DRAFT REPORT

ENVIRONMENTAL MANAGEMENT AND REHABILITATION PLAN FOR THE STABILISATION OF THE WITSAND DUNES, BREEDE RIVER MOUTH

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PROJECT TEAM

Professor Roy Lubke reviewed the information on the area and had the role of project manager. He carried out all the flora and vegetation studies and details on the dune volumes, etc. He provided input on the details of dune dynamics and coastal processes.

Mr. Deon van Eeden provided the information on techniques and cost estimates and will lead his team in the dune stabilization and management programme.

Mr. Colin Fordham assisted with the mapping of the vegetation and the dune field as well as determination of sensitivity areas.

Ms. Leigh-Ann de Wet assisted with the report writing.

ENVIRONMENTAL MANAGEMENT AND REHABILITATION PLAN

1. INTRODUCTION

The purpose of the Environmental Management Plan (EMP) is to translate recommendations identified from the *Interim Report* and *Background Situation Report* and the specifications for "good environmental practice" into a contractual environmental specification for application during construction and stabilisation.

The EMP provides specifications that the Contractor shall adhere to, in order to minimise adverse environmental impacts and optimise opportunities associated with construction activities. This document further includes the stabilisation specifications for the construction and stabilisation of dunes, as stated in the Background Situation Report (CES, 2009).

The EMP is provided to the Contractor at the tender stage so that the costs of implementing the EMP are included in the Contract cost and so that the Contractor is aware of his environmental responsibilities prior to commencing work.

Environmental control officer

It is recommended that an Environmental Control Officer (ECO) be on site during specific project phases and to undertake monthly audits to ensure compliance with the CEMP environmental specifications. The ECO must be independent of the project proponent, contractors and consulting engineers. The ECO must be appropriately trained in environmental management and must possess the skills necessary to impart environmental management skills to all personnel involved in the contract.

The phases are recommended as follows:

1. Demarcation of the construction camp or depot;
2. Clearing of vegetation;
3. Project closure

Environmental auditing

The Environmental Control Officer (ECO) must complete bi-weekly audits for the duration of the contract (or more frequently if required by DEAET) for submission to the project proponent, the Engineers and DEAET, indicating compliance with the CEMP.

For those periods that the ECO is not on site, the Contractor shall appoint an Environmental Officer who shall inspect the site on a daily basis to ensure that the Environmental Specifications are being adhered to. Written reports shall be made on a weekly or monthly basis.

A record of major incidences must be kept. Water quality sample records must be kept to enforce acceptable water quality levels during construction. Non-compliance will require weekly environmental audit reports. The environmental audits must verify that procedures are in place to ensure:

- The Method Statements and Environmental Specifications are the up to date versions.
- Non-compliance and corrective action is taken.
- Emergency procedures are in place.
- Environmental training of personnel is undertaken.

While the applicant will at all times remain accountable for compliance with the terms of the Environmental Authorisation and Environmental Specifications, DEADP reserves the right to additionally hold any party involved in project implementation liable for any non-compliance which might occur.

2. ENVIRONMENTAL POLICY

2.1 CONSTRUCTION ENVIRONMENTAL POLICY

The Contractor and all his employees are required to be familiar with the Construction Environmental Policy and all that it implies, and to adopt and implement the policy throughout the course of construction. The Environmental Policy is as follows:

- The environmental specifications and intentions of the specifications shall be upheld.
- Natural resources will not be degraded, and no environmental degradation shall take place.
- Local labour and local business will be employed in construction activities as much as possible.
- Site activities will be conducted in a manner that does not create a public nuisance or risk.
- Employee and public health and safety shall be considered a priority.

2.2 ENVIRONMENTAL LEGISLATION AND GUIDELINES

The Contractor shall ensure that all South African legislation concerning the natural environment, pollution and the built environment is strictly enforced. Such legislation shall include, but is not limited to:

- Constitution of the Republic of South Africa Act No. 108 of 1996.
- Water Act 54 of 1956 and National Water Act No. 36 of 1998.
- Environment Conservation Act No. 73 of 1989 and National Environmental Management Act No. 107 of 1998.
- National Environmental Management: Biodiversity Act No:10 of 2004
- Sea Shore Act No: 21 of 1935.
- National Roads Act 54 of 1971.
- Hazardous Substances Act No. 15 of 1973.
- Marine Living Resources Act No. 18 of 1998.

3. GENERAL SITE PROCEDURES

1 LOCATION AND DEMARCATION OF THE SITE / DEPOT

The site for stabilisation and rehabilitation will be decided on consultation with CES in conjunction with the authorities and the IAPs who are affected by the drift sands and advancing dunes.

Environmental awareness training
The project manager, before commencement of any construction activities, must implement an environmental awareness programme. All construction personnel, including senior staff, sub-contractors must attend the training programme. The programme must include all aspects covered in the CEMP and must be repeated for all new and/or temporary staff.

Demarcation of the site
The “site” refers to all areas required for construction purposes. The boundary of the site must be agreed with the Hessequa Municipality and the ECO. All activities must be conducted within this area so as to facilitate control and to minimise the impact on the existing natural environment. The Project Manager (Hessequa Municipality) must ensure that the construction is done according to the final site layout only. Final site layout requires the assistance of a botanist (section 9.1).

Activities must be conducted within a limited area so as to facilitate control and to minimize the impact on the existing natural environment, existing tenants, any other construction activities in the vicinity, and public thoroughfare and residential areas.

The Contractor shall demarcate the boundaries of the whole site in order to restrict his construction activities to the site. The Contractor shall ensure that all his plant, labour and materials remain within the boundaries of the site. Failure to do so may result in the Contractor being required to fence the boundaries of the site at his own expense.

General guidelines:

- The area required for the camp and office site must be kept to a minimum.
- Vegetation shall not be unnecessarily disturbed and trees or shrubs shall as far as is practical not be felled/damaged. No trees may be cut or removed without prior Permit from the relevant Provincial Authority (i.e. Local Authority or Department of Nature Conservation) for the cutting of protected trees.
- No stealing of adjacent landowner's products and equipment, including harassment of animals, will be permitted.
- Any impact such as noise, dust, bright lights, etc, which may cause a disturbance or nuisance to the community or any person lawfully living in the vicinity, shall be kept to a limit. Construction must be restricted to within office hours.
- No fires may be lit on site except in the facilities specially constructed for this purpose. Fire extinguishers must be provided in the case of accidental fires that could spread to neighbouring properties.

3.1.1 Domestic waste water

Arrangements for the disposal of domestic waste water will be finalised in conjunction with the environmental site officer and the local Municipality officials, since this depends on the number of workers on site during the construction period.

3.1.2 Refuse

The contractor shall institute an on-site waste management system in order to prevent the spread of refuse within and beyond the site. Refuse refers to all solid waste, including construction debris (wrapping materials, timber, cans etc.), food packaging etc.

All waste shall be collected and contained immediately. The Contractor shall not dispose of any waste and /or construction debris by burning or burying. The use of waste bins is recommended. These should be provided with lids and external closing mechanisms to prevent their contents blowing out. The Contractor shall ensure that all waste is deposited by his employees in the waste bins for removal by the Contractor. Bins shall not be used for any other purposes than waste collection and shall be emptied on a regular basis. All waste shall be disposed of off-site at approved landfill sites.

2 PROTECTION OF NATURAL RESOURCES

All indigenous fauna and flora must be protected throughout the area. **No plants shall be disturbed on the dune systems accept those that specifically require moving according to the accepted design plan.** The harvesting of shellfish and other marine life is not permitted, and the regulations specified by the Marine Living Resources Act must be adhered to. Wild animals shall not be caught by any means.

Building materials, i.e. stone and sand, shall be sourced from a recognized quarry with permission from the Department of Minerals and Energy.

Archaeological
Should any archaeological artefacts be encountered on site, construction activities must be suspended and the appropriate authorities contacted. A qualified archaeologist should be commissioned to investigate the find and make arrangements for its removal, if necessary.

3 WATER MANAGEMENT

3.3.1 Pollution and stormwater management

The Contractor must ensure that erosion or pollution of ground or surface water does not occur as a result of site activities. Pollution could result from the release, accidental or otherwise, of contaminated runoff from construction camps, discharge of contaminated construction water, chemicals, oils, fuels, sewage, run off from stockpiles, solid waste, litter, etc.

The Contractor shall ensure that polluted runoff, such as runoff from construction camps where equipment is cleaned and/or serviced, fuel stores, workshops, etc. is not discharged overland. An earth brick berm 0.5m high shall be erected around such areas and the runoff from these areas shall be collected and stored for removal from site.

The Contractor shall ensure that silt-laden water is not discharged directly into any surface water courses, and shall take suitable measures to prevent this.

Natural run-off shall be diverted away from the work site and storage areas. The Contractor shall take appropriate measures e.g. the erection of silt traps, or drainage retention areas, to prevent silt and sand entering drainage or water courses.

3.3.2 Discharge of construction water

Construction water refers to all water dirtied as a result of construction activities. Silt laden water may be discharged overland and be allowed to filter into the dune sands. Limited quantities (less than 50l) of cement-laden water, i.e. water from washings from trowels, wheelbarrows, etc., may be discharged into dune sand areas. Where possible, water should be collected and reused for mixing new concrete.

4 SERVICING/FUELLING OF CONSTRUCTION EQUIPMENT

Servicing and fuelling should preferably occur off-site. If these activities occur on-site, the Contractor shall ensure that it takes place in designated areas. All waste generated during these activities shall be collected and disposed of off site at an appropriate off site facility capable of handling such waste. All equipment that leaks shall be repaired immediately. In the case of changing oil or lubricants on-site, the Contractor shall have Drizit pads (or equivalent) and/or drip trays available to collect any oil, fluid etc.

The Contractor shall take all reasonable precautions to prevent the pollution of the ground and/or water resources by fuels and chemicals as a result of his activities. No oil, diesel, petrol, etc., must be discharged onto the ground. Pumps and other machinery requiring oil, diesel, etc. that are to remain in one position for longer than two days shall be placed on drip trays. The drip trays shall be emptied regularly and the contaminated water disposed of off site at a facility capable of handling such waste water. Drip trays shall be cleaned before any possible rain events that may result in the drip trays overflowing and before weekends and holidays.

The Contractor shall remove all oil-, petrol-, and diesel-soaked sand immediately and shall dispose of it as hazardous waste.

Tanks containing fuel shall have lids and shall remain firmly shut. Fuel stores shall be placed on a bunded seal base, and waste water or spilled fuel collected within the bund shall be disposed of as hazardous waste. Only clean, empty tanks may be stored on the ground.

The Contractor shall take the necessary precautions to prevent fires or spills at the fuel stores. No smoking shall be allowed in the vicinity of the stores, or activities that can initiate fires.

Any hazardous waste substances must be disposed of off-site at a licensed landfill site.

5 USE OF CEMENT/CONCRETE

The contractor is advised that cement and concrete are regarded as highly hazardous to the natural environment due to the very high pH of the material, and the chemicals contained therein. The Contractor shall therefore ensure that:

- concrete is mixed on mortar boards, and not directly on the ground
- the visible remains of concrete are physically removed immediately and disposed of as waste. Washing it into the ground is not acceptable.
- all aggregate is also removed

6 TRAFFIC MANAGEMENT

The contractor shall ensure that all construction vehicles using public roads are in a roadworthy condition, that they adhere to speed limits, that their loads are secured and that all other regulations are adhered to. Construction vehicles going to site during construction will have to travel through a residential area and this poses a safety hazards for locals.

7 NOISE

The Contractor shall take all reasonable precautions to minimise noise generated on site as a result of his operations. The Contractor shall comply with the National Building Regulations with regard to noise.

8 SITE REHABILITATION

The Contractor shall be responsible for rehabilitating any areas cleared or disturbed for construction purposes at the completion of construction.

All construction equipment and excess aggregate, stone, gravel, bricks, concrete, temporary fencing, etc. shall be removed from the site upon completion of work. No discarded materials shall be buried.

4. STABILISATION AND REHABILITATION

1 INTRODUCTION

Previous studies have shown that the sand deposited on the spit is carried inland by the south and south-westerly winds and stored in the relic dune field. The establishment of the houses and roads across this dune corridor has impeded the natural process of sand movement and this consequently there is a build up of the sand at the houses and along the roads closest to the advancing dunes. It has been explained in the Background Situation Report (CES,2009) and in the CSIR report (CSIR,1983) that the problem of sand accumulation south of the residential area is insoluble as it is not possible to cut off the sand supply and therefore the dune sands around the residential area must be managed.

The suggested management options are therefore:

1. Do nothing or maintain the status quo.
2. Consolidation and stabilisation of the dunes using one of two approaches:
    - Flattening the dune field by bulldozing and removal of sand and consolidating with brushwood and then planting with indigenous dune plants.
    - The artificial build up of dunes using sand fences to trap the wind blown

sand and then stabilisation with indigenous dune plants.

Maintaining the status quo or to do nothing is not a satisfactory approach as the houses would then have to be abandoned and removed to allow the dune field to advance. This does not solve the problem as the dunes would continue to advance eventually cutting the whole of the Witsand resort in two. Thus it is important to manage the dunes and maintain them in a position south of the established houses and roads. However, this option of stabilization south of the existing development does imply:

NO FURTHER DEVELOPMENT OF ANY HARD PERMANENT STRUCTURES SOUTH OF THE EXISTING DEVELOPMENT OR IN THE VICINITY OF STABILISED OR EXISTING DUNE FIELD

2 STABILISATION AND REHABILITATION PLAN

It is proposed that a combination of the two approaches for the consolidation and stabilization of the dunes (as stated above) be used in the overall plan for the area. These will be carried out in a number of phases.

4.2.1 Flattening the dune field by removing and bull dozing the sand

Because of the urgency of the need to remove the sand this process was started in January 2009. Sand has been removed as planned in the interim report (CES, 2008) and the situation as of September, 2009 is as described in the Background Report (CES, 2009).

The procedure suggested was as follows:

- The road in front (south west of) the Opstalletjie House should be use to gain access for the bulldozer and trucks.
- A loading zone should be established off this road where an excavator or front end trucks could load the sand.
- A set back line should be established and to the south over which no sand should be extracted
- Sand should be disposed of at the discretion of the Hessequa Municipality.
- This procedure will be part of the overall Management of the Dune Field.

As stated above a set back line had to be determined and a decision has to be made as to the extent for the removal of sand and the quantity of sand to be removed.

The set back line is proposed as indicated in the following profile diagrams (Figures 4.2.1a and b), which are shown in the plan of the site (Figure 4.2.1c). This is some 40 to 50m from the house or road. One of the aims of the site visit will be to establish the position of this line in the field and the erection of poles as beacons to indicate where sand must be removed.

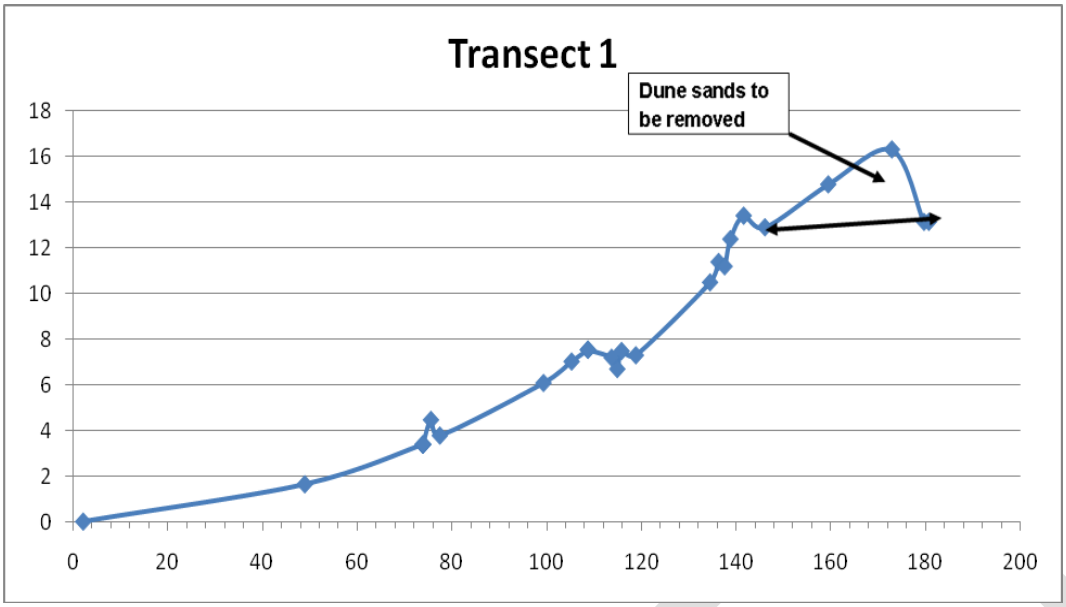

Figure 4.2.1 a: Transect 1, on the Eastern side of the Witsand Dune Field (see Figure 4.2.1c for locality of the line).

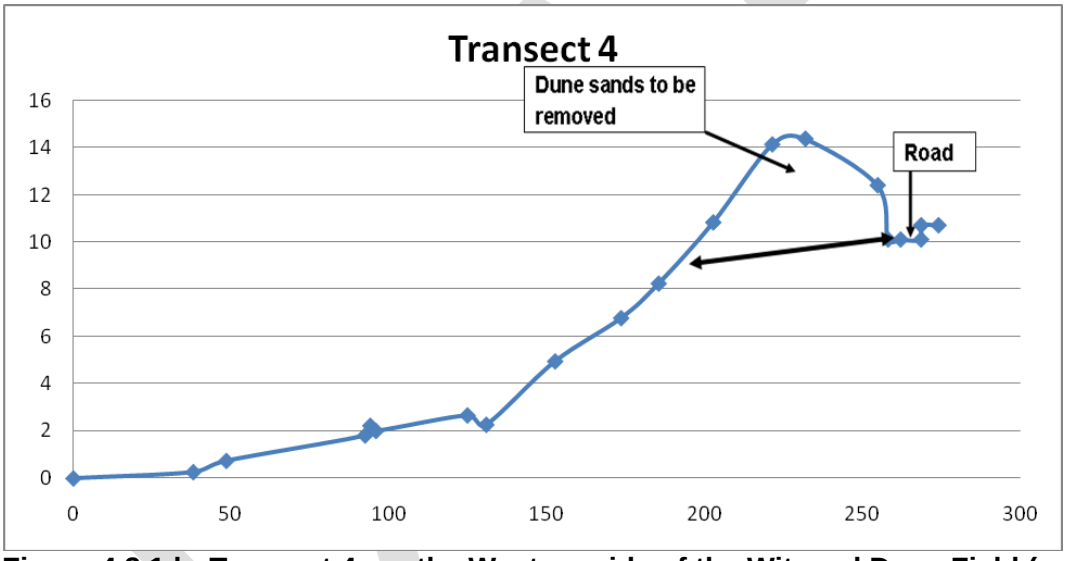

Figure 4.2.1 b: Transect 4, on the Western side of the Witsand Dune Field (see Figure 4.2.1c for locality of the line).

Figure 4.2.1 c: Google image of the Witsand dune field showing the locality of the transect lines. (Only profiles are shown here for the two transects (1 and 4).

4.2.2 Quantity of sand removed or still to be removed

Using the profile diagrams for all the transects it is possible to calculate the area of sand in each profile to be removed (See Figures 4.2.1a and b above) and multiple this by the linear distance between profiles to calculate the volume of sand to be removed.

Profile 1 to 2

Volume 1 = (Area Profile 1 + Area Profile 2)/2 x length between two profiles

Volume 1 = Yet to be finalised

Profile 2 to 3

Volume 2 = (Area Profile 2 + Area Profile 3)/2 x length between two profiles

Volume 2 = Yet to be finalised

Profile 3 to 4

Volume 3 = (Area Profile 3 + Area Profile4)/2 x length between two profiles

Volume 3 = Yet to be finalised

Profile 4 to 5

Volume 4 = (Area Profile 4 + Area Profile 5)/2 x length between two profiles

Volume 4 = Yet to be finalised

Total Volume of sand to be removed =

This gives and approximation of the sand that is required to be removed.

4.2.3 Stabilisation of the dune surface after removal of the sand

After removal of the sand the next process is the consolidating with brushwood and then planting with indigenous dune plants.

Brushwood should be obtained from a suitable source and then laid over the sand so as to limit sand movement while the dune plants become established. The selection of dune plants to be planted are discussed in Section 4.3 below.

4.2.4 Stabilisation of the dunes between the high water mark and the region where sand has been removed

It will be necessary to stabilize the drift sands in front of (south of) the region where the sand has been removed. As these while be migratory dunes it may be necessary to erect fences to limit the movement of sand (Figure 4.2.4). In this region marram grass should be planted in tufts at 30cm intervals.

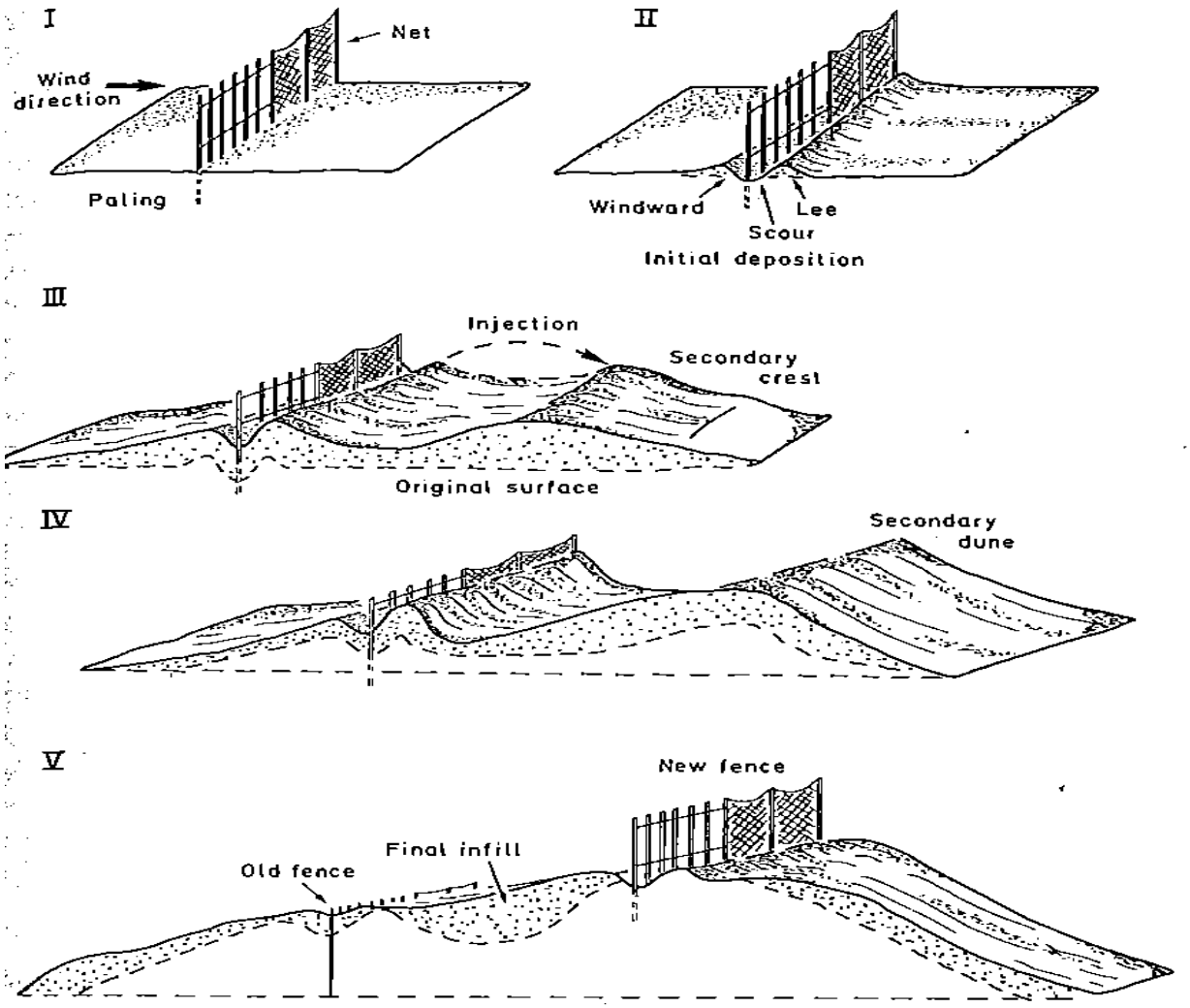

Figure 4.2.4 : Method of establishing dune fences and extending them if sand builds up (from Carter, 199)

Note: Since the stabilisation of the dunes may alter the sedimentary budget of the estuary it has been suggested that detailed sedimentary budget measurements are made in order to detect any adverse consequences of the dune management (CSIR, 1983).

4.2.5 On-going Management

It is important that a process of Management is continued:

- The dunes should be fenced during stabilisation to prevent access on to the dune. Creosote poles with 5-strand galvanised wire should be used for this.
- In order to restrict trampling of dunes, access for pedestrians should be restricted, and confined to wooden walkways (see section 4.3). These access routes should be clearly signposted, and orientated away from the predominant wind direction avoid blowouts (see Figure 4.2.5);

Figure 4.2.5: Establishment of a wooden pathway on a dune in the UK (From UK Sand Dune and Shingle Network Newsletter, July 2009).

- It may be necessary to continue the stabilisation programme with indigenous vegetation.
- The monitoring programme should be continued for some 3 to 5 years.
- On-going maintenance and control of access will be required indefinitely.

3 STABILISATION SPECIFICATIONS

4.3.1 Species suitable for stabilisation and rehabilitation

The selection of suitable species is critical, especially on the fore-dune system, as the young plants will be exposed to salt spray, sand movement and wind pruning. They must therefore be adapted to these conditions. If the incorrect species are planted it could limit the establishment and growth of these species. Species that are specifically adapted to the zones being stabilised will accelerate the natural process of dune colonisation. For example, once pioneer species have trapped and held wind blown sand in the frontal dune, they create conditions that enable other plant species to become established.

The proposed species for stabilisation of dunes are presented in Appendix 1. In addition Appendix 2 is a list of species recorded on the site.

Some plants may be available from nurseries. The following options are presented for

plants that are not available:

1. Collect seeds and germinate species (in greenhouses or under shade cloth). Seeds are then planted in polythene bags with a mixture of 50% beach sand and 50% soil, watered daily for a few months, before transplanting onto the dunes. Plants must be removed from the shade a few weeks before transplantation to allow them to acclimatise;
2. Cuttings or runners of plants like *Chrysanthemoides* and *Sporobolus* can easily be collected from the area to be disturbed during construction.
3. Contract out the establishment of these species. Most large nurseries will probably be

prepared to grow species that are required. This will be necessary for many of the fore-dune species.

4.3.2 Planting and plant densities

The best time to start a stabilisation programme of seeding or planting is during the rainy season. Germination and seedling establishment is likely to have a maximum chance of success if the sands have been well soaked by rains. We assume that rehabilitation will start during the rainy season, and that irrigation will therefore not be needed. Alcosorb or Stockosorb gel (sodium based synthetic polymer) should be used at the time of planting, by saturating 1kg in 200L of water and then applying 250 to 500ml into the planting cavity. Transplanting indigenous seedlings is more costly than sowing seeds, but is much more successful. When transplanting seedlings on fore-dunes, the plants should be set in deeper than normal to prevent exposure of the roots by wind erosion. Shrubs should be planted about 1.5 to 2 metres apart or one plant per 2.25m^2 (i.e. a 1.5m x 1.5m area). Groundcovers should be planted at a density of one plant per m^2. Before seeding one should consider the temporary stabilisation of the substrate (section 4.4).

Appendix1 provides a selection of species that can be used. Not all of these species need to be planted, but at least three woody shrubs, three herbaceous plants and one grass species should be planted. It is preferable to plant a variety of species, in order to increase species diversity and reduce the risk of sudden die-back of a single species.

For this reason, it is recommended that the seed mix include some fast growing annual grasses that will die off in a few years. The most suitable species is *Eragrostis tef* (Tef), and should be seeded at a rate of 5-10 kg per hectare. The seeds are cheap and have a very high germination rate.

Seeds ("clean seed equivalent") should be sown at a total density of 20kg per hectare. "Clean seed equivalent" reduces the cost of producing seed to pure levels. For example, 1kg *Carpobrotus sp.* clean seed would be equivalent to 3 to 4kg of milled figs, based on seed count per mass of the semi-processed material.

4.3.3 Slopes

All slopes are recommended to be 1:3 or 18º. This will facilitate the establishment of vegetation and reduce the risk of erosion. More gentle slopes could also be established, but this will increase the slope area and the cost of stabilisation.

4.3.4 Management of the stabilisation programme

Vegetation growth on dunes can be slow due to the harsh environmental conditions. This can be remedied by irrigation of stabilised/revegetated slopes, since sand movement is restricted and soil moisture content improved. However, as the costs of irrigation will be prohibitive, it is not recommended. It is more cost effective to use indigenous species adapted to the local environment. Stockosorb or Alcosorb (synthetic polymer) should be used (see section 4.3.2).

Alien species (e.g. Rooikrantz -*Acacia cyclops*) should be removed, as they will tend to colonise and out-compete the indigenous species.

Plants that do not survive should be replaced by another suitable species.

Fertilisation could result in a reduced number of plants, as many of the indigenous species do not favour nutrient-rich soils. However, the addition of fertiliser with low levels of nitrogen (e.g. 27 kg/ha equivalent) could benefit the system. Best results will be obtained by adding 100g of 2:3:2 fertiliser/m². This amount is adequate to boost growth but will not burn or weaken the vegetation. The fertiliser should be distributed onto the sand surface and worked in to a depth of 20 – 30cm during the rainy season. The application should be repeated 3 to 4 weeks later, depending on the weather.

4 TEMPORARY STABILISATION

The essential requirement in establishing vegetation on mobile dunes is to prevent sand movement while seedlings or young plants become established, and also create a habitat favourable for seed germination. On mobile foredunes this requires the construction of fences or paddocks to restrict sand movement and/or the use of brushwood to cover the sand.

Fences or paddocks are barriers that protect the stabilised site from being covered by sand and also build a temporary dune which protects the area from erosion or sand deposition. A fence can be constructed using 1m wide nylon shadecloth (40% shade). More economical fences may be constructed of brushwood interlaced between vertically planted poles.

The area may be temporary stabilised by covering with brushwood. Brushwood moderates the fluctuating high and low temperatures of the sand, halts sand drift and increases the humidity and water content of the soil, thus providing an ideal environment for seed germination and growth (Avis & Lubke 1986b). Brushwood using alien plants is not desirable as seed is brought into the area from these plants. Branches should be spread sparsely, with 650 cubic metres per hectare being a good rule of thumb. Branches should be placed facing the direction of the prevailing wind and not lie high above the sand so as to provide less resistance to the wind. Dune crest areas will have to be covered more densely than hollows.

A further alternative to temporarily stabilise the sand surface in exposed areas is to use geo-textiles. Terrasafe is a bio-degradable natural fibre which assists vegetation by stabilising the soil, and degrading naturally over time thus increasing the organic matter and leaving no artificial material behind.

5 PEDESTRIAN PATHWAYS/ACCESS ROUTES

Stabilised footpaths should be constructed over the dunes or over vegetation that is susceptible to trampling. These paths should be orientated away from the predominant winds. (See Section 4.2.5)

Raised wooden boardwalks are recommended, as the area is sensitive. Hand rails should be built where necessary, e.g. on steep slopes.
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5 MAINTENANCE OF STABILISATION

The maintenance to ensure successful stabilisation of the dune and disturbed areas should be undertaken by the contractor for a minimum of 3 years, as well as during the following dry season, when irrigation may be necessary. After this period the landscape contractor is no longer responsible. This should, however, be priced separately because including it into an overhead structure is difficult and may lead to problems during the maintenance period.

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APPENDIX 1: LIST OF RECOMMENDED PLANT SPECIES

Species	Common name	Moisture requirements	Means of planting	Months to be collected	Notes
Grasses					
Ammophila arenaria	Marram grass	H	P	-	Good stabiliser to establish a barrier to the advancing sands
Ehrharta villosa	Pipegras	L	P, S	Oct-Dec	Good in mobile sands
Eragrostis tef	Tef	L	S		annual, fast growing
Elymus distichus	Sea wheat	L	S	Sep-Nov	Foredune pioneer
Sporobolus virginicus	Dune kweek	L	P	-	Good dune forming species.
Herbs					
Arctotheca populifolia	Dune pumpkin	L	P, S	Jan-Dec	In areas close to the high water mark
Felicia aethiopica	Blue daisy	M	P		Useful groundcover in fairly stable areas.
Gazania rigens var. uniflora	Daisy	M	P,S		Good in foredune areas
Senecio elegans	Dune Senecio	L	S	Sep-Jan-	Foredune areas, bi-annual
Succulents					
Carpobrotus edulis	Hottentot fig	L	P, S		good pioneer , groundcover
Tetragonia decumbens or *Tetragonia* sp.	Klappiesbrak	L	P	-	Foredune areas
Shrubs					
Chrysanthemoides monolifera	Bitou	L	P, S	Jun-Jul	Excellent shrub that grows well from seed and spreads rapidly in open areas
Myrica cordifolia	Waxberry	L	P,S	-	Shrub that can be germinated from seed, but is slow growing. The horizontal stems grow along the surface of the dunes.
Passerina rigida	Dune-string	L	S	Dec	Very good in open areas and is a pioneer dune forest species, but seeds are slow to germinate.

L = Low, M = Medium, H = High
P = Plants, S = Seeds, C = Cuttings

APPENDIX 2: SPECIES RECORDED ON THE SITE

Species	Family	Common name	Frequency in Transects	Notes
Grasses - Poaceae				
Ammophila arenaria	Poaceae	Marram grass	Transects 3,5 – only locally abundant	Good stabiliser to establish a barrier to the advancing sands
Ehrharta villosa	Poaceae	Pypgras/ Pipe grass	Transects 3,5 – occasional to common	Good in mobile sands
Agropyron distichum (=Elymus distichus)	Poaceae	Sea wheat	Transects 1,2,3,4 - Common	Foredune pioneer that forms hummocks
Sporobolus virginicus	Poaceae	Dune kweek	Not seen on these dunes	Good dune forming species.
Herbs				
Albucca spiralis	Hyacinthaceae		Transect 3 -rare	An occasional species on dunes but not common
Arctotheca populifolia	Asteraceae	Dune pumpkin	Transects 1,2,3 - Common	In areas close to the high water mark and in the dunes where it forms hummocks
Chironia baccifera	Gentianacae	Christmas berry	Transect 3 – rare in the area	
Felicia aethiopica	Asteraceae	Blue daisy	Not seen in the dune field	Useful groundcover in fairly stable areas.
Gazania rigens var. uniflora	Asteraceae	Dune Gazania	Not seen in the dune field	Good in foredune areas
Senecio elegans	Asteraceae	Wild cineraria	Seen but not recorded	Foredune areas, bi-annual
Succulents				
Carpobrotus edulis	Mesembryanthemaceae	Hottentot fig	Not seen on the dunes	Good pioneer , groundcover
Tetragonia decumbens	Aizoaceae	Klappiesbrak	Transects 2,3,5 – Occassional to Common	Foredune areas
Shrubs				

Species	Family	Common name	Frequency in Transects	Notes
Acacia cyclops	Fabaceae	Rooikrantz	Transect 5 – at end of transect	Alien species that forms dense thickets. Will need to be replaced by indigenous shrubs
Atriplex semibaccata	Chenopodiaceae	Salt marsh salt bush	Transect 5 – at end of transect	A species common of brackish soils, usually around margins of salt marshes
Chrysanthemoides monolifera	Asteraceae	Bitou	Transect 5 – at end of transect	Excellent shrub that grows well from seed and spreads rapidly in open areas
Myrica cordifolia	Myricaceae	Waxberry	Seen in the region but not on these dunes	Shrub that can be germinated from seed, but is slow growing. The horizontal stems grow along the surface of the dunes.
Passerina rigida	Thymelaeaceae	Dune-string	Seen in the region but not on these dunes	Very good in open areas and is a pioneer dune forest species, but seeds are slow to germinate.