also limited during rehabilitation | | Access road from the main gravel road the alluvial sand embankment. | The access road will consist of the upgrading of the existing dirt track and will cross the shore of the artificial impoundment. | **L** | **4** | It is recommended that the proposed access road utilise the existing dirt track and that crossing of the stream systems area avoided.<br><br>As long as the dirt track is utilised and accesses the site via the shore of the artificial dam the impact should remain low. This is also subject to the upgrading and design of the access road minimising erosion and allows for adequate storm water drainage. |

## 5. Anticipated impacts

The sand mine will undoubtedly contribute to impacts on the stream systems and habitat on the site itself (Map 1). As a result strict mitigation measures will have to be implemented to ensure that impacts are kept to a minimum. Predicted impacts include increased sedimentation of the streams, increased establishment of weeds and invaders, loss of habitat and diversity and increased erosion due to disturbance of sandy soils.

The loss of vegetation and habitat will mostly occur on the alluvial sand embankment where sands will be excavated from. As previously indicated, the vegetation type on the site, Matjiesfontein Shale Renosterveld (FRs 6), as well as the Western Cape Biodiversity Spatial Plan (2017) categories of the site indicate that it has a relatively low conservation value (Map 2 & 3). However, the site still contains vegetation in a relatively natural condition. Clearing of the vegetation layer will likely increase the surface runoff volumes and velocity, contributing to erosion and mobilisation of sediments. The artificial impoundment may act as sediment trap though it will still be important to manage runoff and erosion on the site. Adequate topsoil management will be important and the upper 30 cm of soil should be removed, stored on site and utilised during the rehabilitation of the site. Sediments from the site should be prevented from entering the adjacent stream systems and it is recommended that berms be erected between the site and these streams. Mining activities should be confined to the alluvial sand embankment as indicated (Map 1) and should exclude the adjacent stream systems, treating these as no-go areas. The proposed access road will also require the removal of vegetation, however, should the proposed access road follow the existing dirt track this impact will remain relatively low (Map 1).

The site also does not contain any rare or endangered species of high conservation value though it may still be possible that such a species may be present on the site. However, a high proportion of protected species are present, including five protected proteoid species, two Erica species and three Vygie species occurring in this area (Appendix B). However, the proposed mining area is of small extent and seeing as none of these species are rare, endangered or localised their loss is not anticipated to be high. Permits will however have to be acquired to remove these plants. Furthermore, provided that comprehensive rehabilitation and adequate management of topsoil is undertaken it is highly likely that several of these will be able to re-establish on the site after mining has ceased.

The anticipated impact on the adjacent stream systems has been discussed previously (4.3.4 Risk Assessment) and it is considered likely that the impact can be restricted to moderate, provided adequate mitigation is implemented. Should this mitigation be implemented the proposed mining should also not have any long-lasting impacts on these streams.

Due to the removal of vegetation and disturbance of the soil surface the mining area is highly susceptible to the establishment of weeds. Coupled with annual flooding which also causes natural disturbance the establishment of weeds is a high possibility. It is therefore recommended that weed control be judiciously and continually practised. Monitoring of weed establishment should form a prominent part of management of the mining area. Where category 1 and 2 weeds occur, they require removal by the property owner according to the Conservation of Agricultural Resources Act, No. 43 of 1983 and National Environmental Management: Biodiversity Act, No. 10 of 2004.

The impact that the proposed mining operations will have on fauna is mainly the loss of habitat which will decrease the available habitat for faunal species. The faunal population will vacate the site into adjacent natural areas which will put a strain on surrounding populations. However, the development will be of such low extent (approximately 5 hectares) that this impact cannot be considered as high. In order to prevent any direct impact on fauna it is recommended that any hunting, trapping or capturing be strictly prohibited. As mining activities commence they will vacate the area by their own accord. Provided that adequate rehabilitation is undertaken it is likely that the site will again be available as habitat to opportunistic species. Tunnels of one of the Golden Mole species occur along the shore of the artificial dam on the site. According to distribution data this can only be either the Cape Golden Mole (*Chrysochloris asiatica*) or the Fynbos Golden Mole (*Amblysomus corriae*). Of these the former is listed as being of Least Concern (LC) whilst the latter is listed as Near Threatened (NT). The proposed mining activities are anticipated to have an impact on this species since removal of sand will directly affect the habitat. The extent of operations is however small which will limit the impacts on fauna to moderate.

The impact significance has been determined and it is clear that the majority of impacts will be moderate although the impact on the adjacent streams are moderate-high. Through adequate mitigation this impact can also be decreased to moderate.

Please refer to Appendix E for the impact methodology.

### Significance of the impact:

| Impact | Severity | Duration | Extent | Consequence | Probability | Frequency | Likelihood | Significance |
|---|---|---|---|---|---|---|---|---|
| **Before Mitigation** | | | | | | | | |
| Loss of vegetation type and clearing of vegetation | 3 | 4 | 2 | 3 | 4 | 4 | 4 | 12 |
| Loss of protected species | 4 | 4 | 2 | 3.3 | 5 | 4 | 4.5 | 14.8 |
| Impact on watercourses | 5 | 4 | 3 | 4 | 5 | 4 | 4.5 | 18 |
| Infestation with weeds and invaders | 4 | 4 | 3 | 3.6 | 4 | 3 | 3.5 | 12.6 |
| Impact on Terrestrial fauna | 3 | 4 | 2 | 3 | 5 | 4 | 4.5 | 13.5 |
| **After Mitigation** | | | | | | | | |
| Loss of vegetation type and clearing of vegetation | 3 | 4 | 2 | 3 | 4 | 4 | 4 | 12 |
| Loss of protected species | 4 | 4 | 1 | 3 | 5 | 4 | 4.5 | 13.5 |
| Impact on watercourses | 3 | 4 | 2 | 3 | 4 | 4 | 4 | 12 |
| Infestation with weeds and invaders | 2 | 3 | 2 | 2.3 | 3 | 3 | 3 | 7 |
| Impact on Terrestrial fauna | 3 | 4 | 2 | 3 | 5 | 4 | 4.5 | 13.5 |

## 6. Biodiversity condition and sensitivity rating

### 6.1 Overall condition of the study area

**Habitat diversity and species richness:**
Habitat diversity on the site is considered to be at least moderate, being dominated by the alluvial sandy plain, although the adjacent stream systems considerably increase the habitat diversity. These will however be excluded from mining operations. As a result the species diversity on the site is also considered to be moderate.

**Presence of rare and endangered species:**
The site also does not contain any rare or endangered species of high conservation value though it may still be possible that such a species may be present on the site. However, a high proportion of protected species are present, including five protected proteoid species, two Erica species and three Vygie species occurring in this area (Appendix B). These are all relatively widespread and common but still retain a significant conservation value. Permits will however have to be acquired to remove these plants. Furthermore, provided that comprehensive rehabilitation and adequate management of topsoil is undertaken it is highly that several of these will be able to re-establish on the site after mining has ceased.

**Ecological function:**
The terrestrial function of the site still largely intact though the functioning of the adjacent streams has been modified to a significant degree. The site functions as habitat for a variety of fauna, supports a specific vegetation type and also functions in terms of water transport with regard to the stream systems. The site is still largely natural, supports the natural vegetation type and will therefore still provide habitat for a relatively natural faunal population. The stream systems function in terms of water transportation, flood dissipation, wetland and riparian habitat and bioremediation and are therefore highly important in terms of ecological function. Their functioning has however also been modified to a large degree by the artificial impoundment which modifies the flow and flooding regime to a large degree.

**Degree of rarity/conservation value:**
According to Mucina & Rutherford (2006) the area consists of Matjiesfontein Shale Renosterveld (FRs 6). This vegetation type is currently listed as being of Least Concern (LC) under the National List of Threatened Ecosystems (Notice 1477 of 2009) (National Environmental Management Biodiversity Act, 2004) (Map 2). It is not currently subjected to any pronounced transformation pressures and the conservation value of this vegetation type is therefore relatively low. According to the Western Cape Biodiversity Spatial Plan (2017) the site in question is listed as being an Other Natural Area (ONA) although the southern stream system is also listed as being an Ecological Support Area 1 and 2 (Map 3). This does not significantly contribute to its conservation value. The two stream systems do have a high conservation value but they will be excluded from mining activities and treated as no-go areas (Map 1).

**Percentage ground cover:**
The site has burned approximately four years previously, however, re-establishment of vegetation has not bee sufficient and the percentage ground cover is relatively low in comparison to the natural condition. This is most likely as a result of a high natural disturbance regime as sands eroded from the slopes of the mountain is continuously deposited on the site and the sandy soils are also highly mobile, continuously shifting and is easily eroded. In

addition, relatively high levels of trampling and overgrazing by domestic stock will also decrease the vegetation cover and increases erosion of the sandy soils.

**Vegetation structure:**
The vegetation structure on the site is considered to be natural to a large degree although the previous burn and current disturbances on the site does decrease the density somewhat and promotes a higher degree of herbaceous pioneer species.

**Infestation with exotic weeds and invader plants:**
Although a few indigenous pioneer species and indicators of disturbance are present no exotic species could be identified. Downstream areas do however indicate that exotic tree species are present in the area.

**Degree of grazing/browsing impact:**
Given the current drought conditions and utilisation of the site by domestic stock the degree of trampling and overgrazing is quite high. This is especially notable with palatable species (*Pennisetum macrourum*) and high amount of trampling along the stream systems.

**Signs of erosion:**
The site is subjected to a high level of erosion. This is natural to a large degree due to the sandy alluvial soils but is definitely exacerbated by on site disturbances.

**Terrestrial animals:**
The site contains several signs and tracks of mammal species and it is considered likely that the mammal population on the site will be close to natural. Watercourses, especially perennial systems, contain a higher moisture regime compared to surrounding habitats and are therefore able to produce a much higher biomass with a higher diversity of habitat. As a result they often sustain a varied and significant mammal population. This will most likely also be the case on the site. The proximity of the gravel road and livestock farming will likely cause some modification to the natural mammal population but is not considered significant. It may therefore also be likely that the site may contain species of conservation significance. It is also likely that the site will also contain several other mammal species but these were not observed on the site.

Table 5: Biodiversity Sensitivity Rating for the sand mining study area.

| | Low (3) | Medium (2) | High (1) |
|---|---|---|---|
| Vegetation characteristics | | | |
| Habitat diversity & Species richness | | 2 | |
| Presence of rare and endangered species | | | 1 |
| Ecological function | | 2 | |
| Uniqueness/conservation value | | 2 | |
| | | | |
| Vegetation condition | | | |
| Percentage ground cover | 3 | | |
| Vegetation structure | | 2 | |
| Infestation with exotic weeds and invader plants or encroachers | | | 1 |
| Degree of grazing/browsing impact | 3 | | |
| Signs of erosion | 3 | | |
| | | | |
| Terrestrial animal characteristics | | | |
| Presence of rare and endangered species | | 2 | |
| Sub total | 9 | 10 | 2 |
| Total | | 21 | |

**6.2. Biodiversity sensitivity rating (BSR) interpretation**

Table 6: Interpretation of Biodiversity Sensitivity Rating.

| Site | Score | Site Preference Rating | Value |
|---|---|---|---|
| sand mining area | 21 | Acceptable | 3 |

## 7. Discussion and conclusions

The site proposed for the sand mine has been rated as being acceptable for the development. This is however subject to the two adjacent stream systems being excluded from mining activities as indicated (Map 1), adequate topsoil management, erosion monitoring and remediation and comprehensive rehabilitation.

The site is situated at the foot of the Klein Swartberge on a Portion of Portion 5 of the Farm Bezemfontein 213 (Map 1). The site is situated approximately 50 km to the north east of Ladismith and approximately 70 km to the south east of Laingsburg and has an eextent of 4.99 hectares. The site is situated at the foot of the north facing slopes of the Klein Swartberg where sands eroding from the slopes are continuously deposited. The site does contain some transformation in the form of a large artificial impoundment and embankment but is still largely natural. Two prominent and largely natural stream system are also present on the site (Map 1). The proposed mining development will excavate sand from a low mound between the streams. The mining activities are not anticipated to utilise any processing plant and will remain at a very small scale.

According to Mucina & Rutherford (2006) the area consists of Matjiesfontein Shale Renosterveld (FRs 6). This vegetation type is currently listed as being of Least Concern (LC) under the National List of Threatened Ecosystems (Notice 1477 of 2009) (National Environmental Management Biodiversity Act, 2004) (Map 2). It is not currently subjected to any pronounced transformation pressures and the conservation value of this vegetation type is therefore relatively low. According to the Western Cape Biodiversity Spatial Plan (2017) the site in question is listed as being an Other Natural Area (ONA) although the southern stream system is also listed as being an Ecological Support Area 1 and 2 (Map 3). This does not significantly contribute to its conservation value. The two stream systems do have a high conservation value but they will be excluded from mining activities and treated as no-go areas (Map 1).

The site has burned approximately four years previously, however, re-establishment of vegetation has not been sufficient and the percentage ground cover is relatively low in comparison to the natural condition. This is most likely as a result of a high natural disturbance regime as sands eroded from the slopes of the mountain is continuously deposited on the site and the sandy soils are also highly mobile, continuously shifting and is easily eroded. In addition, relatively high levels of trampling and overgrazing by domestic stock will also decrease the vegetation cover and increases erosion of the sandy soils.

The habitat on the site is predominately formed by sands deposited by alluvial deposition. The site is situated at the foot of the north facing slope of the Klein Swartberg. Rainfall along the peaks and steep slopes create runoff with a high velocity, which therefore cause erosion of the sandy soils down the slope to the foot of the mountain. Here the slope drastically and suddenly decreases to a flat plain with low ridges to the north. This essentially halts water flow which allows for the deposition of the sands and forms an alluvial plain. Although water is slowed drastically at the foot of the mountain, large flow events or flooding has caused the formation of two prominent channels, incised into the sandy alluvial plain. These channels form two prominent streams (Map 1). The aim of the mining activities will be to excavate and remove the accumulated sands between these two streams.

From the description of the vegetation on the site it is clear that natural vegetation dominates the site though significant disturbance is also present. The ecological processes on the site are clearly defined and should allow for adequate management of mining operations and rehabilitation after cessation of mining activities. The site contains an elevated alluvial sand embankment which will be the main area of sand excavation (Map 1). This portion has a moderate species diversity, though sparse vegetation cover with a high proportion of protected species including five protected proteoid species, two Erica species and three Vygie species (Appendix B). None of these are however rare or endangered and they are all relatively widespread. However, the proposed mining area is of small extent and seeing as none of these species are rare, endangered or localised their loss is not anticipated to be high. Permits will however have to be acquired to remove these plants. Furthermore, provided that comprehensive rehabilitation and adequate management of topsoil is undertaken it is highly that several of these will be able to re-establish on the site after mining has ceased. This portion of the site is bordered to the north and south by two streams which are considered to have a high conservation value (Map 1). It is therefore recommended that these be excluded from the mining area and that the proposed access road avoid crossing these streams.

The impact that the proposed mining operations will have on fauna is mainly the loss of habitat which will decrease the available habitat. The faunal population will vacate the site into adjacent natural areas which will put a strain on surrounding populations. However, the development will be of such low extent (approximately 5 hectares) that this impact cannot be considered as high. In order to prevent any direct impact on fauna it is recommended that any hunting, trapping or capturing be strictly prohibited. As mining activities commence they will vacate the area by their own accord. Provided that adequate rehabilitation is undertaken it is likely that the site will again be available as habitat to opportunistic species. Tunnels of one of the Golden Mole species occur along the shore of the artificial dam on the site. According to distribution data this can only be either the Cape Golden Mole (*Chrysochloris asiatica*) or the Fynbos Golden Mole (*Amblysomus corriae*). Of these the former is listed as being of Least Concern (LC) whilst the latter is listed as Near Threatened (NT). The proposed mining activities are anticipated to have an impact on this species since removal of sand will directly affect the habitat. The extent of operations is however small which will limit the impacts on fauna to moderate.

The proposed development will include excavation of sand from the alluvial floodplain and construction of an access road to remove the product from the site (Map 1). The streams will be excluded from mining operations but may still be affected by it.

Soil samples taken along the main channel of these streams contain clear signs of wetland conditions and is also indicative of a perennial zone of wetness (Appendix C). Wetland conditions can therefore be confirmed to be present along these two small stream systems (Map 1). Obligate wetland vegetation could be easily utilised to provide an accurate border of wetland conditions. Obligate wetland species are only able to inhabit wetland areas and as a result where they occur wetland conditions can be assumed to occur. The obligate wetland cape reed (*Elegia capensis*), riparian grass (*Pennisetum macrourum*) and geophyte (*Watsonia angusta*) was utilised to provide a quite accurate boundary of wetland conditions and the floodplain of these streams. The main channel and marginal zone can be characterised as a channel wetland system (SANBI 2009). However, the northern stream also contains a portion with a lower gradient, a more diffuse flow regime and consequently also contains elements of an unchanneled valley-bottom wetland (SANBI 2009). Along the northern stream system there is also an artificial crescent shaped channel and berm (Map 1). This furrow or channel diverts a portion of the flow in the stream although its intended function is unclear. It has however also manifested some wetland conditions due to continued inundation and saturated soil conditions. These wetland conditions are however artificial and do not perform any function which is important to the continued natural functioning of the stream. This channel and berm can therefore be included in the sand excavation operations without having a large impact on the functioning of the stream.

The two streams are considered to be mostly natural though some increased erosion due to trampling by domestic stock is likely (Appendix A). This will decrease the vegetation, mobilise the sandy sediments and in so doing increase erosion and sedimentation of the streams. The functioning of these streams is considered highly modified by the artificial impoundment along the eastern border of the site (Map 1). It is clear that this impoundment has heavily modified the natural flow and flooding regime of these streams.

An Index of Habitat Integrity (IHI) was conducted for the two affected streams (Appendix D). The results of the IHI indicated that the study area has an Instream IHI of Category C: Moderately Modified and Riparian IHI of Category C: Moderately Modified. This can be mostly attributed to the modification of the streams brought about by the artificial impoundment.

The EI&S of the stream systems has been rated as being High: Floodplains that are considered to be ecologically important and sensitive. The biodiversity of these floodplains may be sensitive to flow and habitat modifications. They play a role in moderating the quantity and quality of water of major rivers.

A Risk Assessment for the proposed sand mine and affected stream systems has been undertaken according to the Department of Water & Sanitation's requirements for risk assessment and the provisional Risk Assessment Matrix for Section 21(c) & (i) water use (Appendix E).

The mining operations are anticipated to remain at a very small scale. This will significant decrease the risk on the streams. However, as indicated these streams must be regarded as highly sensitive. They should therefore be excluded from any mining activities and the necessary mitigation, mining methods and procedures implemented to minimise any impacts on them (Map 1). Should these be implemented the risk should remain moderate. Firstly, the excavation of sand should be restricted to the central embankment of alluvial sand, excluding the adjacent stream systems, treating these as no-go areas (Map 1). Sediments from the site should be prevented from entering the adjacent stream systems and it is recommended that berms be erected between the site and these streams. Secondly, the depth of sand excavation should not exceed the level of the banks of these streams (Figure 5). This should be feasible since adequate material is not present beyond this depth. In addition, the border between mined areas and adjacent natural areas should be faired in so that sheer drops or steps are avoided as these will cause significant erosion. Thirdly, the site will remain highly susceptible to erosion and comprehensive rehabilitation, including adequate management of topsoil, will be crucial. Extended monitoring and implementation of erosion measures will also be necessary.

The alluvial plain on the site is highly conducive to erosion and even when comprehensive erosion management measures are implemented it remains likely that sand mining will considerably increase the sediment load in downstream sections. However, the artificial impoundment essentially acts as a sediment trap and will prevent any mobilised sediments from entering the downstream sections. This will effectively contain impacts associated with sand mining in the immediate area.

The excavated sand will have to be transported from the site by trucks and heavy vehicles and will require an adequate access road which may affect the two stream systems. Crossing of these streams by such a road will have a significant impact on them and should be avoided. This can be achieved by utilising an existing small dirt track which can be upgraded and accessing the site via the dam shore which is already an artificial and degraded area and will prevent impacting on the stream systems (Map 1). Should this route be used the risk should remain low. It is however also subject to the upgrading of the existing track minimising erosion and its design allowing for adequate drainage of surface runoff without exacerbating erosion.

The impact significance has been determined and it is clear that the majority of impacts will be moderate although the impact on the adjacent streams are moderate-high. Through adequate mitigation this impact can also be decreased to moderate

## 8. Recommendations

- The following highly sensitive areas should be excluded and avoided by mining operations (Map 1):
  - The excavation of sand should be restricted to the central embankment of alluvial sand, excluding the adjacent stream systems, treating these as no-go areas (Map 1).
  - Sediments from the site should be prevented from entering the adjacent stream systems and it is recommended that berms be erected between the site and these streams.
  - Crossing of these streams by the proposed access road should be avoided. Instead the existing small dirt track should be upgraded and the site accessed via the dam shore which is already an artificial and degraded area and will prevent impacting on the stream systems (Map 1).

- Permits must be obtained for protected plant species which will require removal from the site (Appendix B). These may include; *Erica quadrangularis, E. cerinthoides, E. discolor, Leucadendron barkerae, L. eucalyptifolium, Protea eximia, P. laurifolia, P. repens*, *Antimima sp., Ruschia caroli, Lampranthus sp.* and *Watsonia angusta.*

- Due to the removal of vegetation and disturbance of the soil surface the mining area will be highly susceptible to the establishment of weeds. It is therefore recommended that weed control be judiciously and continually practised. Monitoring of weed establishment should form a prominent part of management of the mining area.

- The following mitigation measures are recommended where mining activities will impact on the adjacent stream systems (Map 1):

  - The stream systems should be excluded from mining activities and treated as no-go areas.
  - A berm should be erected between the mining area and the stream systems in order to prevent sediments from entering them.
  - Adequate storm water management measures should be implemented and should include diverting storm- and floodwater around the mining area and preventing sediment and silt from entering the streams.
  - The depth of sand excavation should not exceed the level of the banks of these streams (Figure 5).
  - The border between mined areas and adjacent natural areas should be faired in so that sheer drops or steps are avoided as these will cause significant erosion.
  - The site will remain highly susceptible to erosion and comprehensive rehabilitation will be crucial.
  - Adequate topsoil management will be important and the upper 30 cm of soil should be removed, stored on site and utilised during the rehabilitation of the site.
  - Upgrading of the existing dirt track to provide access to the site should include design aimed at minimising erosion and allowing for adequate storm water drainage. Structures such as culverts and v-drains should be considered.

- The hunting, capturing and trapping of fauna should be prevented by making this a punishable offense during the mining operations.

- No littering must be allowed and all litter must be removed from the site.

- Monitoring of mining and compliance with recommended mitigation measures must take place. This must include at least annual monitoring of the adjacent streams by means of an Index of Habitat Integrity (IHI), sedimentation monitoring and monitoring of the vegetation condition.

- After mining has ceased all construction materials should be removed from the area.

- Comprehensive rehabilitation should be undertaken after mining has ceased. This should include re-instatement of the natural topography as far as possible, replacing topsoil in disturbed areas, prevention of erosion and monitoring and eradication of exotic invasive species.

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Van Oudtshoorn, F. 2004. Gids tot Grasse van Suider-Afrika. Briza Publications, Pretoria.

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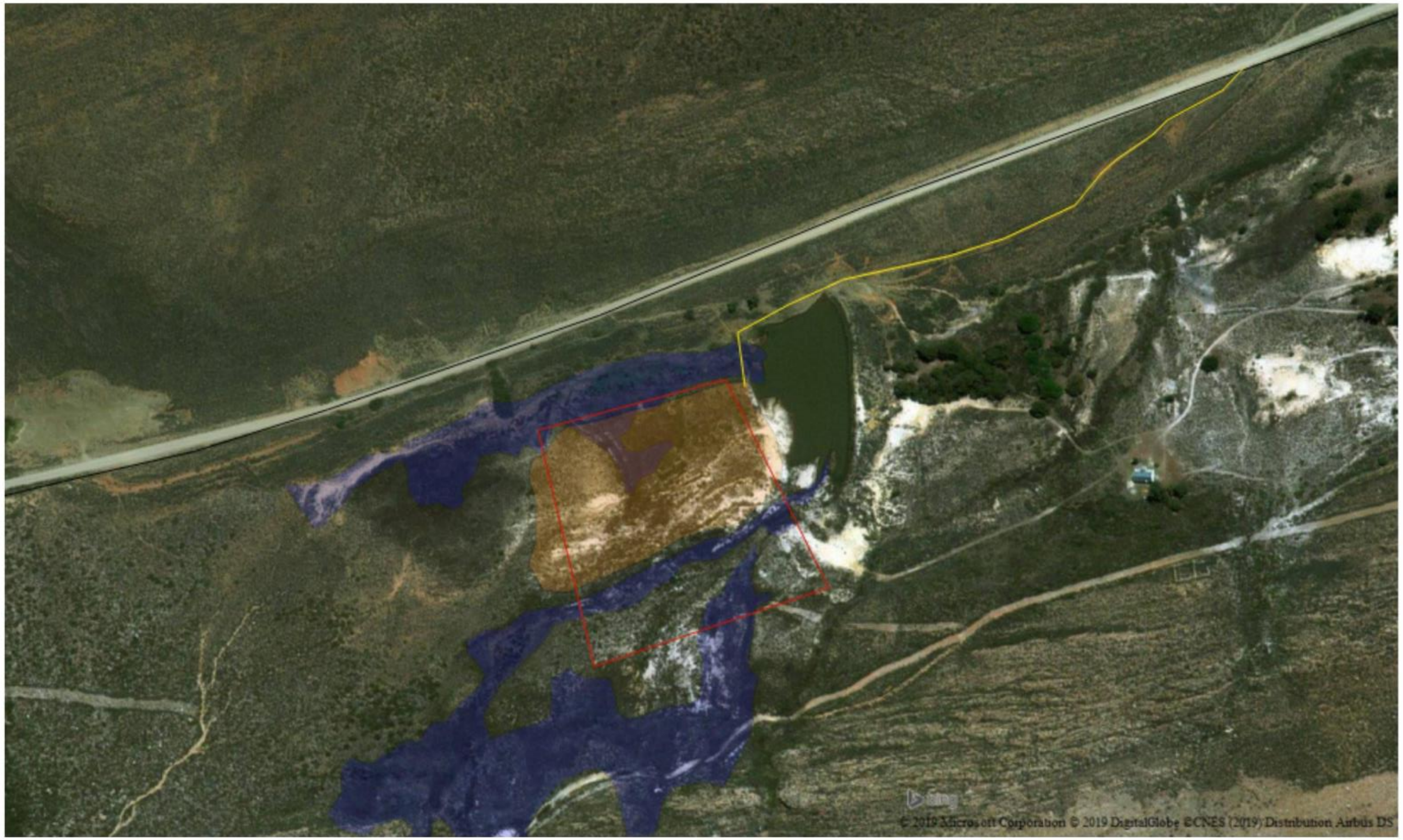
## Annexure A: Maps and Site photos

# Wetland delineation map for sand mining operations on a Portion of Portion 5 of the Farm Bezemfontein 213 near Laingsburg, Western Cape Province.




**Preparred for:**
Blouberg Eiendomme
Plaas Waterval
Laingsburg
6900

**Legend:**

- Site boundary
- Proposed access road
- Stream systems and wetland conditions
- Alluvial sand excavation

**Map Information**

**Spheroid**: WGS 84

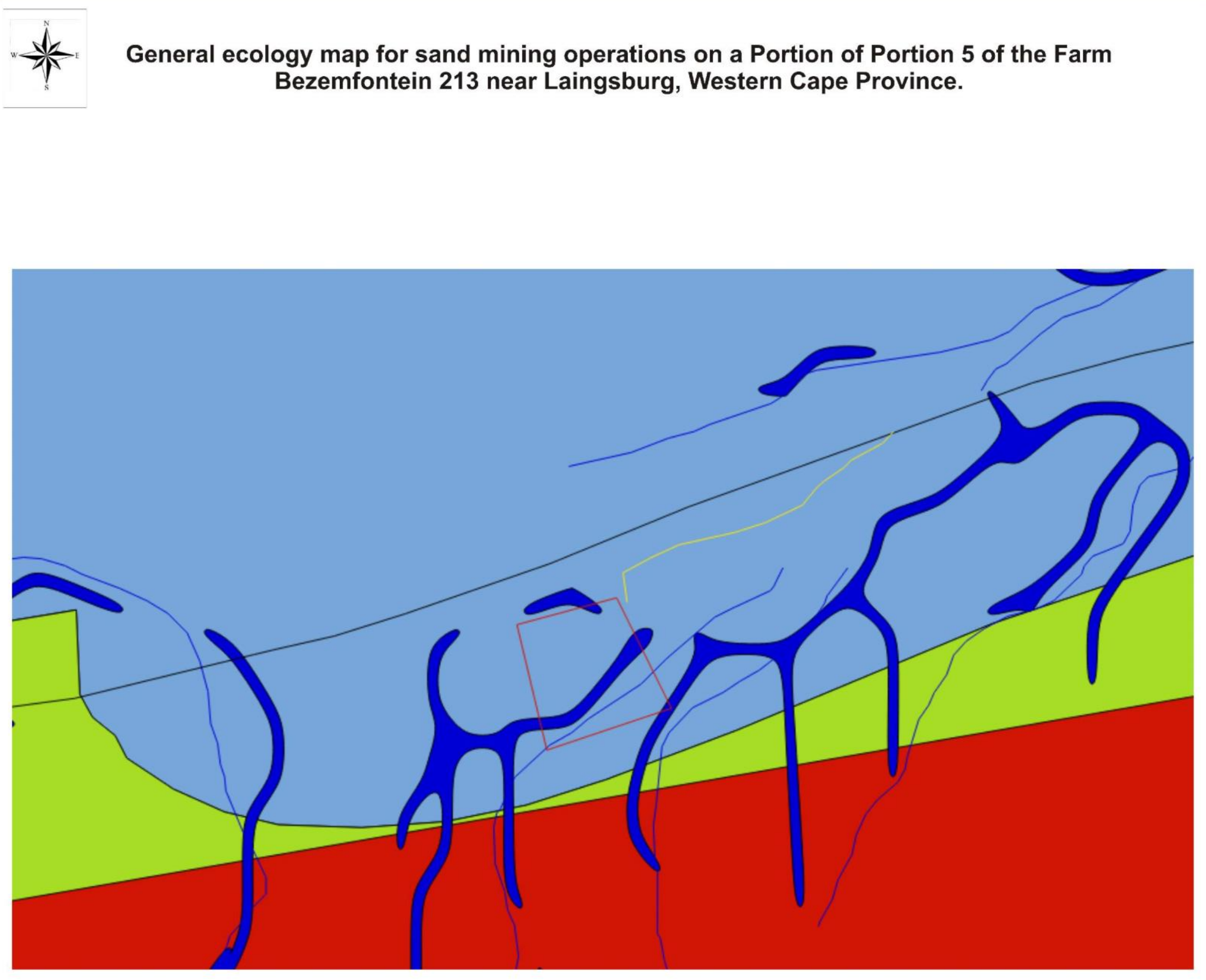
Quantum GIS

**Scale:** 1:6 000


DPR Ecologists
**Contact Darius van Rensburg at:**
darius@dprecologists.co.za
P.O. Box 12726, Brandhof, 9324
**Tel**: 083 410 0770


Map 1: Wetland delineation map of the proposed sand mining on the Farm Bezemfontein 213. The mining area boundary is indicated, as well as the alluvial sand embankment to which mining operations should be confined. The proposed access road follows an existing dirt track. The two stream systems, associated wetland conditions and the artificial impoundment are all visible.

## General ecology map for sand mining operations on a Portion of Portion 5 of the Farm Bezemfontein 213 near Laingsburg, Western Cape Province.



**Preparred for:**
Blouberg Eiendomme
Plaas Waterval
Laingsburg
6900

**Legend:**

- Site boundary
- Proposed access road
- Watercourses
- Probable wetlands and watercourses
- M. Shale Renosterveld
- N Swartberg S-stone Fynbos
- Towerkop Nature Reserve

**Map Information**

**Spheroid**: WGS 84

Quantum GIS

**Scale:** 1:10 000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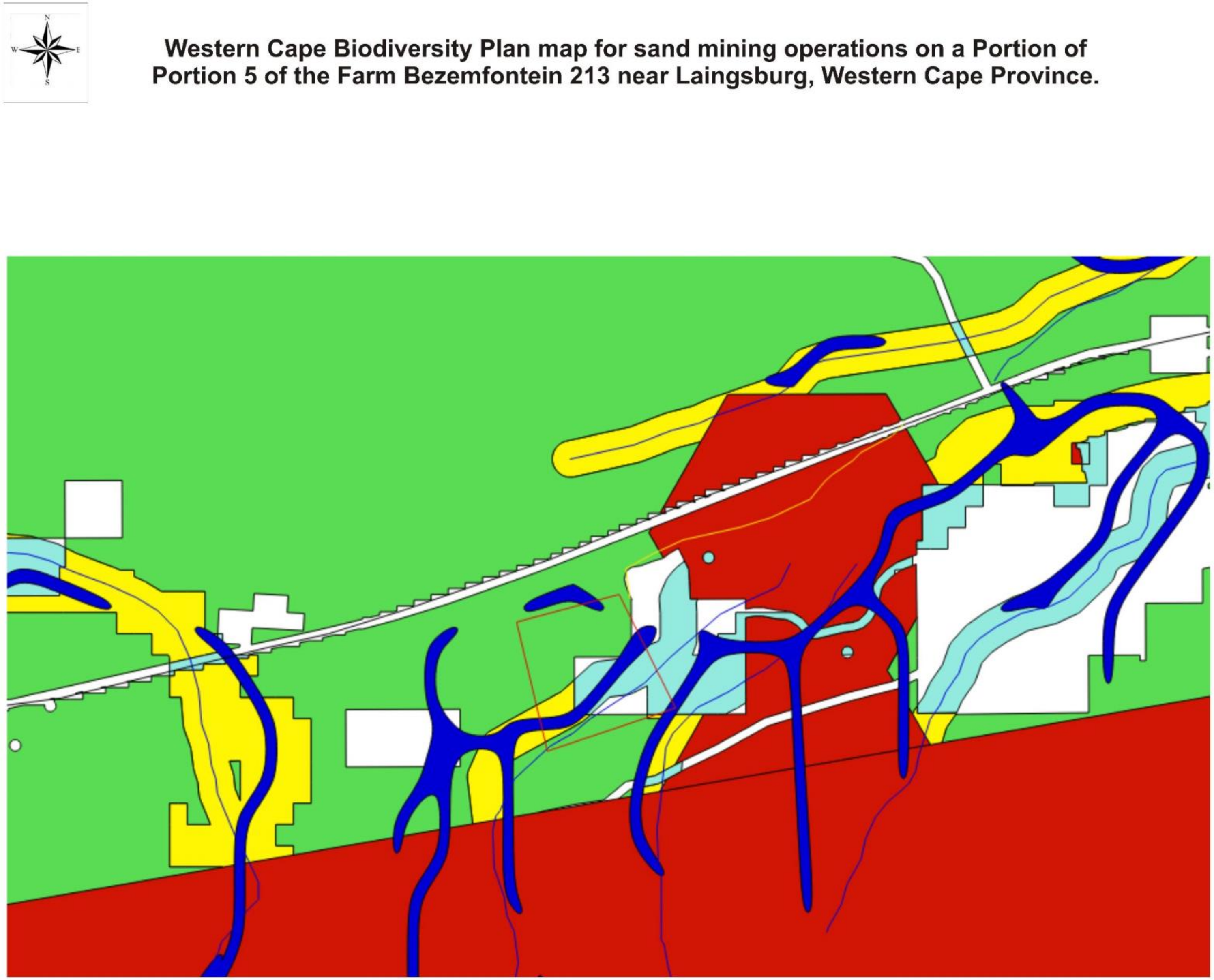
**Tel**: 083 410 0770


Map 2: General ecology map of the proposed sand mining on the Farm Bezemfontein 213. Note that the site is situated on the border of the Matjiesfotnein Shale Renosterveld and North Swartberg Sandstone Fynbos vegetation types. The site, proposed access road and probable wetlands and watercourses on and around the site is also indicated. The Towerkop Nature Reserve to the south of the site is also indicated.

## Western Cape Biodiversity Plan map for sand mining operations on a Portion of Portion 5 of the Farm Bezemfontein 213 near Laingsburg, Western Cape Province.



**Preparred for:**
Blouberg Eiendomme
Plaas Waterval
Laingsburg
6900

**Legend:**

- Site boundary
- Proposed access road
- Watercourses
- Probable wetlands and watercourses
- Critical Biodiversity Area 1
- Critical Biodiversity Area 2
- Ecological Support Area 1
- Ecological Support Area 2
- Other Natural Areas
- Protected Areas

**Map Information**

**Spheroid**: WGS 84

Quantum GIS

**Scale:** 1:10 000

DPR Ecologists
**Contact Darius van Rensburg at:**
darius@dprecologists.co.za
P.O. Box 12726, Brandhof, 9324
**Tel**: 083 410 0770

Map 3: Biodiversity plan map of the proposed sand mining on the Farm Bezemfontein 213. Note that the majority of the site is considered an Other Natural Area with the southern stream system considered an Ecological Support Area 1 and 2. The Towerkop Nature Resreve to the south of the site is also visible.

Figure 1: Panorama of the site at the foot of the Klein Swartberg (background). Note the large artificial impoundment with two stream (blue) flowing into it. The alluvial sand embankment proposed for sand excavation is also indicated (red).

Figure 2: Another panorama of the site with the northern stream indicated (blue).

Figure 3: Storm water from the adjacent gravel road (red) does contribute to significant erosion on the site.

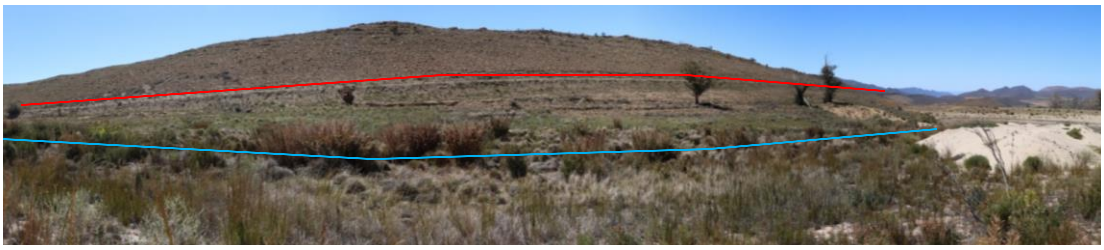


Figure 4: Panorama of the northern stream (blue) as seen from the proposed sand mine area. The adjacent gravel road is also indicated (red).

Figure 5: Panorama of the northern stream (blue) also showing the small artificial channel (red).

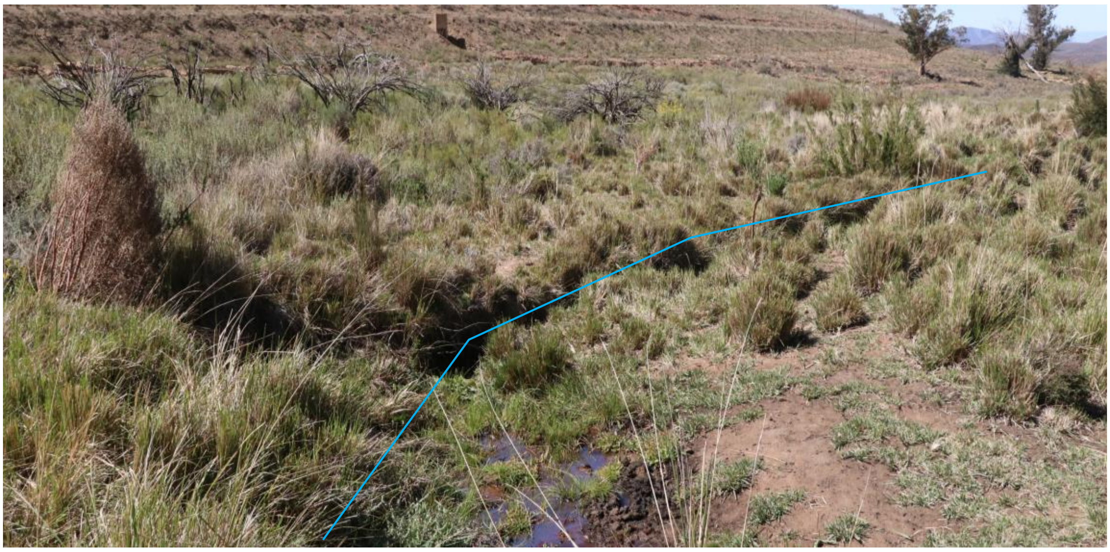


Figure 6: View of a portion of the main channel of the northern stream (blue).

Figure 7: Panorama of the alluvial sand embankment which will be the focus of mining operations. Note that it is elevated above the surrounding stream systems (blue). Note also sparse vegetation cover.

Figure 8: Another panorama of the alluvial sand embankment with the southern stream in the background (blue).

Figure 9: Substantial erosion is also evident on the alluvial plain.

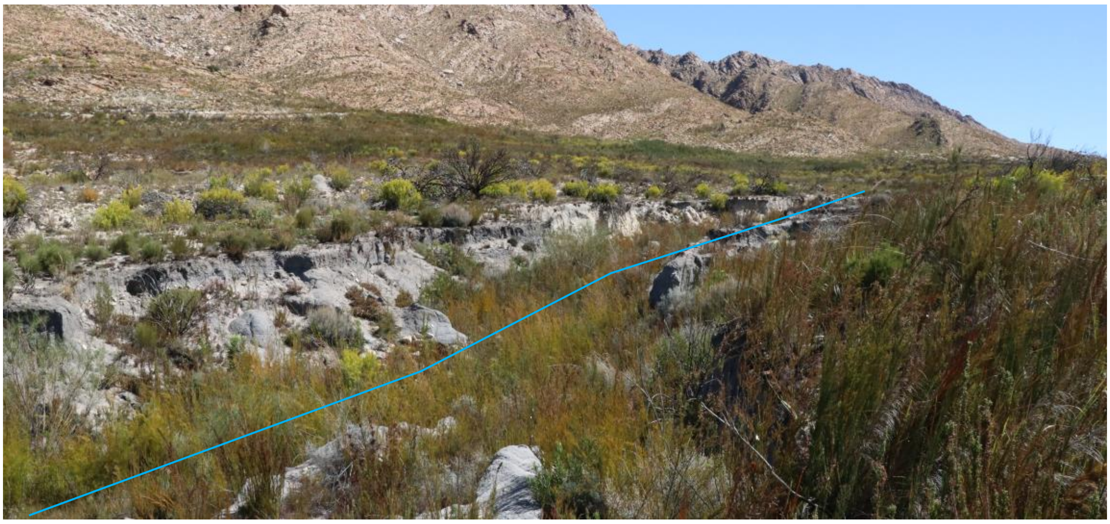


Figure 10: View of the southern stream (blue). Note also significant erosion, though considered to be largely natural.

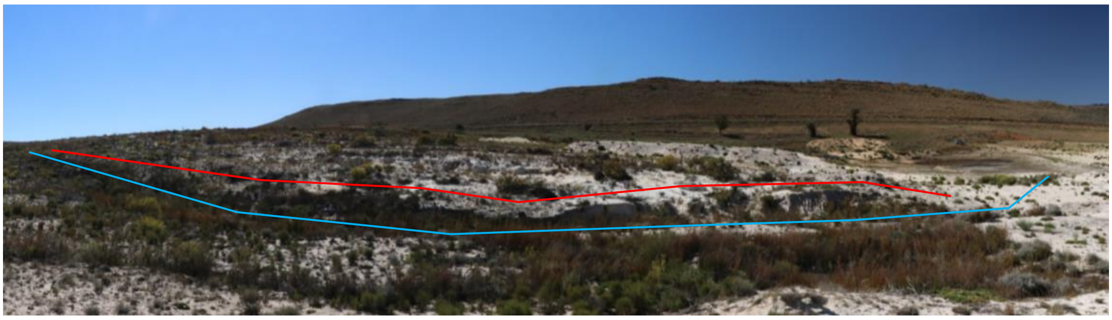


Figure 11: Panorama of the central alluvial sand embankment with the southern stream (blue) visible in the foreground. It should be quite evident that the sand embankment is elevated above the stream and sand excavation will be possible without impacting the hydrology of the streams as long as the depth of excavation does not exceed the level of the stream banks (red).

Figure 12: Another panorama from the artificial impoundment toward the site clearly indicated the alluvial sand embankment (red) surrounded by the two stream systems (blue).

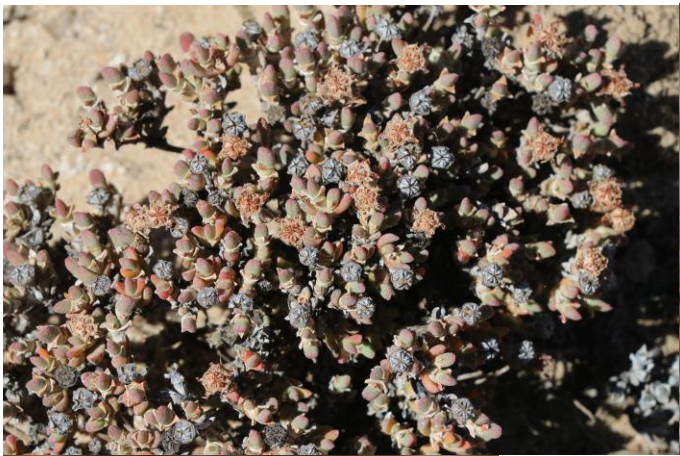



Figure 13: Protected occurring and around the site. Previous page, clockwise from top left; *Antimima sp., Erica cerinthoides, E. discolor* and *E. quadrangularis.* This page, clockwise from top left; *Lampranthus sp., Leucadendron eucalyptifolium, Protea repens, Ruschia caroli, Protea eximia* and *Leucadendron barkerae*.

Figure 14: Tracks and signs of mammals on the site include dung of a small antelope, Common Duiker (*Sylvicapra grimmea*) or Steenbok (*Raphicerus campestris*) and excavated tunnels of the Cape Golden Mole (*Chrysochloris asiatica*) or the Fynbos Golden Mole (*Amblysomus corriae*).

**Appendix B: Species list**

Species indicated with an * are exotic.

Protected species are coloured orange and Red Listed species red.

| Species | Growth form |
|---|---|
| *Alytropappus rhinocerotis* | Shrub |
| *Anthopsermum aethiopicum* | Shrub |
| *Antimima sp.* | Succulent |
| *Aspalathus hirta* | Shrub |
| *Aspalathus rubens* | Dwarf shrub |
| *Berkheya sp.* | Herb |
| *Carpobrotus edulis* | Succulent |
| *Centella asiatica* | Herb |
| *Chrysocoma ciliata* | Dwarf shrub |
| *Crassula cotyledonis* | Succulent |
| *Crassula dependens* | Succulent |
| *Cynodon dactylon* | Grass |
| *Cyperus thunbergii* | Sedge |
| *Dipcadi brevifolium* | Geophyte |
| *Drosera capensis* | Herb |
| *Ehrharta calycina* | Grass |
| *Elegia capensis* | Cape reed |
| *Epischoenus sp.* | Sedge |
| *Erica cerinthoides* | Heath |
| *Erica discolor* | Heath |
| *Erica quadrangularis* | Heath |
| *Ericephalus africanus* | Dwarf shrub |
| *Eriospermum capense* | Geophyte |
| *Euryops lateriflorus* | Shrub |
| *Ficinia nodosa* | Sedge |
| *Gomphocarpus fruticosus* | Shrub |
| *Helichrysum acrophilum* | Herb |
| *Helichrysum petiolare* | Shrub |
| *Hygrophilus rattrayi* | Cape reed |
| *Hypodsicus striatus* | Cape reed |
| *Isolepis setacea* | Sedge |
| *Juncus lomatophyllus* | Rush |
| *Lampranthus sp.* | Succulent |
| *Leucadendron barkerae* | Shrub |
| *Leucadendron eucalyptifolium* | Shrub |
| *Leysera tenella* | Herb |
| *Lobelia linearis* | Shrub |
| *Metalasia densa* | Shrub |
| *Othonna parviflora* | Shrub |
| *Pelargonium fruticosum* | Dwarf shrub |

| | |
|---|---|
| *Pelargonium ovale* | Herb |
| *Pelargonium sp.* | Herb |
| *Pennisetum macrourum* | Grass |
| *Pentameris airoides* | Grass |
| *Protea eximia* | Shrub |
| *Protea laurifolia* | Shrub |
| *Protea repens* | Shrub |
| *Psammotropha anguina* | Herb |
| *Psoralea arida sp. nov.* | Shrub |
| *Pteronia stricta* | Shrub |
| *Rafnia racemosa* subsp. *racemosa* | Shrub |
| *Restio gaudichaudianus* | Cape reed |
| *Ruschia caroli* | Succulent |
| *Selago glomerata* | Dwarf shrub |
| *Senecio juniperinus* | Herb |
| *Stipagrostis sp.* | Grass |
| *Stoebe plumosa* | Dwarf shrub |
| *Trachyandra sp.* | Geophyte |
| *Tribolium hispidum* | Grass |
| *Wahlenbergia sp.* | Herb |
| *Watsonia angusta* | Geophyte |
| *Willdenowia bolusii* | Cape reed |
| *Zantedeschia aethiopica* | Geophyte |

**Appendix C: Soil Samples**

Obligate wetland vegetation was utilised to determine the presence and border of wetlands. Soil was used to confirm the border of wetlands in the study area. Soil samples were taken at approximately 10 meter intervals to determine the edge of the wetland. Soil samples were investigated for the presence of anaerobic evidence which characterises wetland soils.

Within wetlands the hydrological regime differs due to the topography and landscape. For instance; a valley bottom wetland would have a main channel that is below the water table and consequently permanently saturated, i.e. permanent zone of wetness. As you move away from the main channel the wetland would become dependent on flooding in order to be saturated. As a result along this hydrological regime areas of permanent saturation, seasonal and temporary saturation would occur. At some point along this gradient the saturation of the soil would be insufficient to develop reduced soil conditions and therefore will not be considered as wetland.

Within wetland soils the pores between soil particles are filled with water instead of atmosphere. As a result available oxygen is consumed by microbes and plantroots and due to the slow rate of oxygen diffusion oxygen is depleted and biological activity continues in anaerobic conditions and this causes the soil to become reduced.

Reduction of wetland soils is a result of bacteria decomposing organic material. As bacteria in saturated soils deplete the dissolved oxygen they start to produce organic chemicals that reduce metals. In oxidised soils the metals in the soil give it a red, brown, yellow or orange colour. When these soils are saturated and metals reduced the soil attains a grey matrix characteristic of wetland soils.

Within this reduction taking place in the wetland soils there may be reduced matrix, redox depletions and redox concentrations. The reduced matrix is characterised by a low chroma and therefore a grey soil matrix. Redox depletions result in the grey bodies within the soil where metals have been stripped out. Redox concentrations result in mottles within the grey matrix with variable shape and are recognised as blotches or spots, red and yellow in colour.

Soil wetness indicator is used as the primary indicator of wetlands. The colour of various soil components are often the most diagnostic indicator of hydromorphic soils. Colours of these components are strongly influenced by the frequency and duration of soil saturation. Generally, the higher the duration and frequency of saturation in a soil profile, the more prominent grey colours become in the soil matrix.

Coloured mottles, another feature of hydromorphic soils, are usually absent in permanently saturated soils and are at their most prominent in seasonally saturated soils, becoming less abundant in temporarily saturated soils until they disappear altogether in dry soils (Collins 2005).

The following soil wetness indicators can be used to determine the permanent, seasonal and temporary wetness zones. The boundary of the wetland is defined as the outer edge of the temporary zone of wetness and is characterised by a minimal grey matrix (<10%), few high chroma mottles and short periods of saturation (less than three months per year). The seasonal zone of wetness is characterised by a grey matrix (>10%), many low chroma mottles and significant periods of wetness (at least three months per year). The permanent zone of wetness is characterised by a prominent grey matrix, few to high chroma mottles, wetness all year round and sulphuric odour (rotten egg smell).

According to convention hydromorphic soil must display signs of wetness within 50 cm of the soil surface (DWAF 2005).

Table 1: Soil samples taken on and around the proposed sand mining site.

| | |
|---|---|
|  |  |
| Soil sample taken within the main channel of the northern stream system.<br>A grey matrix (>10%) is still present with distinct mottling. This indicates at least seasonal zone of wetness and must be considered to consist of wetland conditions. | Soil sample taken within the main channel of the northern stream system.<br>A grey matrix (>10%) is still present with distinct mottling. This indicates at least seasonal zone of wetness and must be considered to consist of wetland conditions. |
|  |  |
| Soil sample taken along the banks of the northern stream.<br>A grey matrix and mottling is absent and not discernible. However, a high organic content easily distinguish it from the surrounding terrestrial environment. It is therefore still | Soil sample taken on the alluvial sand embankment.<br>A high sand content, with whitish colouration and absence of a grey matrix and mottling clearly differentiate it from surrounding stream systems. |

| | |
|---|---|
| regarded as part of the riparian zone of the stream although wetland conditions are absent. | |
|  |  |
| Soil sample taken in the main channel of the southern stream system.<br>A prominent grey matrix and mottling indicate a permanent zone of wetness and must be considered to consist of wetland conditions. Furthermore, the vibrant reddish colouration is indicative of iron oxide precipitation, a further clear indicator of wetland conditions. | Soil sample taken along the banks of the southern stream.<br>A grey matrix and mottling is absent and not discernible. However, a high organic content easily distinguish it from the surrounding terrestrial environment. It is therefore still regarded as part of the riparian zone of the stream although wetland conditions are absent. |
|  | |
| Soil sample taken along the shore of the artificial impoundment.<br>A grey matrix (>10%) is still present with distinct mottling. This indicates at least seasonal zone of wetness although artificially induced. | |

## Appendix D: Index of Habitat Integrity (IHI) Summary

For the complete IHI please contact the author of this report.

| ASSESSMENT UNIT INFORMATION | |
|---|---|
| | |
| ASSESSMENT UNIT INFORMATION | |
| UPPER LATITUDE | |
| UPPER LONGITUDE | |
| UPPER ALTITUDE | |
| LOWER LATITUDE | |
| LOWER LONGITUDE | |
| LOWER ALTITUDE | |
| SURVEY SITE (if applicable) | Bezemfotein Streams |
| SITE LATITUDE (if applicable) | S 33.366630 |
| SITE LONGITUDE (if applicable) | E 21.370339 |
| SITE ALTITUDE (if applicable) | 1154m |
| WMA | Gouritz |
| QUATERNARY | J24F |
| ECOREGION 2 | 19_9 |
| DATE | 30/10/2019 |
| RIVER | Unnamed streams |
| TRIBUTARY | Bosluiskloof |
| **PERENNIAL (Y/N)** | **N** |
| **GEOMORPH ZONE** | **FOOTHILL** |
| **WIDTH (m)** | **>0-2** |

| METRIC GROUP | RATING | CONFIDENCE |
|---|---|---|
| HYDROLOGY MODIFICATION | 1.9 | 1.7 |
| PHYSICO-CHEMICAL MODIFICATION | 1.6 | 1.1 |
| BED MODIFICATION | 1.5 | 4.0 |
| BANK MODIFICATION | 2.0 | 3.0 |
| CONNECTIVITTY MODIFICATION | 1.5 | 4.0 |
| INSTREAM IHI% | 66.0 | |
| CATEGORY | C | |
| CONFIDENCE | 2.8 | |

| HABITAT INTEGRITY CATEGORY | DESCRIPTION | RATING (% OF TOTAL) |
|---|---|---|
| A | Unmodified, natural. | 90-100 |
| B | Largely natural with few modifications. A small change in natural habitats and biota may have taken place but the ecosystem functions are essentially unchanged. | 80-89 |
| C | Moderately modified. Loss and change of natural habitat and biota have occurred, but the basic ecosystem functions are still predominantly unchanged. | 60-79 |
| D | Largely modified. A large loss of natural habitat, biota and basic ecosystem functions has occurred. | 40-59 |
| E | Seriously modified. The loss of natural habitat, biota and basic ecosystem functions is extensive. | 20-39 |
| F | Critically / Extremely modified. Modifications have reached a critical level and the system has been modified completely with an almost complete loss of natural habitat and biota. In the worst instances the basic ecosystem functions have been destroyed and the changes are irreversible. | 0-19 |

| METRIC GROUP | RATING | CONFIDENCE |
|---|---|---|
| HYDROLOGY | 1.77 | 3.00 |
| BANK STRUCTURE MODIFICATION | 1.40 | 4.00 |
| CONNECTIVITY MODIFICATION | 1.50 | 4.00 |
| RIPARIAN HABITAT INTEGRITY (%) | 69.09 | |
| CATEGORY | C | |
| CONFIDENCE | 3.67 | |

| HABITAT INTEGRITY CATEGORY | DESCRIPTION | RATING (% OF TOTAL) |
|---|---|---|
| A | Unmodified, natural. | 90-100 |
| B | Largely natural with few modifications. A small change in natural habitats and biota may have taken place but the ecosystem functions are essentially unchanged. | 80-89 |
| C | Moderately modified. Loss and change of natural habitat and biota have occurred, but the basic ecosystem functions are still predominantly unchanged. | 60-79 |
| D | Largely modified. A large loss of natural habitat, biota and basic ecosystem functions has occurred. | 40-59 |
| E | Seriously modified. The loss of natural habitat, biota and basic ecosystem functions is extensive. | 20-39 |
| F | Critically / Extremely modified. Modifications have reached a critical level and the system has been modified completely with an almost complete loss of natural habitat and biota. In the worst instances the basic ecosystem functions have been destroyed and the changes are irreversible. | 0-19 |

| | MRU |
|---|---|
| **INSTREAM IHI** | |
| Base Flows | -2.0 |
| Zero Flows | -1.0 |
| Floods | -2.5 |
| **HYDROLOGY RATING** | **1.9** |
| pH | 1.0 |
| Salts | 2.0 |
| Nutrients | 2.0 |
| Water Temperature | 1.5 |
| Water clarity | 2.0 |
| Oxygen | 1.0 |
| Toxics | |
| **PC RATING** | **1.6** |
| Sediment | 1.5 |
| Benthic Growth | 1.5 |
| **BED RATING** | **1.5** |
| Marginal | 2.0 |
| Non-marginal | 2.0 |
| **BANK RATING** | **2.0** |
| Longitudinal Connectivity | 1.5 |
| Lateral Connectivity | 2.0 |
| **CONNECTIVITY RATING** | **1.5** |
| | |
| **INSTREAM IHI %** | **66.0** |
| **INSTREAM IHI EC** | **C** |
| **INSTREAM CONFIDENCE** | **2.8** |

| | MRU |
|---|---|
| **RIPARIAN IHI** | |
| Base Flows | -1.5 |
| Zero Flows | 1.0 |
| Moderate Floods | -2.0 |
| Large Floods | -2.5 |
| **HYDROLOGY RATING** | **1.8** |
| Substrate Exposure (marginal) | 1.0 |
| Substrate Exposure (non-marginal) | 1.0 |
| Invasive Alien Vegetation (marginal) | 0.0 |
| Invasive Alien Vegetation (non-marginal) | 0.0 |
| Erosion (marginal) | 1.0 |
| Erosion (non-marginal) | 1.0 |
| Physico-Chemical (marginal) | 1.5 |
| Physico-Chemical (non-marginal) | 1.0 |
| **Marginal** | 1.5 |
| **Non-marginal** | 1.0 |
| **BANK STRUCTURE RATING** | **1.4** |
| Longitudinal Connectivity | 1.5 |
| Lateral Connectivity | 1.5 |
| **CONNECTIVITY RATING** | **1.5** |
| | |
| **RIPARIAN IHI %** | **69.1** |
| **RIPARIAN IHI EC** | **C** |
| **RIPARIAN CONFIDENCE** | **3.7** |

## Appendix E: Risk Assessment Matrix

**RISK MATRIX (Based on DWS 2015 publication: Section 21 c and I water use Risk Assessment Protocol)**

**Risk to be scored for construction and operational phases of the project. MUST BE COMPLETED BY SACNASP REGISTERED PROFESSIONAL MEMBER REGISTERED IN AN APPROPRIATE FIELD OF EXPERTISE**

| | | | | | Severity | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **No.** | **Phases** | **Activity** | **Aspect** | **Impact** | **Flow Regime** | **Physico & Chemical (Water Quality)** | **Habitat (Geomorph+Vegetation)** | **Biota** | **Severity** | **Spatial scale** | **Duration** | **Consequence** | **Frequency of activity** | **Frequency of impact** | **Legal Issues** | **Detection** | **Likelihood** | **Significance** | **Risk Rating** | **Confidence level** | **Control Measures** |
| 1 | Mostly Operational Phase but also limited during rehabilitation | Sand mining operations | Extraction of sand from the alluvial sand embankment between the two stream systems. | Sand will be extracted from the alluvial sand embankment between the stream systems which may increase sedimentation, promote erosion and alter the functioning and geomorphology of the adjacent stream systems. | 2 | 3 | 3 | 2 | 2.5 | 2 | 2 | 6.5 | 3 | 3 | 5 | 2 | 13 | 84.5 | M | 4 | The extraction of sand will be confined to the central alluvial embankment and the stream systems themselves will be excluded from mining activities. However, due to the close proximity and erosive sandy soils the streams are still likely to be affected by sand excavations. This will mostly be in the form of erosion, sedimentation and modification of the riparian habitat of the streams. These impacts can be mitigated by limiting the depth of sand excavation to the level of the banks of these streams. Furthermore, comprehensive rehabilitation will be necessary, adequate topsoil management and monitoring and remediation of erosion. |
| | Mostly Operational Phase but also limited during rehabilitation | | Access road from the main gravel road the alluvial sand embankment. | The access road will consist of the upgrading of the existing dirt track and will cross the shore of the artificial impoundment. | 2 | 1 | 1 | 1 | 1.25 | 1 | 2 | 4.25 | 3 | 1 | 5 | 2 | 11 | 46.75 | L | 4 | It is recommended that the proposed access road utilise the existing dirt track and that crossing of the stream systems area avoided.<br><br>As long as the dirt track is utilised and accesses the site via the shore of the artificial dam the impact should remain low. This is also subject to the upgrading and design of the access road minimising erosion and allows for adequate storm water drainage. |

## Appendix F: Impact methodology

The environmental significance assessment methodology is based on the following determination:
Environmental Significance = Overall Consequence x Overall Likelihood

### Determination of Consequence

Consequence analysis is a mixture of quantitative and qualitative information and the outcome can be positive or negative. Several factors can be used to determine consequence. For the purpose of determining the environmental significance in terms of consequence, the following factors were chosen: **Severity/Intensity, Duration and Extent/Spatial Scale.** Each factor is assigned a rating of 1 to 5, as described below and in tables 6, 7, 9 and 10.

### Determination of Severity

Severity relates to the nature of the event, aspect or impact to the environment and describes how severe the aspects impact on the biophysical and socio-economic environment.
Table 7 will be used to obtain an overall rating for severity, taking into consideration the various criteria.

Table 7: Rating of severity

| **Type of criteria** | **Rating** | | | | |
|---|---|---|---|---|---|
| | **1** | **2** | **3** | **4** | **5** |
| Quantitative | 0-20% | 21-40% | 41-60% | 61-80% | 81-100% |
| Qualitative | Insignificant / Non-harmful | Small / Potentially harmful | Significant / Harmful | Great / Very harmful | Disastrous Extremely harmful |
| Social/ Community response | Acceptable / I&AP satisfied | Slightly tolerable / Possible objections | Intolerable/ Sporadic complaints | Unacceptable / Widespread complaints | Totally unacceptable / Possible legal action |
| Irreversibility | Very low cost to mitigate/ High potential to mitigate impacts to level of insignificance / Easily reversible | Low cost to mitigate | Substantial cost to mitigate / Potential to mitigate impacts / Potential to reverse impact | High cost to mitigate | Prohibitive cost to mitigate / Little or no mechanism to mitigate impact Irreversible |
| Biophysical (Air quality, water quantity and quality, waste production, fauna and flora) | Insignificant change / deterioration or disturbance | Moderate change / deterioration or disturbance | Significant change / deterioration or disturbance | Very significant change / deterioration or disturbance | Disastrous change / deterioration or disturbance |

**Determination of Duration**
Duration refers to the amount of time that the environment will be affected by the event, risk or impact, if no intervention e.g. remedial action takes place.

Table 8: Rating of Duration

| Rating | Description |
|---|---|
| 1: Low | Almost never / almost impossible |
| 2: Low-Medium | Very seldom / highly unlikely |
| 3: Medium | Infrequent / unlikely / seldom |
| 4: Medium-High | Often / regularly / likely / possible |
| 5: High | Daily / highly likely / definitely |

**Determination of Extent/Spatial Scale**
Extent refer to the spatial influence of an impact be local (extending only as far as the activity, or will be limited to the site and its immediate surroundings), regional (will have an impact on the region), national (will have an impact on a national scale) or international (impact across international borders).

Table 9: Rating of Extent / Spatial Scale

| Rating | Description |
|---|---|
| 1: Low | Immediate, fully contained area |
| 2: Low-Medium | Surrounding area |
| 3: Medium | Within Business Unit area of responsibility |
| 4: Medium-High | Within Mining Boundary area |
| 5: High | Regional, National, International |

**Determination of Overall Consequence**
Overall consequence is determined by adding the factors determined above and summarised below, and then dividing the sum by 4.

Table 10: Example of calculating Overall Consequence

| Consequence | Rating |
|---|---|
| Severity | Example 4 |
| Duration | Example 2 |
| Extent | Example 4 |
| SUBTOTAL | 10 |
| TOTAL CONSEQUENCE:(Subtotal divided by 4) | 3.3 |

**Likelihood**
The determination of likelihood is a combination of Frequency and Probability. Each factor is assigned a rating of 1 to 5, as described below and in Table 11 and Table 12.

**Determination of Frequency**
Frequency refers to how often the specific activity, related to the event, aspect or impact, is undertaken.

Table 11: Rating of frequency

| Rating | Description |
|---|---|
| 1: Low | Once a year or once/more during operation/LOM |
| 2: Low-Medium | Once/more in 6 Months |
| 3: Medium | Once/more a Month |
| 4: Medium-High | Once/more a Week |
| 5: High | Daily |

**Determination of Probability**
Probability refers to how often the activity/even or aspect has an impact on the environment.

Table 12: Rating of probability

| Rating | Description |
|---|---|
| 1: Low | Almost never / almost impossible |
| 2: Low-Medium | Very seldom / highly unlikely |
| 3: Medium | Infrequent / unlikely / seldom |
| 4: Medium-High | Often / regularly / likely / possible |
| 5: High | Daily / highly likely / definitely |

**Overall Likelihood**
Overall likelihood is calculated by adding the factors determined above and summarised below, and then dividing the sum by 2.

Table 13: Example of calculating the overall likelihood

| Consequence | Rating |
|---|---|
| Frequency | Example 4 |
| Probability | Example 2 |
| SUBTOTAL | 6 |
| TOTAL LIKELIHOOD (Subtotal divided by 2) | 3 |

**Determination of Overall Environmental Significance**
The multiplication of overall consequence with overall likelihood will provide the environmental significance, which is a number that will then fall into a range of LOW, LOW-MEDIUM, MEDIUM, MEDIUM, MEDIUM-HIGH or HIGH, as shown in the table below.

Table 14: Determination of overall environmental significance

| Significance or Risk | Low | Low-Moderate | Moderate | Moderate-High | High |
|---|---|---|---|---|---|
| Overall Consequence<br>X<br>Overall Likelihood | 1 - 4.9 | 5 - 9.9 | 10 - 14.9 | 15 – 19.9 | 20 - 25 |

**Qualitative description or magnitude of Environmental Significance**
This description is qualitative and is an indication of the nature or magnitude of the Environmental Significance. It also guides the prioritisations and decision making process associated with this event, aspect or impact.

Table 15: Description of the environmental significance and the related action required.

| Significance | Low | Low-Moderate | Moderate | Moderate-High | High |
|---|---|---|---|---|---|
| Impact Magnitude | Impact is of very low order and therefore likely to have very little real effect. Acceptable. | Impact is of low order and therefore likely to have little real effect. Acceptable. | Impact is real, and potentially substantial in relation to other impacts. Can pose a risk to the company | Impact is real and substantial in relation to other impacts. Pose a risk to the company. Unacceptable | Impact is of the highest order possible. Unacceptable. Fatal flaw. |
| Action Required | Maintain current management measures. Where possible improve. | Maintain current management measures. Implement monitoring and evaluate to determine potential increase in risk. Where possible improve | Implement monitoring. Investigate mitigation measures and improve management measures to reduce risk, where possible. | Improve management measures to reduce risk. | Implement significant mitigation measures or implement alternatives. |