IMPUMA QUARRY

THE FARMS KLEINRIVIER 713 Ptn 32 & BUFFELSBOSCH 742 Ptn 14, HUMANSDORP

BIODIVERSITY SENSITIVITY ANALYSIS

PREPARED FOR Mr C DONALD

JUNE 2012

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1. INTRODUCTION

1.1 TERMS OF REFERENCE

Ken Coetzee of *Conservation Management Services* was contracted by Mr Craig Donald of *Siteplan*, on 1 March 2012 to conduct a biodiversity sensitivity analysis on an area proposed for a mining right application on the farms Kleinrivier 713 Ptn 32 and Buffelsbosch 742 Ptn 14 - Humansdorp district.

The sites were visited on 16 April 2012 to collect the necessary biodiversity information, make a photographic record and reconnoitre the surrounding landscape.

1.2 DECLARATION OF INDEPENDENCE AND COMPETENCY

I hereby declare that I, Ken Coetzee trading as Conservation Management Services, comply with all the conditions of PWC: DEA&DP for a person appointed in terms of the NEMA EIA Regulations to compile a specialist report, viz:

- I am independent;
- Have the required expertise, including knowledge of the NEMA, the EIA Regulations and any guidelines that have relevance to the proposed activity and specialist input or study;
- I am registered with the South African Council for Natural Scientific Professions in the field of Ecological Science - Reg No 400099/08.
- Perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant;
- Comply with NEMA, the EIA Regulations and all other applicable legislation;
- Disclose to the applicant, EAP and the Department all material information in the possession of the person that reasonably has or may have the potential of influencing –
  - (i) any decision to be taken with respect to the application by the competent authority in terms of these Regulations; or
  - (ii) the objectivity of any report, plan or document to be prepared by the person in terms of these Regulations for submission to the competent authority;
- Ensure EIA best practice and clear communication on the methodologies used, and the assumptions, uncertainties and gaps in knowledge; and
- Adhere to the National Environmental Management principles contained in Section 2 of NEMA and the general objectives of Integrated Environmental management contained in Section 23 of NEMA.

1.3 LEGISLATIVE FRAMEWORK

The national legislation protecting environmental and biodiversity resources include the following, which ensure the protection of natural systems, ecological processes and biotic diversity in the natural environment:

- Mineral & Petroleum Resources Development Act, Act 28 of 2002.
- Environmental Conservation Act (Act 73 of 1989).
- National Environmental Management Act, 1998 (Act 107) (NEMA).
- National Environmental Management Biodiversity Act, 2004 (Act 10 of 2004) (NEMBA).

It has been ensured in this report that the provisions of this legislation have been considered in terms of the project proposal and the mitigation of potential impacts on the vegetation and the vertebrate fauna and its habitats.

1.4 METHODOLOGY AND APPROACH

STUDY SITES: 'The study sites' is the term given to the entire area covered by this biodiversity impact study. It is defined by the outside boundary of the quarry development areas as provided in the background information document.

Figure 1A shows the locality of the study sites near to Humansdorp and Cape St Francis in the Eastern Cape. Figure 1B shows the precise locality of the two study sites, Site 1 south of Site 2 and approximately 1,7 km apart.

Figure 2 shows the landscape detail of Site 1 and Figure 3 shows the landscape at Site 2.

STUDY APPROACH: Each of the two sites was closely examined on foot, covering all of each area in detail. A record of plant presence and habitat was made on site. Plants requiring identification were collected and referred to specialist botanist Jan Vlok (*Regalis Environmental Services*) for identification. In order to determine vertebrate fauna sensitivity to negative impact, it was necessary, to first determine what fauna potentially occur on the property. As it was not possible to locate all this fauna for such a survey, use was made of the published information to determine geographical distribution and the habitat requirements for all of the vertebrates likely to occur in the general study area and surrounds. This information was augmented with personal knowledge of the habitats and the vertebrates typical of them, as well as the detailed investigation of the habitats on the study area.

A list of potential impacts was then identified in terms of the observations made in the study area and the probability of occurrence of the Red Data Book listed vertebrate species in the study area. The potential impacts were then assessed in terms of their severity and significance and mitigatory measures were proposed where required.

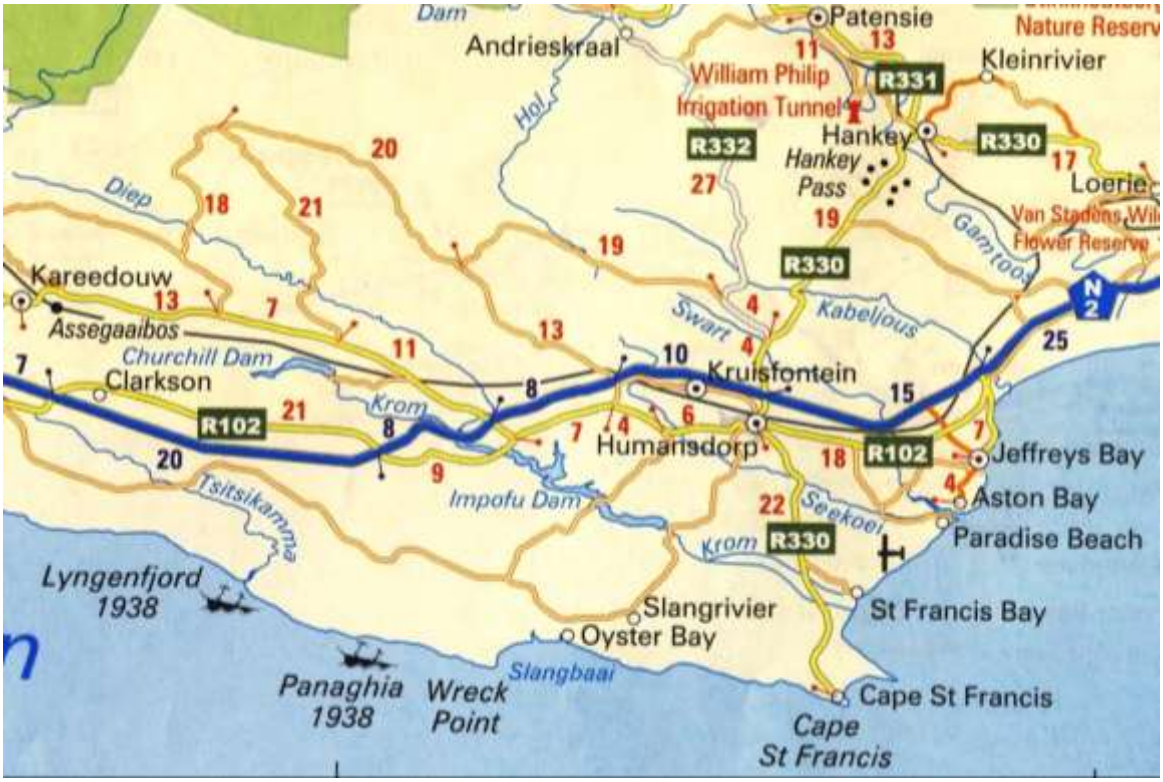

TABLE 1A: Approximate locality of the study area approximately 14 km south of Humansdorp in the Eastern Cape.

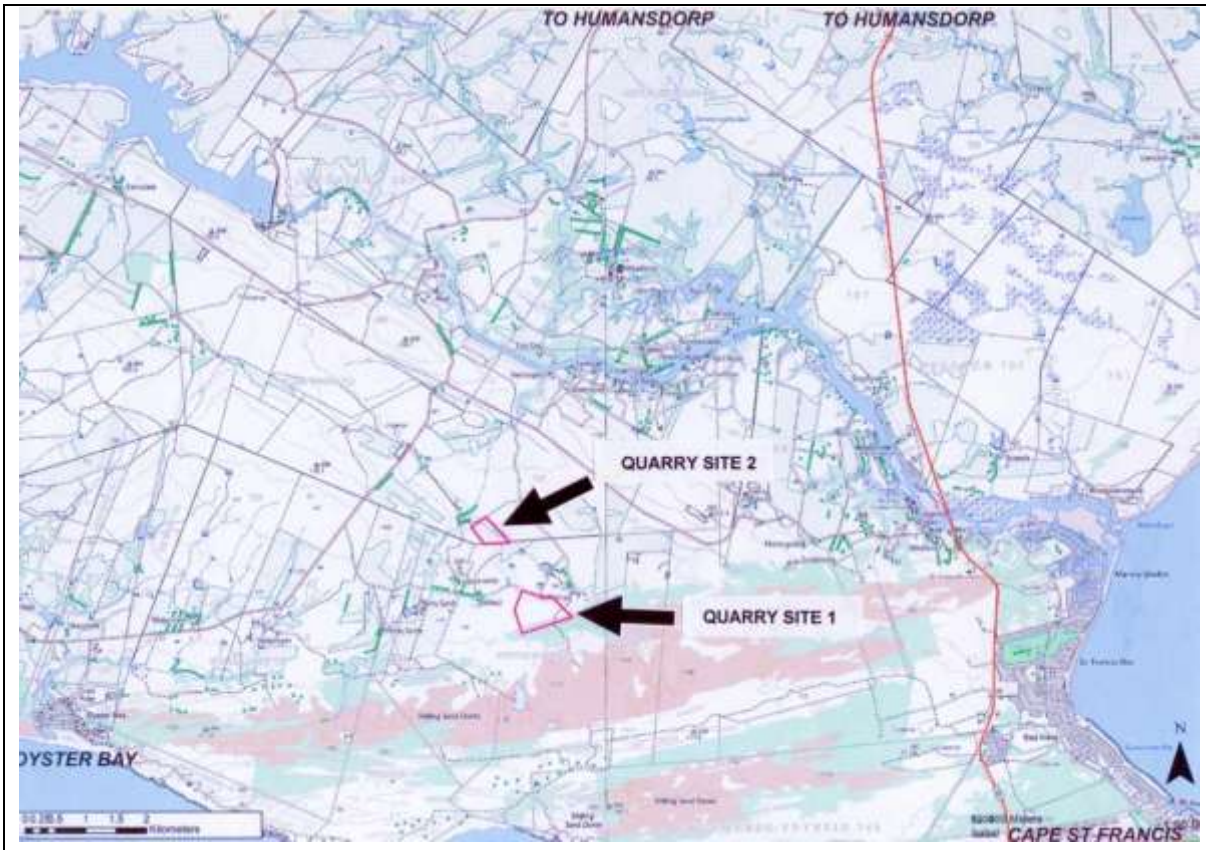

FIGURE 1B: Locality of the study sites 1 & 2, approximately 14 km west of St Francis Bay and 14 km north-east of Oyster Bay on the Eastern Cape Coast.

FIGURE 2: Layout of the landscape of Site 1.

FIGURE 3: Layout of the landscape of Site 2.

LIMITATIONS: Although many of the Fynbos plant species were in flower at the time of the field visit, a more thorough collection would require field visits during the full range of flowering periods in order to fully identify all the geophytes and annual plants.

Some of the smaller, more cryptic plants may have escaped detection in denser vegetation. The plant checklist is, however, considered to contain the majority of plant species at the two study sites.

The occurrence of vertebrate fauna is predicted by means of the described method. There is no other way in which to produce accurate occurrence data other than by means of long term detailed collecting and inventorizing of the fauna on site. Similarly, there is no more accurate rapid method for verifying the occurrence of the Red Data listed species.

The assumption is that if the habitat is suitable and the geographic range of a particular species correlates with the study area, then that species is likely to occur.

A degree of credibility is given to these predictions by the extensive personal knowledge of the author of Eastern Cape habitats and the fauna that occur in them.

2. DESCRIPTION OF THE STUDY AREA

2.1 SUBSTRATES AND SOILS

At both study sites, there are outcroppings of sandstone which belong to the Goudini Formation, Nardouw Subgroup, of the Table Mountain Group of Rocks. These are rocks of the Cape Supergroup (Geol Survey, 1991).

The rocks are brownish weathering quartzitic sandstone which is obviously suitable in terms of the application for a mining right on the study sites.

These rock layers are overlain by loamy sand in the shallow valleys in between the ridges and outcrops of sandstone. Most of the areas of sandy loam have been transformed for agricultural cropping, as is the case over much of both study sites.

2.2 VEGETATION

The vegetation of the two study sites was described by Mucina et al (2006) as Tsitsikamma Sandstone Fynbos. They describe it as either Proteoid, Restioid or Ericoid Fynbos with Fynbos Thicket in wetter areas. Cowling & Heijnis (1999) described the broad habitat unit within which the study area falls as Humansdorp Grassy Fynbos in their determination of Broad Habitat Units for systematic conservation planning in the Cape Floristic Region.

In their mapping of the Subtropical Thicket Biome, Vlok & Euston-Brown (2002) also map the vegetation as Humansdorp Grassy Fynbos on the *STEP* Vegetation Map.

SITE 1: Here, the last remaining patches of untransformed Grassy Fynbos occur within rocky outcrop areas at the northern edge and south-western part of the study site. As the rocks "smooth out" to the cultivated area, the Fynbos becomes more grassy and it becomes pure grass at the edge of the cultivated area. (See Plates 1 & 2).

PLATES 1 & 2: The Grassy Fynbos of the low sandstone outcrops on Site 1.

Typical species are:

Agathosma ovata
Aspalathus spinosa
Asparagus africanus
Bobartia orientalis
Erica sparmanni
Euryops munitus
Metalasia pungens
Morella quercifolia
Nylandtia sinosa
Phylica lachnaeoides
Relhania genistifolia
Searsia lucida forma lucida
Stoebe plumosa
Thamnochortus cinereus.

Most of Site 1 consists of a completely transformed area of cropland on deeper sandy soil deposits over the rock layers below. (See Plates 3 & 4). These croplands appear to be currently planted with oats. Other than the planted crop, the cropland area also contains the following plant species:

Stoebe plumosa
Pennisetum clandestinum (alien)
Stenotaphrum secundatum
Oxalis sp
Cynodon dactylon
Exomis michrophylla.

Of the above species, *Cynodon dactylon* (kweekgras) is the most important in terms of a soil surface cover.


PLATES 3 & 4: The cultivated cropland/pastures which cover most of Site 1.

On the eastern edge of the cropland area of Site 1 is relatively dense infestation of *Acacia saligna*. The entire infested area, which extends further to the east and off the study areas, consists of *A saligna*, occasional isolated *Searsia lucida* shrubs, patches of shrubby *Rhamnus prinoides* and *Asparagus* sp and a sparse ground cover of grasses. It is a completely transformed habitat unit. (See Plates 5 & 6).

A small stand of last remaining original Fynbos Thicket plants persists in between a few rocks on Site 1. The thicket plant species are *Pterocelastrus tricuspidatus, Searsia longispina, Carissa bispinosa, Acacia cyclops* and *Searsia lucida forma lucida.* These small thicket trees persist as individual plants rather than an intact remnant of thicket.


PLATES 5 & 6: The infestation of *Acacia saligna* on Site 1.

SITE 2: At Site 2 there is an extensive untransformed north-facing rocky slope with a cover of undisturbed Restioid Fynbos. (See Plates 7 & 8). Plant species are the same as at Site 1 with the addition of *Leucospermum cuneifolium* and a few more restioid species. *Relhania genistifolia* is prevalent. At midslope the fynbos becomes more grassy, becoming pure grassy pasture at the flat area at the foot of the slope on deeper sandy soil. (See Plate 9). The bottom half of the site contains an area of formerly cultivated old lands upon which the pioneer *Stoebe plumosa* and grasses, particularly *Stenotaphrum secundatum*, dominate. (See Plate 10). This lower part of the site is severely invaded by alien *Acacia saligna* and *Acacia mearnsii*. (See Plates 11 & 12).


PLATES 7 & 8: The untransformed Restioid Fynbos of Site 2.

PLATE 9: Grassy conditions at mid- and lower slope on deeper soils on Site 2.

PLATE 10: Grassy pasture at the bottom of the slope of Site 2, probably cultivated in the past.


PLATES 11 & 12: Infestations of *Acacia saligna* and *Acacia mearnsii* on Site 2.

Grasses that occur in the fynbos at both sites include:

Cymbopogon plurinodis
Cynodon dactylon
Digitaria eriantha
Ehrharta calycina
Eragrostis capensis
Eragrostis curvula
Hyparrhenia hirta
Pennisetum clandestinum
Sporobolus africanus
Stenotaphrum secundatum
Themeda triandra.

A small seepage area occurs below a small earth dam within a dense stand of *Acacia saligna* trees in the bottom north-eastern corner of Site 2. The presence of water is probably seasonal and the moist conditions are dominated almost exclusively by the grass *Stenotaphrum secundatum* with an overstory of invasive alien trees.

PLANT CHECKLIST

The following plant species were located on both study sites during the field evaluation. For a more complete list, including all annuals and geophytes, it will be necessary to visit and collect during the other seasons of the year.

Acacia cyclops (alien)
Acacia mearnsii (alien)
Acacia saligna (alien)
Agathosma ovata
Anthospermum galioides
Arctopus echinatus
Aristida adscensionis
Aspalathus spinosa
Asparagus africanus
Asparagus suaveolens
Bobartia orientalis
Boophane disticha
Canthium inerme
Carissa bispinosa
Crassula muscosa
Cymbopogon plurinodis
Cynodon dactylon
Cyphia volubilis
Delosperma littoralis
Digitaria eriantha
Diospyros dichrophylla
Disa saggitalis
Ehrharta calycina
Eragrostis capensis
Eragrostis curvula
Erica gracilis
Erica sparmannii
Euryops munitus
Exomis michrophylla
Helichrysum cymosum

Helichrysum patulum
Heliophila subulata
Hibiscus aethiopicus
Hyparrhenia hirta
Ischyrolepis capensis
Lampranthus sp
Leucadendron salignum
Leucospermum cuneiforme
Lobelia tomentosa
Metalasia pungens
Morella quercifolia
Nylandtia spinosa
Oxalis bifurca
Oxalis imbricata
Oxalis smithiana
Pelargonium alchemelloides
Pennisetum clandestinum (alien)
Phylica lachnaeoides
Podalyria myrtillifolia
Pteridium aquilinum
Ptrocelastrus tricuspidatus
Relhania genistifolia
Rhamnus prinoides
Rubus pinnatus
Searsia glauca
Searsia laevigata
Searsia longispina
Searsia lucida forma lucida
Selago corymbosa
Selago glomerata
Senecio lilicifolius
Senecio othonniflorus
Sporobolus africanus
Sporobolus fimbriatus
Stenotaphrum secundatum
Stoebe plumosa
Struthiola macowanii
Thamnochortis cinereus
Themeda triandra
Watsonia angusta.

2.3 VERTEBRATE FAUNA

INVENTORY: No specific studies of the vertebrate fauna of the study sites have been done before. Published literature about the distribution of fauna, in particular the Red Data Book listed species, together with an on-site habitat evaluation was used as a basis for predicting the likely presence of vertebrate fauna in the general area and on the study sites in particular.

HABITAT: The two study sites contain a relatively limited variety of habitat types for vertebrate fauna occupation. The transformed croplands are suitable habitat for only the most ubiquitous and generalist species, many of which are birds and small mammals. The rocky fynbos areas are the least transformed and thus provide habitat for a good variety of reptiles, rodents and birds. The alien tree-infested areas, like the croplands, provide habitat for only the most disturbance-tolerant vertebrates. Grassy pasture areas, like the croplands and alien tree infestations, provide habitat for a range of catholic species consisting mostly of rodents, birds and a few reptiles and amphibians.

Site 1 can be classed as a highly disturbed and transformed area while Site 2 is only partly transformed and less disturbed.

LANDSCAPE TRANSFORMATION: The two study sites, both of which contain remnants of the historical fynbos of the general area, are almost completely surrounded by a highly transformed landscape. Most of the transformation is due to the cultivation of arable soils for crops and forage for livestock, but extensive areas have become degraded by invasions of alien trees like *Acacia cyclops, Acacia saligna* and *Acacia mearnsii*, all of which occur on both of the study sites.

As a result of these transformations, much of the natural indigenous vertebrate fauna of the study sites has been lost due to the effects of disturbance, habitat overutilization, habitat loss and fragmentation.

The following account outlines likely occurrence, as well as the predicted sensitivity of the fauna, to the likely impacts of the quarrying activities.

2.3.1 REPTILES AND FROG FAUNA

ANURA:

The study area falls within a zone of moderate species richness for the Anura, between 11 and 20 species for most of the south and eastern Cape Coastal area (Minter et al, 2004).

Of the 15 species that have been recorded in the quarter degree in which the study area is located, all of them fall into the Red Data Book category ***least concern*** and are thus not in any way classed as threatened, vulnerable or endangered (Minter et al, 2004).

REPTILIA:

There is no current or up-to-date Red Data Book for the reptiles of South Africa. The Southern African Red Data Book for reptiles and amphibians (Branch, 1988) is thus the only reference, albeit out of date. According to this work, no endangered, vulnerable or threatened reptile species are recorded for the quarter degree within which the study area is located. Branch (1998), Alexander & Marais (2007) and Tolley & Burger (2007) were also consulted regarding a more up-to-date distribution of Red Data listed reptiles.

2.3.2 MAMMALS

At least 50 mammal species are predicted to occur within the quarter degree in which the study area occurs. These include 10 herbivores, 12 carnivores, 12 bats, 6 insectivores, 2 hares, 2 primates, 1 elephant shrew, aardvark and 19 rodents.

The study sites obviously do not contain suitable habitat for all the mammal species predicted to occur in the area. Only two of the likely species are recorded in the Red Data Book for Mammals (Friedman & Daly, 2004). They are:

Oribi	- *Ourebea ourebi*	- Endangered
Fynbos golden mole	- *Amblysomis corriae*	- Near threatened.

Oribi are restricted to untransformed grassveld providing short grass for grazing and tall grass for cover (Skinner & Chimimba, 2005) and are easily outcompeted by cattle overgrazing. The fynbos and pastures of the two study sites do not contain suitable Oribi habitat nor are they anywhere near to any suitable habitat for this species.

The fynbos golden mole is marginal for the study area (occurring mostly westwards), but it is also restricted to deeper soils at forest fringes and associated fynbos. The study sites, situated on hard sandstone rock outcrops and cropland with shallow soils certainly do not provide typical suitable habitat for this mole. It can thus be summarised that these Red Data listed mammal species are in no way threatened on the study area by the proposed quarrying activity, due to the lack of suitable habitat for either species as well as the small restricted area that will be ultimately impacted.

2.3.3 BIRDS

According to Barnes (2000), the following birds that occur in the same quarter degree as that of the study area, are listed in the Red Data Book for the birds of South Africa and may therefore occur in the study area.

COMMON NAME	SCIENTIFIC NAME	RED DATA BOOK CATEGORY
Martial eagle	*Polemaetus bellicosus*	Vulnerable
African marsh harrier	*Circus ranivorus*	Vulnerable
Blue crane	*Anthropoides paradiseus*	Vulnerable
Stanley's bustard	*Neotis denhami*	Vulnerable
White bellied korhaan	*Eupodotis cafra*	Vulnerable
Knysna warbler	*Bradypteris sylvaticus*	Vulnerable
Secretary bird	*Saggitarius serpentarius*	Near threatened

Due to the habitat types available on both study sites, the Knysna warbler can be excluded as a possible inhabitant because it prefers the dense tangled vegetation typical of watercourses, the edge of forests and open alien tree infestations (Hockey, et al, 2005).

Similarly, the martial eagle can be excluded as it requires extensive ranges which include open woodland, savannah, forest edges, shrubland and drainage line woodland. The study sites provide neither a suitable area or the required habitat.

The known (published) distribution of white-bellied korhaan, blue crane, Stanley's bustard, secretary birds and African marsh harrier coincides with the area in which the quarries are proposed. The following is a tabular analysis of the potential impact that the quarrying activities may have on these birds.

SPECIES	DO THE SPECIFIC STUDY SITES CONSTITUTE OPTIMAL HABITAT FOR THE SPECIES	WHAT ASPECT OF THE QUARRYING ACTIVITY MAY IMPACT ON THE SPECIES	WHAT MITIGATORY MEASURES COULD BE APPLIED	SIGNIFICANCE OF THE IMPACT OF THE ACTIVITY ON THE LOCAL POPULATION
White-bellied korhaan *Eupodotis cafra*	***They do not.*** White-bellied korhaan prefer tall dense grassland and only occasionally will use modified pasture habitat. In the East Cape, lower densities occur on heavily grazed and generally disturbed farming areas.	Spatial habitat loss is insignificant due to the relatively unsuitable habitat for this species on both sites. The impacts of noise, blasting, dust and general disturbance are thus unlikely to have a significant impact on the Humansdorp area population.	None required - the Humansdorp population is unlikely to be affected by this site-specific activity.	Low
Denhams bustard *Neotis denhami*	***They marginally do.*** These birds breed in Lowland Fynbos and grasslands, often in rocky areas and occasionally use cultivated pastures (especially in winter). The birds avoid heavily grazed areas such as Site 1. They also avoid ploughed fields.	If the species does make use of the area, all aspects of the quarrying will have an impact. The habitat is considered to be marginally suitable which means that it will not be utilized by a significant part of the local population or for a significant time	No mitigation is re-commended, as the importance of the study sites as habitat is consider-ed to be very low.	Low - medium.
Blue crane *Anthropoides paradiseus*	***They do.*** In the west & east Cape, these birds are confined to cereal crop fields and pastures. Site 1 consists mostly of a planted crop. Site 2 contains part of an old land/pasture.	These birds mostly breed on the coastal plain. The quarrying activities are thus not likely to have any significant impact on the local blue crane population. These birds occur widely on transformed habitat, often near to highways, towns, railway lines and existing disturbances like quarries, grain harvesting, etc. The spatial habitat loss to the quarry activities is unlikely to impact significantly, as croplands in all its forms are the dominant habitat in all of the landscape around the study sites.	No mitigation is considered necessary.	Low.
African marsh harrier *Circus ranivorous*	***They do not.*** These birds almost exclusive-ly occur at inland and coastal wetlands. These habitats do not occur within or close to the study areas.	None of the activities will have an impact, as these birds will not occur on the study sites.	No mitigations are required.	No significance.
Secretary bird *Saggitarius serpentarius*	***They do not.*** This species favours open, natural grassland, shrubland with scattered trees and savannah. They are absent from rocky hill habitats.	None of the activities will have an impact, as these birds will not occur on the study sites.	No mitigations are required.	No significance.

<u>TABLE 1</u>: Analysis of habitat suitability*, potential impact of the proposed quarrying activity and significance of this impact on populations of the Red Data species that may occur on the study sites.
*** Hockey et al (2005); Harrison et al (1997); Barnes (2000).**

3. SUMMARY OF SITE SENSITIVITY

3.1 VEGETATION

Almost all of the Site 1 is located within an area of cultivated pastures. Small areas of untransformed Fynbos, which is heavily impacted by cattle grazing, occurs at the north-eastern edge and in the south-western quarter of Site 1. The Fynbos that will be lost at Site 1 due to the proposed excavation of rock is not considered to be particularly sensitive. It has been used for cattle grazing for some time and as a consequence, it has become grassy, probably at the expense of some of the Fynbos biodiversity.

In Figure 4A, the Fynbos of the sandstone outcrop area of Site 1 is mapped as a Critical Biodiversity Area (CBA), as is the area to the west of it. Field evaluation, however, found that the area to the west and a large portion of study Site 1 is, in fact, completely transformed and thus cannot be justifiably classed as a CBA.

Almost half of Site 2 (north-eastern half) has been transformed, presumably for grazing pasture, although it may have been cultivated in the past. A part of this transformed area is classed as the vulnerable vegetation type: Eastern Coastal Shale Band Vegetation (see Figure 4B). This vegetation is grassy and has been heavily grazed (lawned) in parts. It may have been classed as vulnerable, but it is transformed and also severely grazed. In addition to its transformation, the lower (north-eastern) edge is severely infested with alien black wattle (*Acacia mearnsii*).

The balance of the area on the rocky slope of Site 2 consists of relatively undisturbed Fynbos which is also classed, by Mucina et al (2006), as vulnerable, but is not considered to be vulnerable enough to be classified as a CBA in Figure 4B. Although classed as vulnerable, the Fynbos of the two study sites contain no vulnerable, threatened or endangered (Red Data listed) plant species (Raimondo et al, 2009). The isolated nature of these Fynbos patches is also a problem for the long-term status of the patches. Fragmentation of the original habitat has had its negative impact and heavy livestock grazing is also having an impact.

In summary, it is estimated that the Fynbos that occurs on the two study sites is not particularly sensitive and that the loss of this Fynbos will not be significant in terms of the conservation of this particular habitat type in the area. In terms of the CBA mapping and sensitive sites mapping in Figures 4A and 4B, some of the corridors, linkages and ecological processes proposed for the maintenance of CBA classification were found to be invalid and inaccurate at the fine scale of the study site evaluation.

As a mitigatory measure, it is proposed that a biodiversity offset, consisting of the complete and careful conservation of all the other sandstone outcrops on the farms affected be considered. This would entail fencing the outcrops to ensure controlled utilization by livestock at an acceptable frequency.

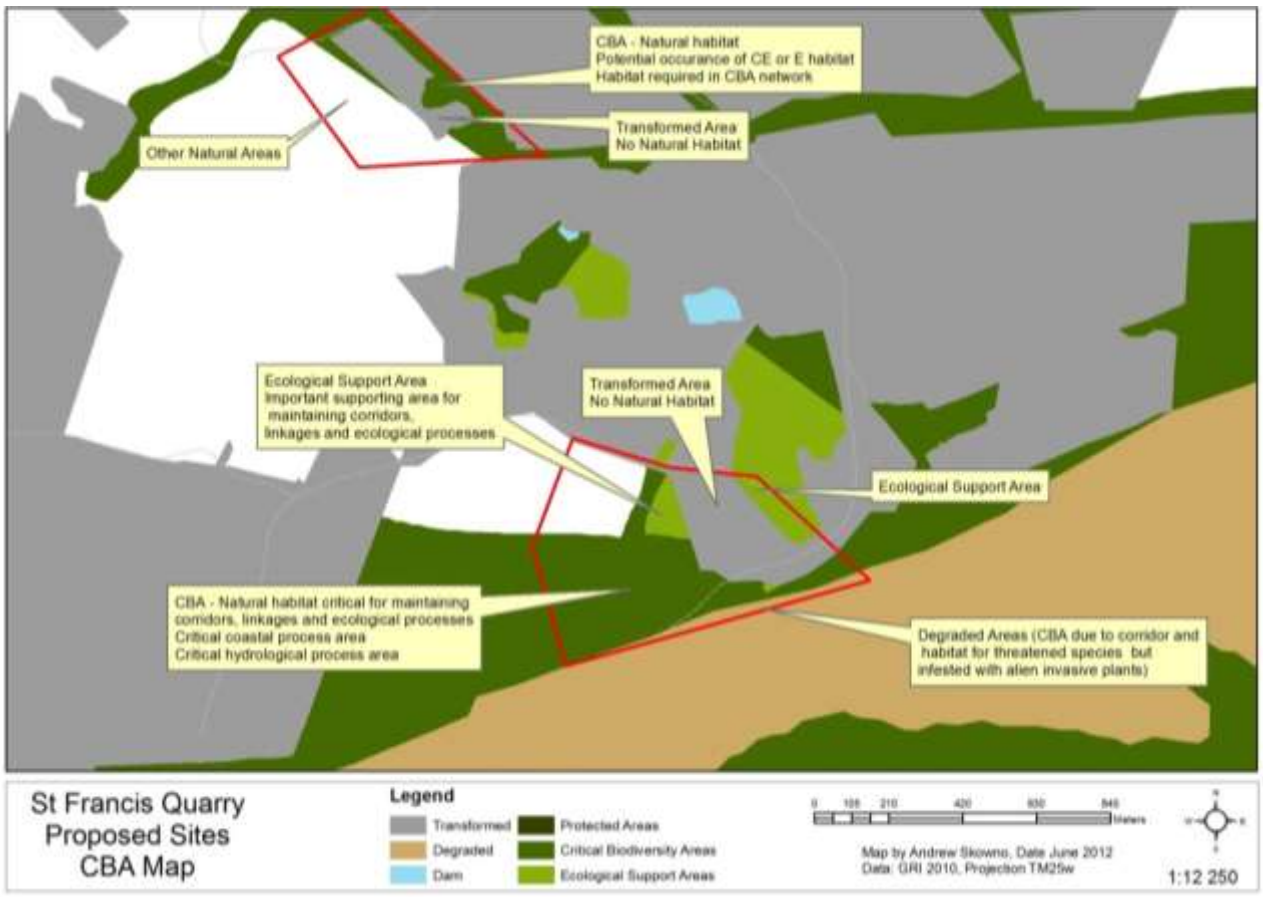

FIGURE 4A: Critical Biodiversity Area Map of the study site area.

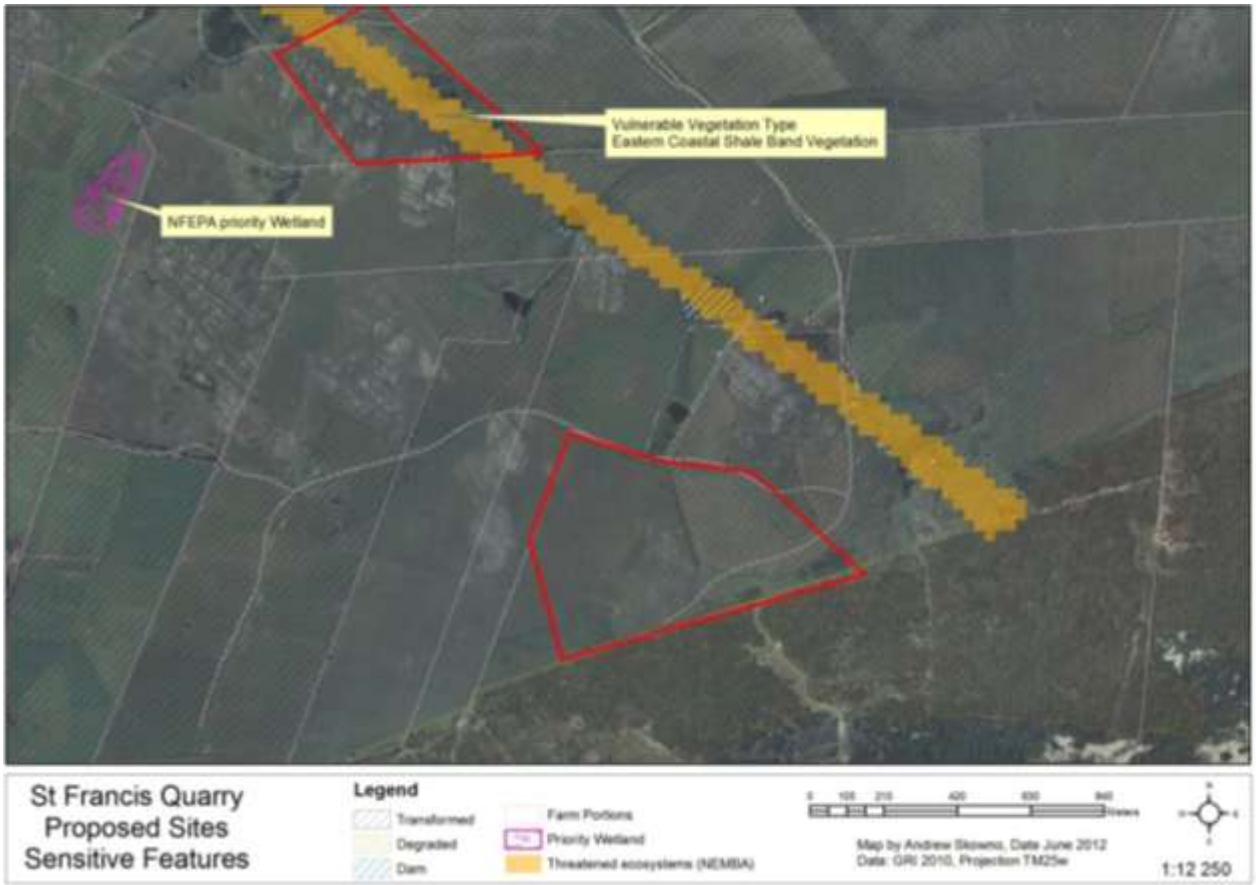

FIGURE 4B: Sensitive features of the study site area.

3.2 VERTEBRATE FAUNA

None of the frog or reptile fauna predicted to occur at the two study sites consists of Red Data listed or otherwise important species. Neither of the two Red Data listed mammals for the area (oribi and fynbos golden mole) are provided with suitable habitat on the two study sites and it is thus unlikely that they do occur on these sites or in the general area.

Of the five Red Data listed birds that are known to occur in the general area, only the blue crane is provided with suitable habitat on the study sites. Their preferred habitat is not in the Fynbos, but the transformed croplands which are extensive well beyond the two study sites. The two Red Data listed birds of concern in the general area, the white-bellied korhaan and Denham's bustard, will not find suitable habitat on the two study sites. Both species appear to avoid heavily grazed areas, which excludes approximately half the two study sites and the ploughed fields and fynbos on the remainder of these sites is also not preferred habitat for either species.

As pointed out by interested party, Ms Maggie Langlands (2012) of the St Francis Kromme Trust "These bird species are highly selective about habitat." The evaluation of the two study sites revealed that the habitat is not completely suitable for either the white-bellied korhaan or Denham's bustard.

The concentrations of Denham's bustard that Ms Langlands refers to were not observed and certainly are not restricted to the vicinity of the two study sites, but probably occur in other relatively undisturbed and more suitable lowland habitats.

4. LANDSCAPE CONNECTIVITY

From the satellite photo image in Figure 5, it can be seen that both Sites 1 and 2 lie within a largely transformed agricultural landscape, with all of the arable land used for either crops or pastures. Both study sites lie along a ridge of low sandstone outcrops, each of which are cut off from the next by sections of cultivated lands. Connectivity along the ridge is thus not continuous, but broken-up or fragmented. This fragmentation may not be problematic for bird connectivity, but it is certainly problematic for the connectivity of small vertebrates that occupy the sandstone outcrops, and in most cases, it is predicted with confidence, that little or no vertebrate movement occurs between the outcrops. Larger animals like small and medium sized mammals can probably still maintain some connectivity between the sandstone outcrops.

To the south-east of Site 1, approximately 800m away lies an inland dunefield and the area between Site 1 and the dunefield is completely infested with dense thickets of alien *Acacia saligna* and *Acacia cyclops*.

There is thus no potential for landscape connectivity between the two study sites and the coastal area. It is thus clear that there are no important or necessary corridors or connections across, to or from the two study sites and the surrounding landscape.

FIGURE 5: Layout of the landscape around the study sites, showing the high degree of transformation for crops and pastures.

5. CONCLUSION AND RECOMMENDATIONS

5.1 CONCLUSION

It is concluded that the proposed quarry Sites 1 and 2 do not contain particularly sensitive biodiversity and that neither of the sites are an indispensable part of any landscape connectivity potential.

The CBA map indicates that the Eastern Coastal Shale Band vegetation on Site 2 is vulnerable, but at fine scale on the study site, it was found that this habitat had been transformed and is thus no longer a conservation priority at that site.

The Tsitsikamma Sandstone Fynbos is also classified as vulnerable, but on Site 1 it is impacted by cattle grazing and it is fragmented within a matrix of cultivated lands.

On Site 2 the Fynbos is completely undisturbed and the loss of this habitat to quarrying could be mitigated by means of a valuable biodiversity offset, ie, fencing and conserving the other remaining sandstone outcrops (with Fynbos) on the farms affected.

It is also concluded that no Red Data listed vertebrate fauna will become additionally vulnerable or threatened due to the proposed quarrying activities at the two sites.

5.2 RECOMMENDATIONS

5.2.1 BIODIVERSITY OFFSETS

It is recommended that the protection and advised management of the Fynbos on the remaining sandstone outcrops on the affected farms be considered as a suitable biodiversity offset to compensate the loss of Fynbos, particularly at Site 2, due to the proposed quarrying activity.

If this recommendation is pursued, it will be necessary for the outcrops to be fenced to exclude livestock, so that a suitable grazing regime can be implemented. The fence should be built to a height of 1,4m and it should be open at the bottom to allow for small animal movement under the fence. The bottom wire should be approximately 200mm above the ground. A suitably qualified botanist/ecologist should assist with the demarcation of these biodiversity offset areas.

This offset is suggested as a means of conserving other sandstone outcrop vegetation on the farms, but it is not suggested as a prescription.

5.2.2 ALIEN PLANT CONTROL

It is recommended that the organisation that is given approval to quarry on the two study sites, should accept the responsibility to prevent further alien plant invasion of the quarry sites and surrounds, as well as the responsibility of clearing the quarry sites of all existing invasive alien plants. The methods to use for this control are provided in Appendix 1.

On closure of the quarries, the responsible party should ensure that no alien plants invade the sites for a period of at least six months after closure of the quarries. This is to ensure that the topsoil used for rehabilitation will not result in a new infestation of weeds due to seeds that may have been stored in the topsoil when it was collected.

5.2.3 REHABILITATION

Details of the proposed quarry attenuation measures are given in the background information document (BID). The physical reshaping of the sheer rock faces of the quarries after closure by means of buttress blasting and the creation of benches and slump slopes will certainly improve the chances of success with any attempt to establish plants in these areas.

After the available topsoil has been spread over these reshaped surfaces it is proposed that they be seeded with a variety of indigenous grasses. Seeding should be at a rate of at least 6 kg/ha and should consist of a mix of grasses, rather than single-species seeding.

The grasses to use are:

Cenchrus ciliaris - foxtail buffalo grass*
Digitaria eriantha - finger grass*
Ehrharta calycina - rooisaadgras*
Cyndon dactylon - couch grass/kweek*
Eragrostis curvula - weeping love grass*
Chloris gayana - Rhodes grass*
Hyparrhenia hirta - dekgras.

(*Commercially available).

The seed should be sown at the beginning of spring, ie: early September to October or directly after the first spring rains into moist soil.

After seeding, it is proposed that the seeding sites be covered immediately with a layer of wood chip mulch. The mulch should not be too thick, it must permit sunlight, water and air to penetrate, a 50mm layer will be adequate. It is critical that wood chip mulch be used, because hay, mielie hay or crop straw is too light and is generally lost during the first windy period. The wood chip mulch is heavier and more durable, will keep exposed soil surfaces cool in hot weather, will retain moisture in the soil and will also shelter the germinating plant seedlings.

Wood chip mulch is obtainable at relatively low cost from sawmills that produce rounded poles and is generally sold in $30m^3$ loads at the cost of delivery to the site.

5.2.4 RUBBISH AND CONTAMINANTS

It is recommended that all forms of waste, litter, rubbish and contaminants be removed from the quarry sites to be disposed of in approved managed disposal sites.

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APPENDIX 1

THE CONTROL OF INVASIVE ALIEN *ACACIA SALIGNA, ACACIA MEARNSII* AND *ACACIA CYCLOPS*

The following descriptions of the alien tree species found on the two study sites have been largely extracted from the Cape Nature Conservation Handbook, Plant Invaders: Beautiful but Dangerous, edited by Stirton (1978) and the book: Alien weeds and invasive plants by Leslie Henderson (2001). ***It is very important that the ecology of these invaders is well understood and that they can be correctly identified if any significant progress is to be made with their control at the two quarry sites.***

DESCRIPTION OF THE INVADERS:

A. ROOIKRANS

Acacia cyclops
(Legume family - Fabaceae)

1. *ACACIA CYCLOPS*
a flowering twig
b fruiting twig
c seed with swollen seed-stalk

Rooikrans is an evergreen shrub or small tree up to 6 m tall, and has a dense tangled, clumpy appearance. It has no true leaves, but flattened leaf-stalks, phyllodes that resemble true leaves. They are 3 - 9 cm long and up to 1,5 cm wide, fairly straight, and have 3 - 5 prominent longitudinal veins with more or less longitudinal veinlets anastomosing between them. The first few leaves, resembling those of black wattle, are feathery but are soon superseded by phyllodes. The bright yellow flowers are borne in rounded inflorescences in the axils of phyllodes, usually from October to May, with a peak in December to January, but also sporadically throughout the year. The pods of rooikrans (some are always present on mature trees) are a distinctive feature. They are twisted, flattened, lack constrictions between the seeds and are retained on the plant for several months after releasing the seeds. The seeds are dark brown to black, and are encircled by a bright red or orange seed-stalk much relished by birds.

Origin: Rooikrans is a plant native to south-western Australia. This coastal plant favours calcareous dune-sands and a rainfall of at least 250 mm per annum. In its natural habitat it usually grows singly or scattered, rarely forming dense stands.

Spread: Rooikrans is the most widespread Australian wattle in the Cape Province and occurs mainly in the lowlands, particularly along the coastline. This is not surprising, because seed has been actively distributed for dune binding from Port Nolloth to Port Elizabeth. This wattle is well established in the Mountain Fynbos and Lowland Fynbos vegetation groups.

B. PORT JACKSON
Port Jackson
Acacia saligna
(Legume family – Fabaceae)

6. *ACACIA SALIGNA*
a flowering twig
b wavy phyllode with conspicuous mid-vein
c pod , slightly constricted between seeds

Port Jackson has an open, willowy appearance and grows up to 9m in height. The flattened blue-green leaf stalks, (phyllodes) resemble true leaves and have a single conspicuous midvein, are 1 – 5cm broad and up to 20cm long, and are usually pendulous, straight or slightly curved. The phyllodes on coppice shoots, rootsuckers and seedlings are conspicuously broader than those of the more mature parts of the plant. As the plant ages, the newly produced phyllodes become narrower and less wavy. Rounded, canary-yellow inflorescences are produced from August to October with a peak in September. The flat 5 – 10 cm long pods are straight or slightly curved, and have margins slightly constricted between the seeds. These pods fall off the plant fairly soon after they have released their seed. The hard, long-lived seeds are dark brown and slightly flattened. The seed-stalk is short, thick and off-white. Large accumulations of seeds can be found in the soil beneath these trees.

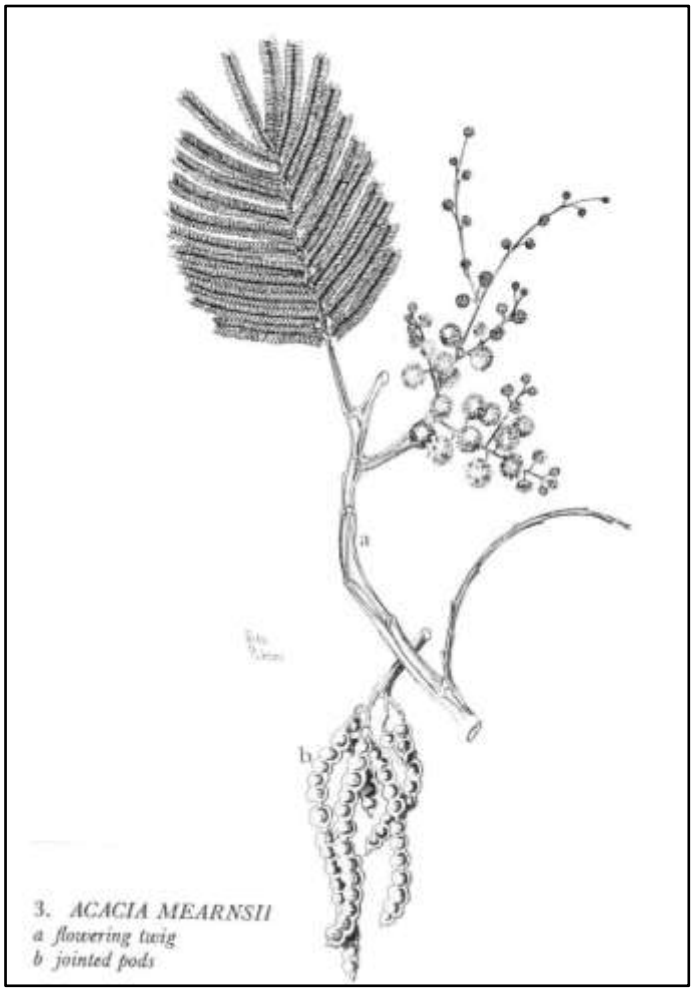
Origin: Port Jackson is a native of the south-western areas of Western Australia. Although common in areas receiving a mean annual rainfall of over 380mm, it nevertheless extends along rivers into the more arid areas (250mm annual rainfall area).

Spread: Port Jackson is confined mainly to the coastal plain in areas of a mean rainfall greater than 250mm. It occurs commonly from the Olifants River in the south-western Cape, to as far east as the great Kei River in the Eastern Cape. But as in Australia, this wattle has also extended inland, especially along river valleys of the south-western Cape. Port Jackson has become established in the following vegetation groups: Mountain Fynbos, Lowland Fynbos, Eastern Cape Forest, Southern Forest, Succulent Karoo, Grassveld and in the southern margins of the Karoo.

The principal dispersal agents are man and water. Spread is particularly prevalent along roads because road-building materials are often transported from areas such as quarries and riverbanks, where large populations of these heavily seeding wattles occur. Seeds are also transported in sand that is used for dam walls, buildings, and gardens. Seeds will even germinate in the painted concrete walls of houses. The transportation from lowland areas, of sand contaminated by Port Jackson seed is a major cause of the species being introduced into mountain areas. Other dispersal agents are red-wing starlings, doves and baboons.

Danger: A common sight today is the dense, often impenetrable thickets of tall shrubs with interlocking crowns. These thickets, although striking when in flower during August to October, are there at the expense of the indigenous vegetation. For most of the year they form, with rooikrans (*A cyclops*), full vistas. Port Jackson coppices rapidly after fires and sprouts profusely when the trunks are severed. These phenomena make them difficult to clear off land required for agriculture or nature conservation.

C. BLACK WATTLE
Swartwattel
Acacia mearnsii
(Legume family - Fabaceae)



Black wattle trees can grow up to 15 m tall. Young branchlets are slightly hairy, annular and have distinctive russet or golden tips, whereas the foliage is dark green. The leaf midrib has, characteristically, many raised glands along its upper surface at and between the junctions of the side branch pairs. Strongly-scented, pale-yellow flowers are borne in rounded inflorescences massed at the ends of branches. Flowering occurs between August and November with a peak in November. Pods are flattish and jointed or slightly constricted between the black seeds which have small, whitish-yellow seed-stalks and ripen in about 14 months.

Origin: Black wattle occurs naturally in south-eastern Australia. This adaptable species forms part of the understory in *Eucalyptus* forests and favours soils derived from sandstone, shale, granite and dolerite. It is restricted to areas with an average annual rainfall of between 500 and 1 500 mm and an altitudinal range from sea-level to 880 m.

Spread: Black wattle is a widespread plant invader in South Africa, particularly along rivers, streams and ditches. In the Cape it has spread along roads and rivers and extends from the Cedarberg to the Transkei republic. It grows very well in high rainfall areas in deep, well-drained soils, but establishes on shallower soils if there is sufficient water.

Danger: In many areas where it occurs, excluding commercial plantings, ***black wattle forms dense, impenetrable 'jungle thickets' that suppress the indigenous vegetation and, along water courses, impede water flow.*** The beauty of the delicate indigenous forest and fynbos ecosystems is being supplanted by a monotonous sea of black wattles.

Seeds of black wattle are now known to have a lifespan of over 50 years. If one considers also that the soil below an old tree can contain over 20 000 per square metre, then the potential for spread and the problems of control cannot be over-estimated. Dense thickets of black wattle are often a feature of burnt areas because fire stimulates the germination of the seeds (Boucher, 1978).

GENERAL STRATEGY FOR CONTROL

The following stages, in order of priority, outline an effective approach for the control of the invasive alien trees:

STAGES FOR AN EFFECTIVE APPROACH FOR CONTROL:

A. Eradicate plants in sparsely invaded areas first and apply follow up within 3-6 months, then …

B. Clear small isolated infestations and apply follow-up within 3-6 months, then …

C. Stop the edges of dense infestations spreading and apply follow-up within 3-6 months, then …

D. Reduce the area of dense infestations working from the edges inwards and apply follow-up within 3-6 months, then …

E. Follow-up on A to D as required.

The aim must thus be to prevent new or small infestations, or isolated, scattered plants, from becoming mature and producing a seed reserve, eg: the follow-up of new growth is critical before the new plants produce and release their seeds. In this way, small infestations are controlled before they infest the area with a long-term seed reserve and immature infestations are controlled before they can flower and produce seed. Mature, dense stands must thus be ***isolated*** and left for later treatment. **The mature, dense infestations can't get any worse, whereas the light infestations can spread.**

This approach should be pursued at the dense infestations on Site 2 (north-eastern half) and at the south-eastern edge of Site 1. The effective eradication of invasive alien trees on and around the quarry sites will certainly reduce the potential for the reinfestation of these areas.

CONTROL METHODS

Literature and experience has given us a range of effective treatments for alien vegetation control. It must, however, be appreciated that sometimes the prescribed method may need to be adapted to accommodate local conditions. The following control methods are suggested for the infestation at both quarry sites:

A. ROOIKRANS:

Mechanical eradication is an effective method of control for rooikrans. Rooikrans rarely coppices after effective cutting, but care must be taken to cut the stem as close to the ground as possible, thereby ensuring that no buds will resprout.

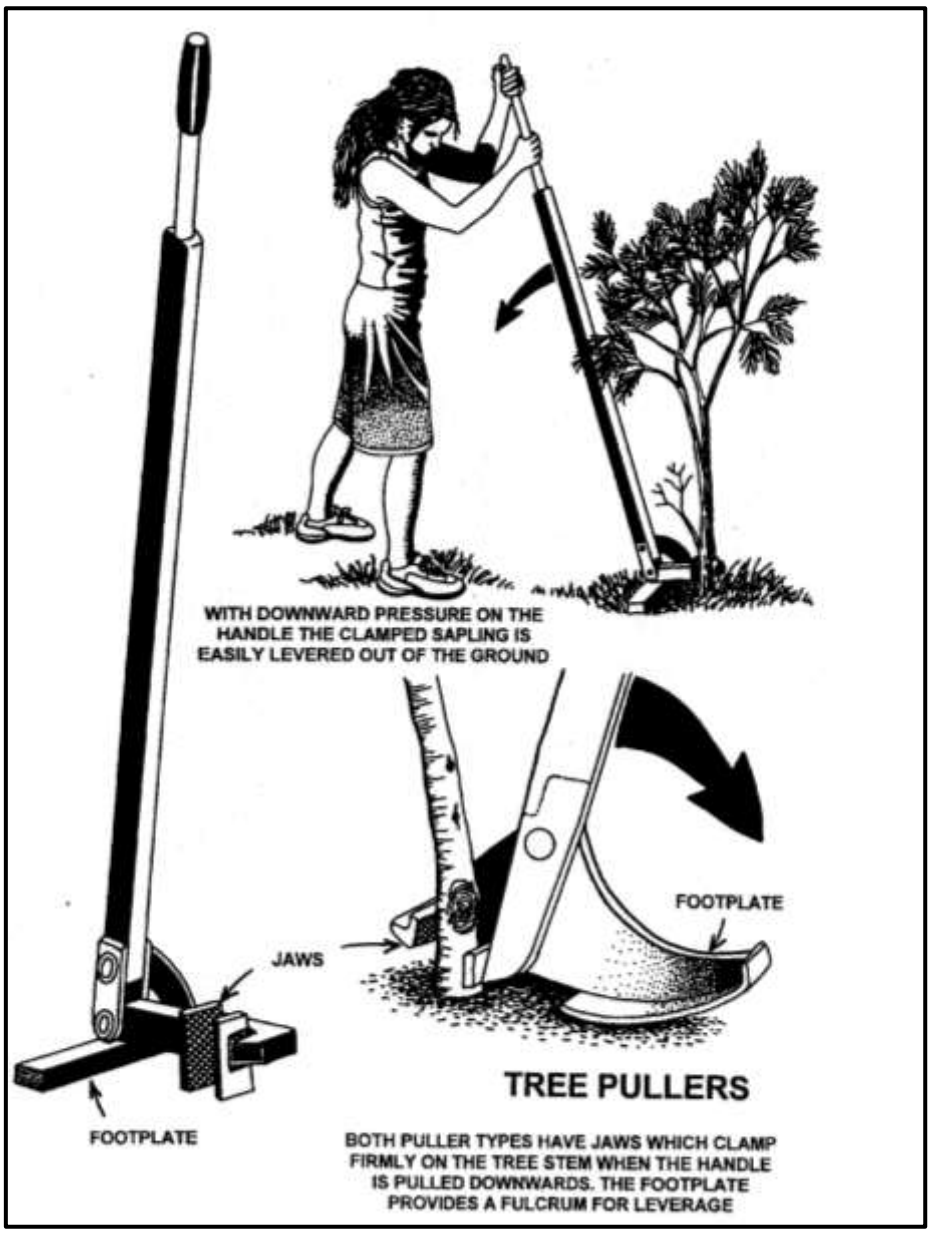
Young plants can be pulled by hand, as they have shallow roots and intermediate sized saplings should be cut off below the root/stem junction. Spraying the regrowth of seedlings with herbicide is not recommended, due to possible impact on the indigenous vegetation.

It is suggested that mature trees simply be cut off as close to the ground as possible and left to rot, standing on site, or the wood can be removed for use. Alternatively, the lighter wood, branches and leafy material can be put through a chip-mulch machine to produce a coarse mulch for rehabilitation work. Care must be taken to do this when the seeds are still unripe or after they have been dropped, as one does not want to distribute additional viable seed in the mulch.

As with all alien vegetation control, follow-up action 3 months after the initial control is possibly more important than the initial control. This is because once a mature tree is removed, much of the long-lived seed reserve in the soil under the parent tree germinates, which means that if no follow-up takes place, one mature tree can be replaced with hundreds of small trees and the situation gets worse. Also, when blocks are burnt after clearing the rooikrans seed reserve in the soil will be stimulated to germinate, resulting in mass new growth. This is why the follow-up control is as necessary as the initial control.

Where felled Rooikrans is burned, the area must be monitored for the germination of Rooikrans seedlings and those of other alien plant species. Small numbers of seedlings can be pulled up by hand, but large populations could be sprayed with a herbicide. Best results for eradicating Rooikrans seedlings (< 30cm tall) have been obtained by spraying them with *GARLON* during the active growth season (August-March). The seedlings must be sprayed with a mix of 200 ml GARLON on 20 liters of water. Where mature, but not too old (< 2m tall) single Rooikrans trees occur, they can also be sprayed with a mix of 100 ml *GARLON* on 5 liters of *DIESEL*. Drift of this herbicide can be prevented by putting a funnel-shaped hood (stiff plastic) around the spray nozzle. It saves herbicide and prevents indigenous plants from being killed.

Young plants can be pulled by hand and intermediate sized saplings should be cut off below the root/stem junction, or be pulled out of the ground with a tree puller. (See Figure advert for details of the puller).



B. PORT JACKSON WILLOW:

Particular care must be taken when eradicating Port Jackson to ensure that the plants are either removed entirely or that the stumps are treated with herbicide. This is necessary as Port Jackson coppices readily from stumps left after felling or burning. Both young saplings and mature trees can be eradicated by cutting the tree off as close to the ground as possible and immediately applying liberal amounts of a suitable herbicide (like *Tordon* or *Garlon*) to the edge of the remaining bark of the stump.

Alternatively, the tree can be cut off above the ground and then all the bark stripped off the stump right down into the soil. Care must be taken to remove all of the living cambium right down to the wood. Young saplings can be completely removed with a tree popper tool, which grips and levers the plant out of the ground. (See *Tree Popper* advert).

Recommended equipment for control: Chain saw, bush saw, branch loppers, tree popper and herbicide.

C. BLACK WATTLE:

Mature black wattle trees (diameter greater than 20 cm) can be killed by means of ring-barking. A ring of about 10 cm wide must be cut near the base of the trunk, taking care to remove all the bark right down to the wood. Treatment of the cut area with herbicide increases costs, but also increases effectivity of control. (See diagram).

Younger trees and saplings are usually eradicated with a combination of cutting and burning. Once trees are cut, the enormous soil-stored seed reserve germinates and this new flush is then burnt off. In the case of the quarry sites, if the use of fire is not acceptable, the growth flush after the plants are cut, will have to be treated chemically or be hand pulled. Both methods are costly, in terms of herbicide plus labour, or simply intensive labour.

Young saplings can be cut off below the root-stem junction, but cutting any higher will not be effective, because the plants will coppice from the same rootstock and form a denser tree than the original.

Small to large trees (diameter less than 20 cm), should be killed by strip-barking. Bark is stripped from the tree from waist-height down to the soil surface and no herbicide is used. The sapwood is stripped off with the bark and the tree slowly dies. This method will require about 12,6 man-days to strip 1 000 stems. (See Diagram).

Alternatively, young trees can be cut down at ± 30 cm above the ground and then strip-barked down to the soil surface. This method will take about 7,6 man-days to cut and strip 1 000 stems. Treating the stumps with herbicide (*Garlon* or *Roundup*) will increase the success rate, but will also increase cost.

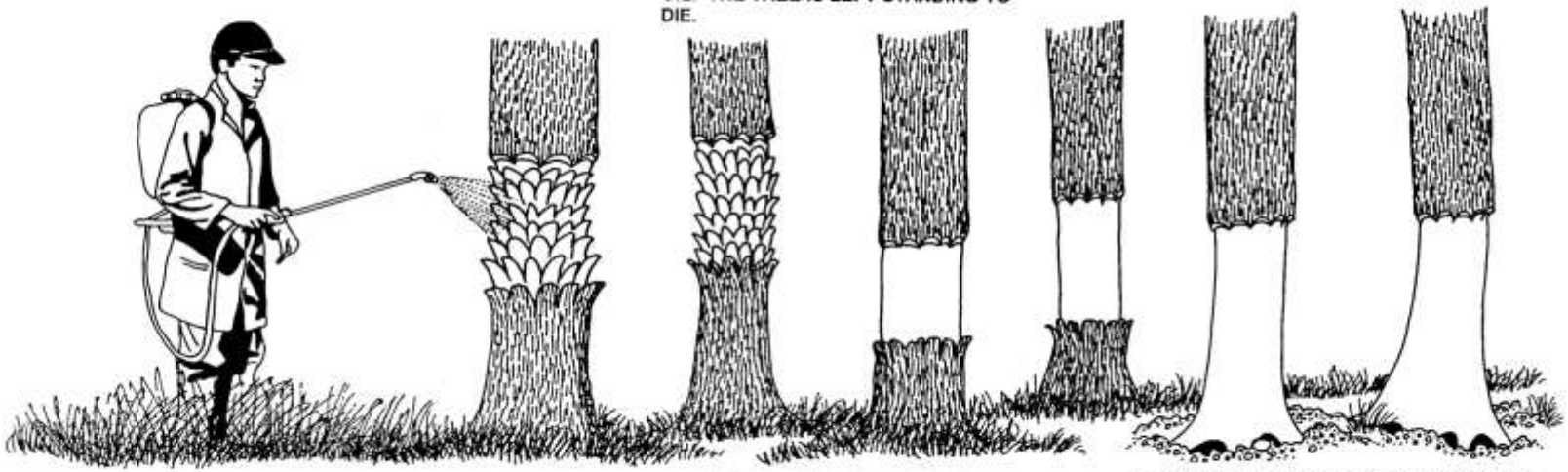
Garlon 4 or *Roundup* herbicide van be used to spray dense seedlings up to 50 cm in height. Knapsack sprayers with flat-fan nozzles are most effective. Seedlings can also be pulled out by hand, but this is labour-intensive and relatively expensive. (See Diagram). The method used will depend on the ability and cost of local casual labour and supervision for hand pulling. Alternatively, a tool called the *tree popper* (see advert for details) can be used to pull young trees and saplings out of the ground.

RINGBARKING, FRILLING AND DEBARKING TO KILL ALIEN TREES

A. STRIPPING: ALL THE BARK IS REMOVED FROM WAIST-HEIGHT DOWN TO GROUND LEVEL. NO HERBICIDE IS APPLIED AND THE TREE IS LEFT STANDING TO DIE.

B. FRILLING AND OLD OIL TREATMENT: ANGLED CUTS ARE MADE WITH AN AXE INTO THE SAPWOOD AND THE INJURED AREAS ARE TREATED WITH OLD ENGINE OIL. THE TREE IS LEFT STANDING TO DIE.

C. CUT AND STRIPPING: TREES ARE CUT DOWN AND THE STUMPS ARE THEN STRIPPED OF BARK DOWN TO BELOW GROUND LEVEL WITH A CANE KNIFE OR LIGHT AXE.



D. FRILLING: CUTS ARE MADE WITH AN AXE AT AN ANGLE INTO THE WOOD. HERBICIDE IS THEN APPLIED WITH A KNAPSACK SPRAYER OR BRUSH.

E. RING-BARKING: REMOVAL OF ALL THE BARK AND CAMBIUM AROUND THE TREE TRUNK WITH AN AXE OR CANE KNIFE. NO HERBICIDE IS APPLIED.

F. RINGBARKING FOR COPPICING SPECIES: ALL THE BARK AND CAMBIUM IS REMOVED RIGHT DOWN TO BELOW THE GROUND WITH A CANE KNIFE, AXE OR SLASHER. NO HERBICIDE IS USED.

FOLLOW-UP CONTROL:

Follow-up control, after the initial eradication of all alien trees, is critical. If the follow-up control is not diligently applied, the situation can actually become worse than it was before the initial control.

Control sites should be visited at 3 months after control and follow-up clearing applied and again at 6 months after initial clearing and again cleared. A final follow-up inspection at 9 months after clearing should indicate whether any further follow-up work is required.

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