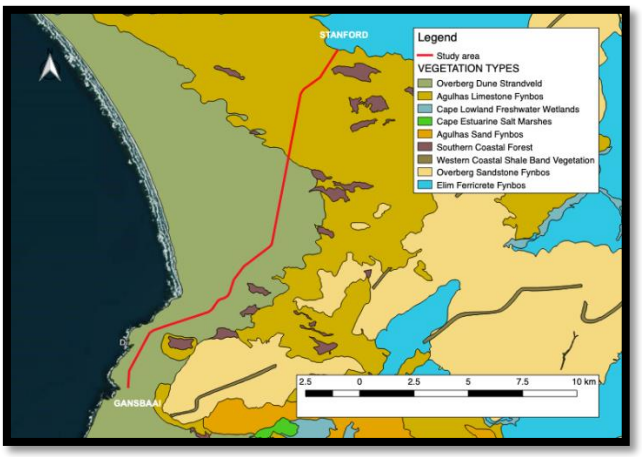
REHABILITATION REPORT

PROPOSED REHABILITATION AND UPGRADING OF TRUNK ROAD 28 SECTION 2, AND RELATED EXISTING DEGRADED STORM WATER INFRASTRUCTURE (CULVERTS), BETWEEN STANFORD AND GANSBAAI, FROM KM 23.83 TO KM 43.88, WESTERN CAPE.



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Contents

GNEC REF: 20595 (TR28/2 Rehabilitation Report)
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LIST OF FIGURES

1. INTRODUCTION

Guillaume Nel Environmental Consultants (GNEC) were appointed by EFG Engineers (Pty) Ltd who were appointed by Western Cape Government (WCG), Department of Transport and Public Works: Provincial Roads and Transport Management Branch, for the proposed rehabilitation/upgrading of Trunk Road 28 Section 2 (TR28/2), and the proposed upgrade of the existing degraded culverts/storm water infrastructures along the road within the road reserve, between Stanford and Gansbaai from Km 23.83 to Km 43.88.

Road rehabilitation and upgrade:

- Proposed road rehabilitation and upgrade will remain mostly within the previously disturbed 30m road reserve;
- The narrow existing road cross-section is substandard and is to be upgraded to a Class 1 rural cross section. The lanes will be widened from 3.2 m to 3.7 m each and 2 m surfaced shoulders will be added to the carriageway;
- Ensure compliance to the 100 km/h design speed guidelines;
- Allow passing opportunities along the road. (High accident risk currently);
- Upgrade of deteriorating pavement structure;
- Improve unsafe access locations in terms of insufficient shoulder sight distances and access spacing;
- Improving the existing destination, tourism and road warning signage and road markings; and
- Concrete lined side drains.

Storm Water Infrastructure (Culverts) upgrade:

It was found that the existing degraded culverts within the road reserve do not have the required minimum diameter and according to the Rational method, the existing minor culverts cannot accommodate the design flood peaks. Therefore, larger storm water infrastructure (culverts) are proposed at existing culvert positions, as well as at new locations where additional culverts are required.
Severe damage and degradation has been identified at the storm water infrastructure (culverts).
It is evident that the areas at the storm water infrastructure (culverts) have been previously disturbed due to road construction, road maintenance, and ongoing erosion.
Degradation and erosion to the storm water infrastructure (culverts) and related environment is an ongoing event and poses a safety hazard to people using this road. Due to the disturbance of erosion, loss of topsoil and vegetation, invasive species are establishing in these areas, negatively impacting on the ecological and biodiversity value of the areas. The original character of the area at the culverts has been changed due to these activities. The areas at the storm water infrastructure show signs of alien infestation.

It's is highly recommended that the degraded storm water infrastructure (culverts) be upgraded to ensure adequate flow and eliminate/minimise further erosion to these structures and related environment.
The proposed repair and upgrade of the existing degraded storm water infrastructure (culverts) will positively contribute to the road infrastructure.

The rehabilitation report will discuss in details the mitigation and rehabilitation measures necessary for successful rehabilitation of all disturbed areas.

2. SITE LOCATION AND STUDY AREA

Road:

Trunk Road 28 section 2 to be rehabilitated and upgraded extends from the Town of Stanford from Km 23.83 to the Town of Gansbaai and ends at Km 43.88.

The proposed rehabilitation and upgrade of Trunk Road 28 section 2 will remain mostly within the road reserve.

Storm Water Infrastructure:

It was found that the existing degraded culverts within the road reserve do not have the required minimum diameter and according to the rational method, the existing minor culverts cannot accommodate the design flood peaks. Therefore, larger storm water infrastructures (culverts) are proposed at existing culvert positions, as well as a new locations of a culvert where required.

Severe damage and degradation has been identified at these storm water infrastructures (culverts).
It is evident that the areas at these storm water infrastructures (culverts) have been previously disturbed due road construction, road maintenance, ongoing erosion and alien infestation.
It's is highly recommended that these degraded storm water infrastructures (culverts) be upgraded to ensure adequate flow and eliminate/minimise further erosion to these structures and related environment.
The proposed repair and upgrade of the existing degraded storm water infrastructures (culverts) will positively contribute to the road infrastructure.

The triggered existing degraded storm water infrastructures (culverts) to be upgrade is situated within the road reserve of Trunk Road at:

- Culvert at Km 24.088;
- Culvert at Km 24.138;
- Culvert at Km 24.198;
- Culvert at Km 25.092;
- Culvert at Km 25.115;
- Culvert at KM 25.138;
- Culvert at Km 25.161;
- Culvert at Km 25.184; and
- Culvert at Km 25.200.

Due to the presence of the Western Leopard Toad within the watercourse/wetland between Km 24.088 and Km 24.198, it is recommended by the freshwater and faunal specialist that additional culverts be installed within this section.

The upgrade of the R43 road creates a unique opportunity to improve the survival of the Western Leopard Toad.

The current culverts are woefully inadequate and inappropriate for the safe and free passage of the toads and probably also other animals like the Cape Clawless Otter, genets and porcupines which also occupy the catchment area.

The freshwater and Faunal specialist recommended the installation of additional culverts to ensure effective movement of the Leopard Toad and other faunal species between the upstream and the downstream of the watercourse.

Additional culverts need to be installed at: (For Leopard Frog and Faunal Movement)

- Km 24.112; x1 Box Culvert 1.5m x 1.5m
- Km 24.125; x1 Box Culvert 1.5m x 1.5m
- Km 24.163; x2 Box Culvert 2.4m x 1.5m
- Km 24.175; x1 Box Culvert 1.5m x 1.5m
- Km 24.188; x1 Box Culvert 1.5m x 1.5m

Please refer to Figure 1 below for the locality map of Trunk road extending between Stanford and Gansbaai.
Please refer to Figure 2 below for the locality map of the culverts to be upgraded.
Please refer to Figure 3 below for the locality map of the culverts to be upgraded.

Figure 1: Locality Map of Trunk Road 28, Section 2, between Standord and Gansbaai.

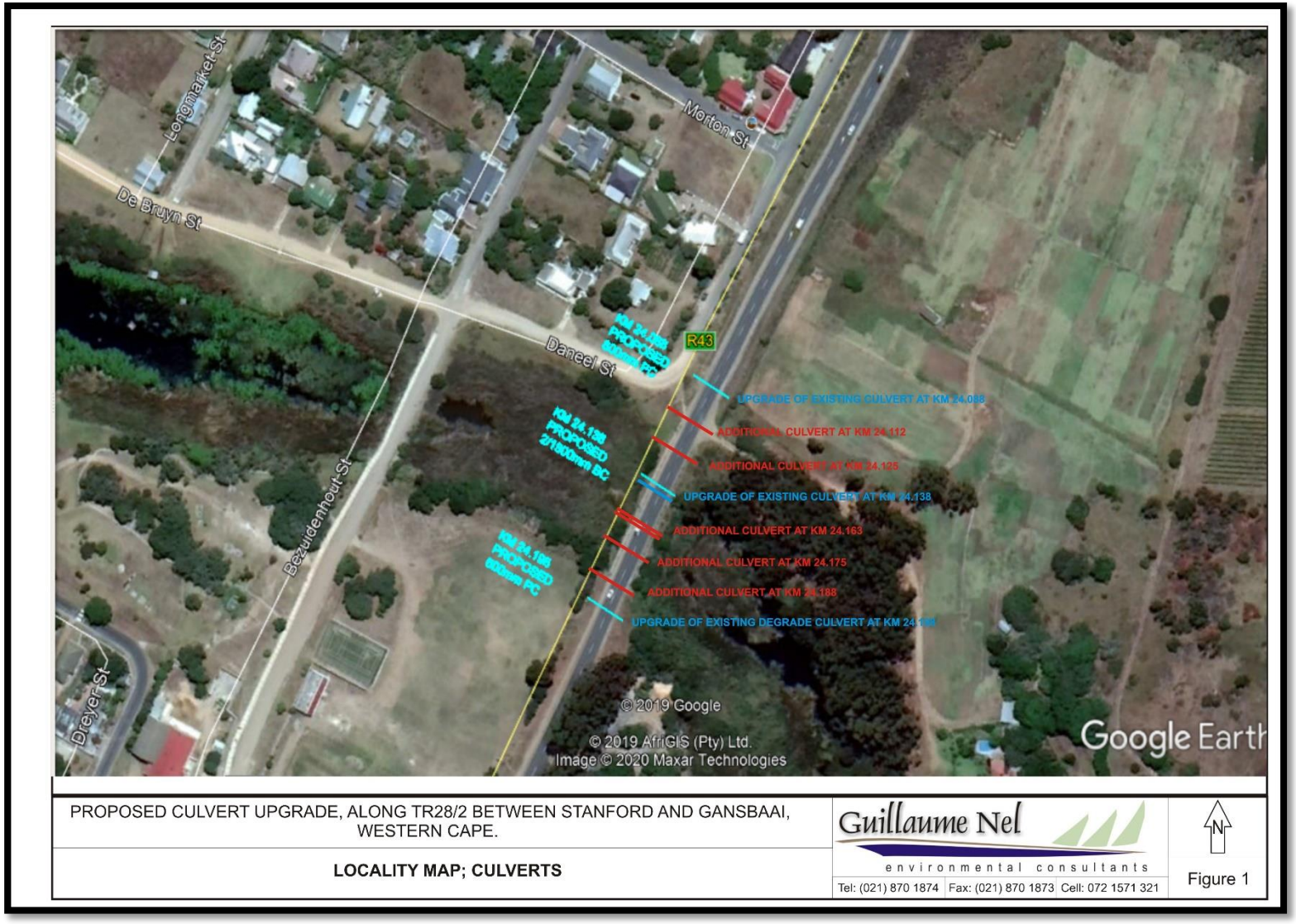

Figure 2: Locality Map of the triggered culverts to be upgraded and the installation of additional culvert along Trunk Road 28, Section 2, between Standford and Gansbaai.

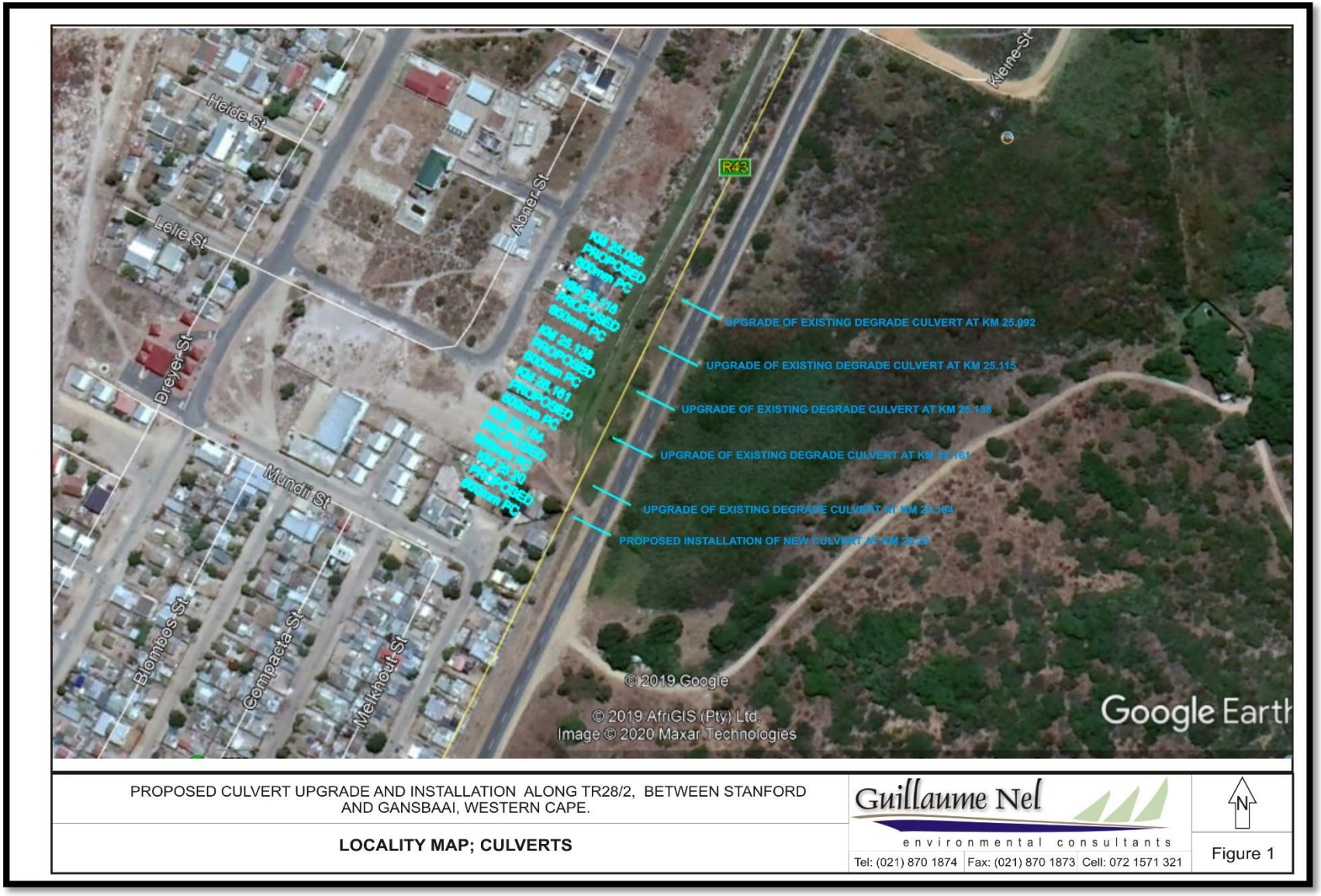

Figure 3: Locality Map of the triggered culverts to be upgraded and the installation of additional culvert along Trunk Road 28, Section 2, between Standford and Gansbaai.

3. THE VEGETATION

3.1 Vegetation along Trunk Road 28, Section 2

Trunk road 28 section 2, extending between the town of Stanford and Gansbaai, comprise of two vegetation types;

- Agulhas Limestone Fynbos (30% of the area)
- Overberg Dune Strandveld.(70% of the area)

In general the vegetation along Trunk Road within the study area is in good condition, although sections infested with invasive species are present. The wetland/watercourse with related culverts between km 24 and Km 25 is highly infested with invasive species.

Conservation Status:

***Agulhas Limestone Fynbos**:*

- The National List of Threatened Terrestrial Ecosystems, VULNERABLE (D1).
- The Western Cape State of Biodiversity, VULNERABLE (D1).
- The National Biodiversity Assessment, CRITICALLY ENDANGERED

Overberg Dune Strandveld:

- The National List of Threatened Terrestrial Ecosystems, LEAST THREATENED
- The Western Cape State of Biodiversity, LEAST THREATENED
- The National Biodiversity Assessment, CRITICALLY ENDANGERED

Distinctive habitats that occur along both sides of the road reserve within the study area:

1. Lowland flats vegetation;
2. Wetland vegetation;

2a. Moist sedge lands;

3. Fynbos shrub lands;
4. Exposed limestone fynbos;
5. Strandveld shrub lands; and
6. Milkwoods.

Species identified within these distinctive habitats that occur along both sides of the road reserve within the study area:

1. Lowland flats vegetation

Anthospermum aethiopicum, Gnidia squarrosa, Gymnosproria buxifolia, Helichrysum patulum, Leucadendron galpinii (VULNERABLE), Leucadendron coniferum (VULNERABLE), Leucadendron linifolium (VULNERABLE) Muraltia spinosa, Orphium frutescens, Osteospermum moniliferum, Searsia laevigata and Metalasia densa; Trees: Olea europaea subsp. africana; Graminoides: Hyparrhenia hirta; Stenotaphrum secundatum and Thamnochortus sp.; Herbs: Lichtensteinia lacera.

2. Wetland vegetation

The riverine vegetation includes wetland habitat dominated by common reed Phragmites australis, with scattered invasive Brazilian pepper tree (Schinus terebinthifolius), Senecio halimifolius, and the bridge embankment, which includes Searsia laevigata, Olea europaea subsp. africana, Gymnosporia buxifolia and invasive rooikrans (Acacia cyclops). Note that PROTECTED milkwood trees (Sideroxylon inerme) occur at waypoint 002 (34°26'39.76"S; 19°27'22.12"E).
Section: Wetland crossing from KM2.092 to KM25.02 (includes five culverts).
This intact wetland is dominated by Phragmites australis, Psoralea pinnata and invasive rooikrans (Acacia cyclops). Additional species include Cliffortia strobilifera and Leonotus leonurus.
A third distinctive wetland was located at culvert KM30.906. The habitat supports an unidentified sedge species (cf. Epischoenus sp.)

3. Fynbos shrublands

The fynbos shrublands contain intact vegetation on both sides of the road. Disturbance is generally low, however, Port Jackson willow (Acacia saligna) is present at the northern end of this section. The habitat supports a healthy subpopulation of the VULNERABLE Leucadendron coniferum between KM27.727 and KM27.275 (Figure 26) and a variety of shrub species. The species include (*= dominant): Shrubs/small trees: Anthospermum aethiopicum, Aspalathus sp., Colpoon speciosum, Elytropappus rhinocerotis, Erica sp., Gnidia juniperina, *Gnidia squarrosa Helichrysum patulum, Indigofera sp., Leonotus leonurus, *Metalasia densa, *Metalasia muricata, *Osteospermum moniliferum, Otholobium bracteolatum, *Passerina corymbosa, Protea obtusifolia, *Searsia glauca. *Searsia laevigata, *Searsia lucida; Graminoides: Eragrostis curvula, Thamnochortus insignis; Other perennials: Pelargonium capitatum.

4. Exposed limestone fynbos

Several patches with exposed limestone support a distinctive species composition. These areas comprise small patches characterized by low shrubs and exposed limestone.
Shrubs: Collumia sp., Erica coccinea, Indigofera brachystachya, Metalasia muricata, Morella quercifolia, Muraltia cf. satureioides., Otholobium bracteolatum. Passerina cf. rigida, Phylica cf. selaginoides, Prismatocarpus sp., Protea obtusifolia (NEAR THREATENED), Salvia africana-lutea, Disparago anomala and Zygophyllum cf. fulvum; Graminoides: Restio eleocharis and Ficinia praemorsa

5. Strandveld shrublands

The strandveld is similar to the fynbos shrubland in terms of species complement and has a broad ecotone that is difficult to define. The strandveld habitat has a distinct lack of proteoids and has the following dominant species: Shrubs: *Cassine peragua, Diosma hirsuta, Eriocephalus africanus, *Euclea racemosa, Felicia echinata, Gymnosproria buxifolia, Metalasia densa, Osteospermum moniliferum, Otholobium bracteolatum, Passerina cf. rigida, Pterocelastrus tricuspidatus, Searsia glauca, Searsia laevigata, Olea exasperata and Zygophyllum fulvum; Graminoids: Ehrharta villosa, Thamnochortus insignis and Willdenowia teres; Geophytes: Brunsvigia orientalis; Succulents: Carpobrotus sp. Note that fynbos elements occur within this strandveld habitat but these do not dominate the vegetation. Invasive rooikrans (Acacia cyclops) is most common near De Kelders and the Gaansbaai side of this section.

A few patches of open dune strandveld occur within this habitat with open vegetation dominated by Restio eleocharis with Euclea racemosa . These open habitats were probably disturbed during the initial road construction works but have recovered naturally to intact condition and support a healthy variety of species, including: Shrubs/small trees: *Anthospermum aethiopicum, Diosma hirsuta, *Eriocephalus africanus, *Felicia echinata, *Helichrysum patulum, Indigofera sp., Pterocelastrus tricuspidatus, *Zygophyllum fulvum and *Olea exasperata, Graminoides: *Restio eleocharis, Succulents: *Carpobrotus acinaciformis and *Joradaaniella dubia.

6. Milkwoods

At least 18 milkwood trees were located, with ten of these being old to very old individuals. Some of these may fall outside the project footprint but are included since these should be protected during construction phase of the project. The localities are indicated below.

Localities of protected milkwood (Sideroxylon inerme) trees:

Waypoint	Coordinates	Age class
002	34°26'39.76"S; 19°27'22.12"E	Old
004	34°26'40.80"S; 19°27'22.69"E	Old
011	34°27'9.32"S; 19°27'1.46"E	
013	34°27'10.44"S; 19°27'0.72"E	Old
014	34°27'11.53"S; 19°27'0.15"E	Old
015	34°27'11.72"S; 19°26'59.88"E	Old
016	34°27'12.11"S; 19°26'59.56"E	Old
017	34°27'11.37"S; 19°26'59.39"E	
019	34°27'23.06"S; 19°26'47.68"E	Old
020	34°27'23.55"S; 19°26'47.74"E	
021	34°27'23.64"S; 19°26'47.14"E	Old
022	34°27'23.87"S; 19°26'46.50"E	
KM36.405	34°32'25.59"S; 19°24'14.68"E	Old
043	34°33'4.31"S; 19°23'37.03"E	
045	34°33'25.53"S; 19°22'25.17"E	Old
051	34°34'17.90"S; 19°21'18.22"E	
052	34°34'18.75"S; 19°21'18.14"E	
053	34°34'26.98"S; 19°21'12.85"E	

Please refer to Figure 4 below for the study area superimposed on a portion of the vegetation map of South Africa.
Please refer to Figure 5 below indicating the habitats along Trunk Road 28 Section 2
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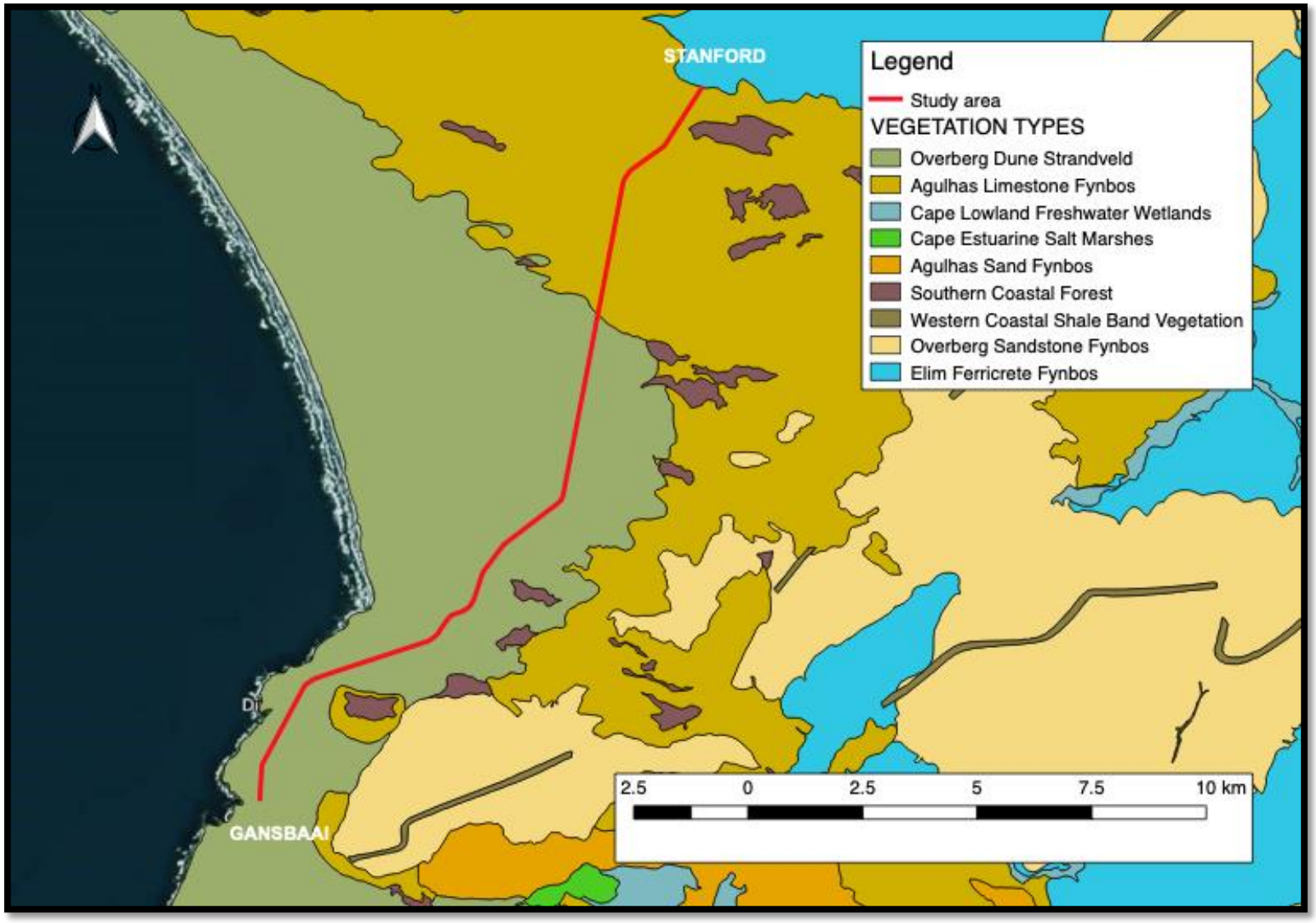


Figure 4: Study area superimposed on a portion of the vegetation map of South Africa.

Figure 5: The habitats along Trunk Road 28 Section 2.

4. REHABILITATION MEASURES

4.1 Alien Clearing Management Plan

Prior to commencement of the road upgrade activity it is suggested that the entire road reserve or TR28/2 need to be cleared of invasive vegetation.

An alien clearing management plan need to be implemented for at least one year after rehabilitation to manage the aliens that might germinate within the rehabilitated areas. It is suggested that follow up alien clearing practices be conducted every 3 months for at least one year after rehabilitation.

Alien clearing practices to follow:

4.1.1 Cutting and painting of medium size individuals

Applicable where the invasive species are too difficult for hand pulling. Invasive trees need to be cut leaving a stem of 10cm. The remaining stem needs to be painted using a brush with a systemic herbicide. The systemic herbicide need to be coloured to ensure that all the cut stems be treated. Care should be taken not to spill systemic poison when painting the stems. The systemic poison will infiltrate the stem killing the roots, and prevent the invasive tree from re-sprouting again. Cut down invasive trees need to be removed from site to the nearest licensed landfill site to prevent the spread of seeds.

Systemic Poison, Enviro - Glyphosate; 2% Application. (Registered for use near waterbodies)

Figure 6: Picture of a cut down stem treated with a coloured systemic herbicide.

4.1.2 Hand pulling of smaller invasive species

Seeing that the area is surrounded by natural vegetation, no spot spraying of invasive species will be allow as the draft might negatively impact upon adjacent natural vegetation. It is suggested that smaller invasive species be hand pulled with manual labour. This is the most effective and environmental friendly way to eradicate smaller invasive vegetation.

Figure 7: Picture of smaller species ideal for hand pulling.

4.1.3 Ring barking of larger species

Ring barking is a technique that involves removing a ring of bark around a tree trunk. Ring barking interferes with the circulation of the tree and results in it slowly dying. Remove a 30 to 40 cm strip of bark around the base of the tree trunk to ground level. Ring-barking removes the cambium/phloem, a layer just beneath the bark, which carries food from the leaves down to the roots. The roots will eventually die thereby killing the tree. The ring barked area can then be painted with a systemic poison.

Figure 8: Example of ring barking larger invasive trees.

4.1.4 Storage and Removal of invasive vegetation

- During alien eradication an area needs to be identified for temporary stockpiling of the invasive vegetation;
- Only one area to be identified to prevent the spread of seeds and to prevent contamination of adjacent natural areas;
- The area identified should not be in close proximity of a watercourse/wetland to prevent seeds from entering and spreading along the watercourse;
- Invasive vegetation left on site is a fire hazard;
- Invasive vegetation left on site inhibit the germination of Fynbos seeds;
- All invasive vegetation to be removed immediately from site to the identified stockpile area ones clearing has been completed;
- Alien vegetation to be transported in preferably a closed truck to prevent the seeds from spreading along the road. Alternatively the alien vegetation can be covered with a biddem material during transport;
- The invasive vegetation at the stockpile area needs to be removed on a regular basis and be dispose to the nearest licensed landfill site; and
- No burning of vegetation on site allowed.

4.1.5 Wetland/Watercourse management measures during alien clearing practices

- The contractor needs to make sure that excessive quantities of sand and silt do not enter the wetland/watercourse habitat;
- The contractor needs to take cognisance of weather forecast. No clearing activities allowed during times of high rainfall;
- Alien clearing to be conducted within wetland/watercourse habitat, need to be done by manual labour, no heavy machinery allowed;
- All potential pollutants should be kept away from the wetland/watercourse habitat including:

    - Oil, diesel or petrol used for machinery during alien clearing activities;
    - Any chemicals for the control of alien vegetation; and
    - Sanitation structures.

- No spoil material should be placed in close proximity to the wetland/watercourse habitat, dumped on riparian or bank habitats, spread out around trees, used to fill hollows and other irregularities in the wetland/watercourse, or be used for erosion control, but must be removed to approved dumping site; and
- No spraying of herbicide allowed in close proximity to any water bodies.

4.1.6 Burning

Burning of cleared invasive vegetation on site is strictly prohibited. Cleared invasive vegetation needs to be taken to the nearest licensed landfill site. Should burning of invasive vegetation on example a farmers land be considered, the necessary permits need to be applied for and in place. Burning without the necessary permits are a criminal offence and a fire hazard.

4.1.7 Protective gear

Working in a dangerous environment, operators need to have the necessary protective gear:

- Safety boots, steel cap;
- Safety gloves;
- Face mask to prevent herbicide inhalation;
- Safety glasses for eye protection; and
- Reflector vests to ensure visibility.

4.1.8 Frequency of Alien Clearing

Prior to commencement of the road upgrade activity the road reserve of Trunk Road needs to be cleared of invasive vegetation.

An alien clearing management plan needs to be implemented for at least one year after rehabilitation to manage the aliens that might germinate within the rehabilitated areas. It is suggested that follow up alien clearing practices be conducted every 3 months for at least one year after rehabilitation.

Reasons for follow up:

- Due to the disturbance of soil during the initial clearing activities, invasive seeds within the seedbank of the soil will start to germinate. These germinated species need to be removed before they produce seed to prevent ongoing infestation.
- Cut down and treated trees also tend to re-sprout. A 2nd application of herbicide will be necessary for these species.

4.2 Management of topsoil

Topsoil is the most crucial element for rehabilitation as it contains all the Fynbos seeds that is necessary for natural rehabilitation. Topsoil needs to be strictly and correctly managed.

Prior to commencement of construction:

- 200mm of topsoil needs to be carefully stripped;
- The topsoil needs to be safely windrowed outside the construction footprint in the exact location it was stripped from. This will ensure that the correct topsoil be placed back in the correct location after construction;
- The topsoil needs to be clearly seen as no go areas and protected;
- The topsoil needs to be clearly demarcated with danger tape as well as the necessary signage erected;
- ECO needs to inspect and monitor the topsoil and include the findings within the ECO audit reports;
- Topsoil may not be higher than 2m; and
- Topsoil needs to be monitored for invasive vegetation and cleared as required.

It was found that windrow of topsoil is the most effective for the following reasons:

- It limits the handling of topsoil;
- Ensure that topsoil is replaced within the exact location is was removed from; and
- Prevent the mixing of different topsoil form different sections.

4.3 Search and rescue of endemic species

The search and rescue operation can divided into the following sections:

- Seed collection;
- Cutting of species for propagation purposes;
- Search and rescue of species that can be directly removed and transplanted; and
- The search and rescue of geophytes.

Prior to commencement of activities a search and rescue for endemic species need to be conducted within the road reserve and construction footprint of the entire site.
The search and rescue needs to be conducted by a qualified team, consisting of a Horticulturist/Botanist/Rehabilitation specialist with well trained staff to ensure that the search and rescue be conducted sustainably. The search and rescued species need to be taken to a rehabilitation nursery, where these plants, geophytes, seeds and cuttings need to be managed and maintained.

The searched and rescued species will be used to rehabilitate the disturbed road reserves.

Rehabilitation must take place with species sourced from each site as per report.
No species, plant material and seed form areas outside the study area must be introduced to the study area.
Rehabilitation practices must be done by a qualified Botanist/Horticulturist/Rehabilitation specialist.

Maintenance and management activities include:

- Bagging the searched and rescues species within the nursery;
- Planting the searched and rescued wetland species within artificial wetland ponds for safe keeping and multiplying during the extent of the project;
- Propagation and multiplying of species form which cuttings have been made;
- Pruning, water, fertilizing and disease management of search and rescued species;
- Cleaning of collected seed from pods and cones;
- Drying of collected seed prior to storing;
- Storing of collected seed under desired condition keeping seeds alive until site is ready for hydro seeding; and
- Smoke treatment of Fynbos seeds prior to Hydro-Seeding.

The Horticulturist/Botanist/Rehabilitation specialist responsible for maintaining these plants within the rehabilitation nursery, needs to keep record of the searched and recued plants. This will include:

- The species;
- The quantities;
- Growth monitoring; and
- The exact location from where the species have been collected from.

4.3.1 Seed Collection (As per Botanical Report)

Species identified for seed collection:

Osteospermum moniliferum

Metalasia muricata

Metalasia densa

Searsia crenata

Searsia glauca

Searsia laevigata

Searsia lucida

Leucandendron galpinii

Leucadendron coniferum

Leucadendron linifolium

Berzellia lanuginose

Helichrysum patulum

Felicia echinata

Euclea racemose

Gymnosporia buxifolia

Pterocelastrus tricuspidatus

Protea obtusifolia

Sustainable Harvest:

- The search and rescue needs to be conducted by a qualified team, consisting of a Horticulturist/Botanist/Rehabilitation specialist with well trained staff to ensure that the search and rescue be conducted sustainably;
- When a plant is within the construction footprint all the seeds can be harvested; and
- When seed is harvested in the surrounding natural areas only one third of the seed on the plant can be harvested, to ensure enough seed remain on the plant.

Drying and cleaning of seeds:

- Seeds need to be sun dried. When dried, the seeds need to be taken from the seeds pods. The hydro-seeder cannot take seed pods larger than a 10 cent coin.
- Cleaning of seeds from pods also ensure a wider distribution of seeds when hydro-seeded.

Storing of Seeds:

- Seeds need to be stored per specie and accurately labelled;
- Record to be kept of the location from where the seeds have been collected;
- Record to be kept of the quantity of seeds collected;
- Seed to be stored under cool conditions;
- Seed to be stored within a container free of rodent and pests to prevent damage to the seeds;
- Fungicide and insecticide powder to be added to the stored seeds to prevent fungal infection; and
- Seeds need to be very dry before storing to prevent the outbreak of mildew.

4.3.2 Species identified from which cutting to be made for propagation

Species identified for cuttings:

Pelargonium capitatum

Carpobrotus edulis

Carpobrotus acinaciformis

Joradaaniella dubia.

Osteospermum moniliferum

Erica irregularis

Cliffortia anthospermoides

Sustainable Harvest:

- The search for cuttings need to be conducted by a qualified team, consisting of a Horticulturist/Botanist/Rehabilitation specialist with well trained staff to ensure that the search for cuttings be conducted sustainably;
- When a plant is within the construction footprint the entire plant can be used for cuttings; and
- When cuttings are taken from plants within the surrounding natural areas only a quarter of the plant can be used for cuttings to ensure sustainable harvesting.

Propagation of cuttings:

- Propagation of cuttings to be supervised by a well-trained nursery manager/horticulturist;
- Cuttings to be treated with a hormone powder to stimulated root formation and growth; (Hormone powder number 2)
- Cuttings to be planted within a well-drained medium to prevent root rot;
- The growing medium used for the cuttings need to be steam sterilized;
- Cutting to be placed in a hardening off area with a 50% shading area to ensure the rooted cuttings adapts and strengthen before moving them to a sunny area.

Nursery management:

- Regular stock take of the plants;
- Record of where the cuttings have been collected from;
- Record of the quantify of plants;
- Pest and disease control; and
- Regular pruning to ensure compact multi branched plants that is strong for replanting during rehabilitation.

4.3.3 Species identified for removal and multiply within rehabilitation nursery. (Especially wetland species)

Species identified for direct removal:

Ischrolepsis subverticillata

Cyperus textilis

Carpha glomerata

Zantedeschia aetiopica

Wachendorfia thyrsiflora

Prionium serratum

Isolepis prolifera

Isolepis cernua

Juncus lomatophyllus

Thamnochortus insignis

Sustainable Harvest:

The search and rescue need to be conducted by a qualified team, consisting of a Horticulturist/Botanist/Rehabilitation specialist with well trained staff to ensure that the search and rescue be conducted sustainably.

Artificial wetland ponds:

Figure 9: Artificially constructed wetland ponds.

- Search and rescued wetland plants to be placed in artificially constructed wetland ponds;
- The ponds can be constructed by digging holes to the required size and lining these holes with PCV plastic;
- Before placing the search and rescued wetland species within the ponds, the ponds need to be lined with a 30cm layer of wetland soil. Wetland soil is important for:
    - Soil will act as a growing medium for the roots and rhizomes of the wetland species to anchor, grow and distribute in;
    - The soil will act as a growing medium where all sediment will settle, resulting in the formation of organic material supplying the necessary nutrients for the wetland species; and

- For a functioning wetland to establish the sediment and organic matter developing over time is critical for a sustainable functioning wetland.

- The water need to regularly circulate through these ponds to prevent stagnant and rotting water; and
- Artificial wetland ponds are an ideal medium to store the search and rescued wetland species and multiply them for rehabilitation purposes.

Nursery management:

- Regular stock take of the wetland species; and
- Record of where the species have been collected from.

4.3.4 Geophytes search and rescue

Species identified for direct removal:

Brunsvigia orientalis

Watsonia sp.

Bonatea speciosa

Corycium bicolorum

Disa bracteata

Pterygodium catholicum

Acrolophia bolusii

Pterygodium vermiferum

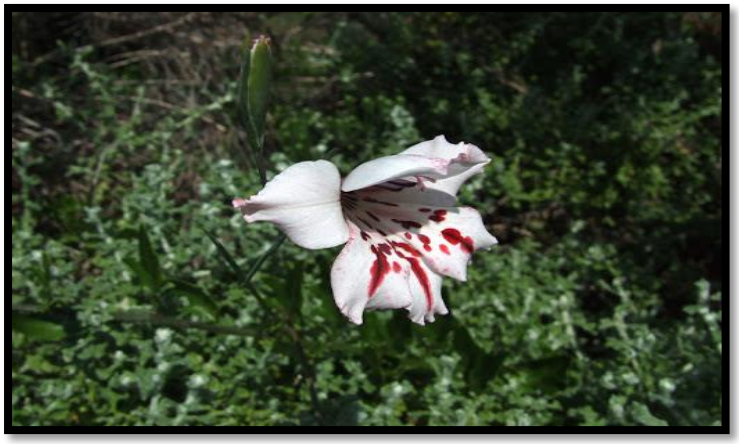
Satyrium carneum

Babiana nana

Chasmanthe aethiopica

Gladiolus vaginatus

Gladiolus variegatus



Lachenalia spp.

Trachyandra spp.

Planting of geophytes within the rehabilitation nursery:

- Planting of the search and rescued geophytes to be done by a well-trained nursery manager/horticulturist;
- Geophytes to be planted within a well-drained medium to prevent bulb rot; and
- The growing medium used for planting need to be steam sterilized.

Nursery management:

- Regular stock take of the geophytes;
- Record of where the geophytes have been collected from;
- Record of quantify of geophytes; and
- Pest and disease control.

4.4 Preparation of soil prior to rehabilitation

Prior to planting and hydro-seeding all the disturbed and affected areas, soil preparation is crucial for effective rehabilitation.

4.4.1 Ripping and shaping

All compacted areas need to be ripped, protected topsoil need to be spread, and area needs to be shaped in such a way that it blends in with the natural contour and drainage lines of the site.

Ripping and shaping will ensure:

- That all compacted areas be loosened and aerated;
- Effective infiltration of hydro-seeded seeds;
- Will ensure better infiltration of precipitation and less erosion;
- Will make planting during rehabilitation easier;
- Will stimulate natural rehabilitation by means of seed germination; and
- Will positively contribute to the visual and aesthetic value of the site.

Figure 10: Example of a previously compacted area that has been ripped, shaped and topsoil spread over the affected area prior to rehabilitation.

4.4.2 Embankment Stabilization

Since some of the cut and fill slopes might be steep, erosion control, along with preservation of the topsoil would be very important for rehabilitation. Stabilization should be done by ensuring that the velocity of surface runoff is reduced through naturally aligned terracing. Terracing can be done by using hand labour to create natural horizontal terraces. If necessary biodegradable sausages can be placed within the created naturally aligned terraces to help with slope stabilization.

Figure 11: Example of horizontal terracing to reduce down slope erosion.

Figure 12: Example of horizontal terracing with biodegradable sausages to reduce down slope erosion.

4.5 Timing of rehabilitation and hydro-seeding

Planting:

Due to the fact that there will be no irrigation to help the plants to settle and strengthen, the best time for planting will be at the beginning of the rainy season. This will help the plants to settle and preparing them for the summer to follow. All plants (even water wise plants) need water in the establishment phase. Should planting be done during the summer months (not advised) the planted areas need to be water at least once a week.

Hydro seeding:

Hydro seeding needs to be done directly after the surface has been ripped to ensure effective infiltration as explained above.
Hydro-seeding needs to be done during late Summer to Autumn (January to March). The seeds will start to germinate in time to receive the winter rain to strengthen and preparing them for the following summer to follow.

4.6 Hydro-seeding practise

Hydro-seeding, being fast and very effective, is best for larger areas as Trunk Road with related road reserve. Seed is an accepted source to result in the diversity of plants required as part of the rehabilitation process.

- Hydro-seeding needs to be done by a professional hydro-seeding company;
- The seed ratio and seed mixes for hydro-seeding needs to be supplied to the hydro-seeders by the Botanist/Rehabilitation Specialist/Horticulturist;
- The smoke water solution to enhance seed germination needs to be supplied to the hydro-seeders by the Botanist/Rehabilitation Specialist/Horticulturist; and
- Binding agent needs to be added to the hydro-seeding mix to ensure that the sown seeds stick to the surface. This binding agent is a temporary germination medium for the sown seeds and also prevent the seed from blowing away. Binding agents are added to the mix by the professional hydro-seeding company.

4.7 Rehabilitation of storm water infrastructures (culverts)

The newly upgraded storm water infrastructure (culverts) along Trunk Road needs to be rehabilitated for the following reasons:

- Enhance the visual and aesthetic appearance of the disturbed areas;
- Will re-introduce endemic Fynbos and Wetland species to the highly degraded and disturbed areas;
- Improve the ecological and biodiversity value and functioning of the disturbed wetland/watercourse;
- Will stabilize bare soil and prevent further erosion of the disturbed areas; ad
- Ensure effective water distribution through the culverts.

Plants for rehabilitation of the upgraded culverts have been carefully selected using the following criteria:

- An on-site survey has been conducted to identify the locally indigenous vegetation naturally occurring on site and surrounding areas;
- The national vegetation Book (Mucina *et al*. 2005, Mucina & Rutherford 2006) has been consulted and species carefully selected for rehabilitation which naturally occur in areas under discussion; and
- The botanical and freshwater reports compiled by the specialists have been consulted.

Rehabilitation needs to be done with a selection of the following endemic species:

Please refer to Figure 13 below, culvert rehabilitation plan.

Zone 1; Dry Bed Planting:

Eriocephalus africanus

Leonotus leonurus

Watsonia

Salvia Africana lutea

Helichrysum patulum

Osteospermum moniliferum

Metalasia muricata

Metalasia densa

Searsia crenata

Searsia laevigata

Searsia lucida

Carpobrotus edulis

Carpobrotus acinaciformis

Pelargonium capitatum

Joradaaniella dubia

Osteospermum fruticosum

Thamnochortus insignis

Zone 2; Wet/Seasonal Wet Bed Planting:

Berzellia lanuginosa

Cyperus textilis

Ischrolepsis subverticillata

Carpha glomerata

Zantedeschia aethiopica

Wachendorfia thyrsiflora

Prionium serratum

Isolepis prolifera

Isolepis cernua

Juncus lomatophyllus

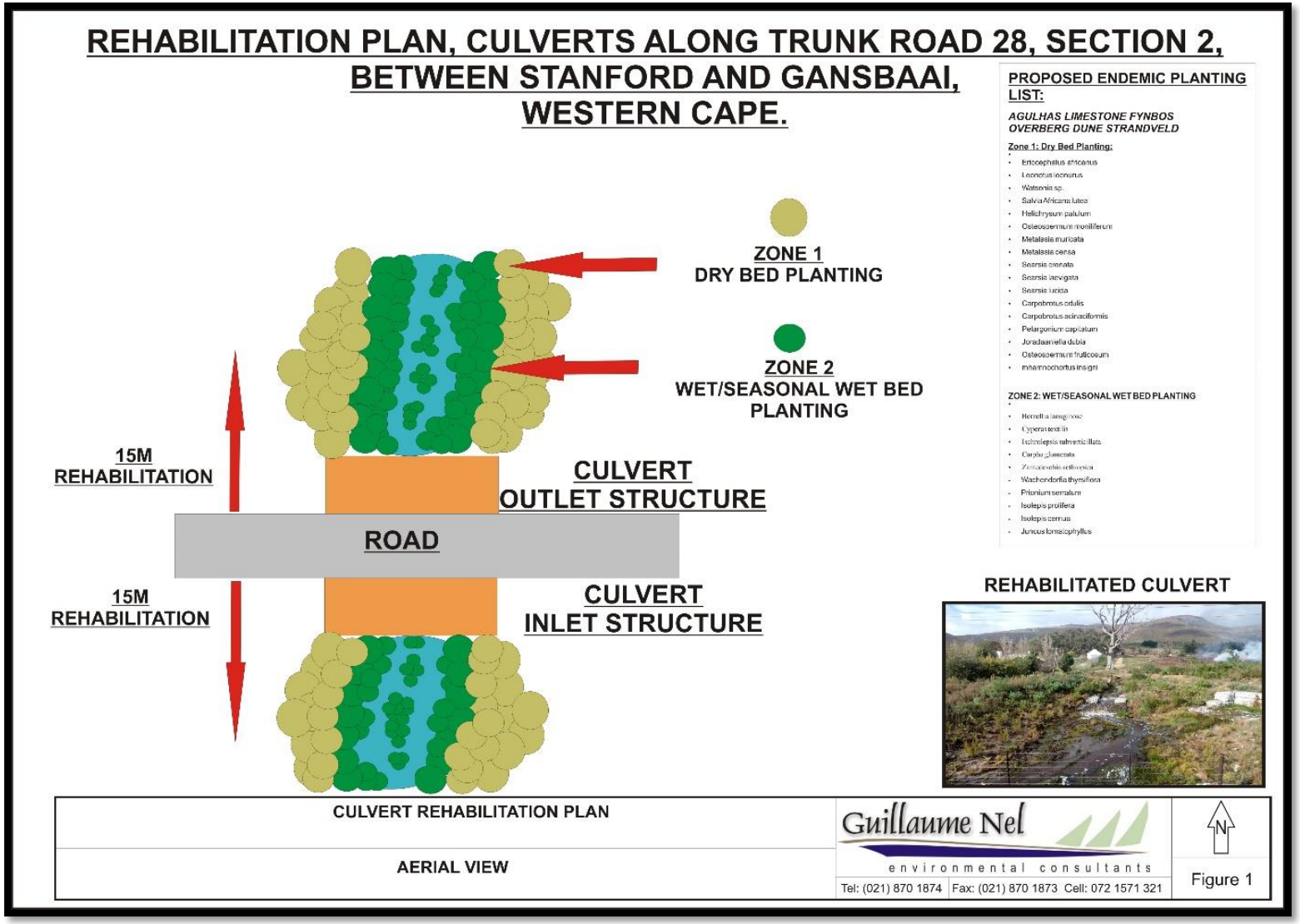


Figure 13: Culvert Rehabilitation Plan.

4.8 Cordoning off rehabilitated area

After rehabilitation the areas need to be clearly cordoned off to ensure that no damage is done to the rehabilitated area. Trampling of the areas will:

- Inhibit the successful growth and germination of plants.
- Lead to compaction of soil, poor water infiltration and erosion.

4.9 Future Maintenance Steps for the rehabilitated areas:

- An alien clearing management plan must be implemented for at least three years after rehabilitation to manage the aliens that might germinate in the rehabilitated areas. Follow-up alien clearing practices must be conducted every 6 months for three years after rehabilitation.
- Regular Visual inspections to monitor erosion or any gully formation. It is suggested that visual inspection to be conducted every 3 months for 2 years.
- Should any erosion or gullies be identified during site inspections, a qualified Horticulturist or Rehabilitation Specialist need to be consulted for rectifying measures.
- Rehabilitated road reserves need to be Cleary seen as no go areas.
- Species of conservation concern to be planted deep within the road reserve to ensure that mowing of vegetation close to the road will not impact upon these species.

5. CONCLUSION

GNEC in our professional capacity as rehabilitation specialists strongly feel that the above mentioned rehabilitation will:

- Enhance the visual and aesthetic appearance of the disturbed areas;
- Will re-introduce endemic species to the highly degraded and disturbed areas;
- Will stabilize bare soil and prevent/minimise further erosion of the disturbed areas;
- Improve the ecological and biodiversity value and functioning of the disturbed areas;
- Will help to reduce/minimise any further loss of topsoil;
- Will help to reduce/minimise any further loss of endemic vegetation; and
- Will ensure effective flow for the peak storm water flow through these culverts.

Rehabilitation must take place with species sourced from each site as per report.
No species, plant material and seed form areas outside the study area must be introduced to the study area.
Rehabilitation practices must be done by a qualified Botanist/Horticulturist/Rehabilitation specialist.

6. CULVERT REHABILITATION DONE BY GNEC

Hemel and Aarde Valley

Before:

Figure 14: Culvert Rehabilitation carried out by GNEC.

After:

Figure 15: Culvert Rehabilitation carried out by GNEC.

Figure 16: Culvert Rehabilitation carried out by GNEC.

Figure 17: Culvert Rehabilitation carried out by GNEC.

Figure 18: Culvert Rehabilitation carried out by GNEC.

Figure 19: Culvert Rehabilitation carried out by GNEC.

Figure 20: Culvert Rehabilitation carried out by GNEC.

Figure 21: Culvert Rehabilitation carried out by GNEC.

Figure 22: Culvert Rehabilitation carried out by GNEC.

Figure 23: Culvert Rehabilitation carried out by GNEC.

Before:

Figure 24: Culvert Rehabilitation carried out by GNEC.

After:

Figure 25: Culvert Rehabilitation carried out by GNEC.

Figure 26: Culvert Rehabilitation carried out by GNEC.

Figure 27: Culvert Rehabilitation carried out by GNEC.

Figure 28: Culvert Rehabilitation carried out by GNEC

Figure 29: Culvert Rehabilitation carried out by GNEC.

Figure 30: Culvert Rehabilitation carried out by GNEC.

Figure 31: Culvert Rehabilitation carried out by GNEC.

Figure 32: Culvert Rehabilitation carried out by GNEC.

7. EMBANKMENT REHIBILTATION DONE BY GNEC

Hemel & Aarde Valley:

Before

Figure 33: Embankment Rehabilitation carried out by GNEC.

Figure 34: Embankment Rehabilitation carried out by GNEC.

Figure 35: Embankment Rehabilitation carried out by GNEC.

Figure 36: Embankment Rehabilitation carried out by GNEC.

Figure 37: Embankment Rehabilitation carried out by GNEC.

Figure 38: Embankment Rehabilitation carried out by GNEC.

Figure 39: Embankment Rehabilitation carried out by GNEC.

After:

Figure 40: Embankment Rehabilitation carried out by GNEC.

Figure 41: Embankment Rehabilitation carried out by GNEC.

Figure 42: Embankment Rehabilitation carried out by GNEC.

Figure 43: Embankment Rehabilitation carried out by GNEC.

Figure 44: Embankment Rehabilitation carried out by GNEC.