Mulilo Struisbult Photovoltaic Energy Plant (PV2) Re-vegetation and Habitat Rehabilitation Plan

Copperton, Northern Cape

February 2022

CLIENT

Prepared by:

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Report Name	**Mulilo Struisbult PV2 Re-vegetation and Habitat Rehabilitation Plan**
Reference	**Mulilo Struisbult PV2 – Rehabilitation Plan**
Submitted to/Client	EIMS ENVIRONMENTAL IMPACT MANAGEMENT SERVICES
Report Writer	**Michael Schrenk** 
	Michael completed his professional Civil and Environmental engineering degree at the University of the Witwatersrand in 2016. He has been working in the fields of project management, biodiversity and habitat assessment and ecological restoration for over 3 years.
Reviewer	**Andrew Husted** 
	Andrew Husted is Pr Sci Nat registered (400213/11) in the following fields of practice: Ecological Science, Environmental Science and Aquatic Science. Andrew is an Aquatic, Wetland and Biodiversity Specialist with more than 12 years' experience in the environmental consulting field. Andrew has completed numerous wetland training courses, and is an accredited wetland practitioner, recognised by the DWS, and also the Mondi Wetlands programme as a competent wetland consultant.
Declaration	The Biodiversity Company and its associates operate as independent consultants under the auspice of the South African Council for Natural Scientific Professions. We declare that we have no affiliation with or vested financial interests in the proponent, other than for work performed under the Environmental Impact Assessment Regulations, 2017. We have no conflicting interests in the undertaking of this activity and have no interests in secondary developments resulting from the authorisation of this project. We have no vested interest in the project, other than to provide a professional service within the constraints of the project (timing, time and budget) based on the principals of science.

DECLARATION

I, Michael Schrenk, declare that:

- I act as the independent specialist in this application;
- I will 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;
- I declare that there are no circumstances that may compromise my objectivity in performing such work;
- I have expertise in conducting the specialist report relevant to this application, including knowledge of the Act, regulations and any guidelines that have relevance to the proposed activity;
- I will comply with the Act, regulations and all other applicable legislation;
- I have no, and will not engage in, conflicting interests in the undertaking of the activity;
- I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing any decision to be taken with respect to the application by the competent authority; and the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
- All the particulars furnished by me in this form are true and correct; and
- I realise that a false declaration is an offence in terms of Regulation 71 and is punishable in terms of Section 24F of the Act.

Michael Schrenk

Environmental Consultant

The Biodiversity Company

February 2022

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1 Introduction

Struisbult PV2 (Pty) Ltd holds an Environmental Authorisation (EA) (DEA Reference: 12/12/20/2502/AM4), dated 04/12/2020, to develop the 100 MW Photovoltaic (PV) solar energy facility (PV2) on the farm Struisbult (portion 1 of farm no. 104) in the Siyathemba local municipality near Copperton in the Northern Cape province. The authorised 300 ha solar energy facility will comprise the following infrastructure:

- PV module arrays;
- Upgrading of existing internal farm roads and the construction of new roads to accommodate the construction vehicles and access to the site;
- Construction of a 132 kV transmission line to connect the proposed PV plant with Eskom's grid via the Cuprum substation;
- Electrical fence to prevent illegal trespassing and the possible theft of panels, and to keep livestock from roaming between the solar arrays and causing accidental damage; and
- Other infrastructure includes an office, connection centre and a guard cabin.

The Biodiversity Company was commissioned to develop a Re-vegetation and Habitat Rehabilitation plan (Rehabilitation Plan) to meet the requirement of the issued EA. The EA stipulates that a Re-vegetation and Habitat Rehabilitation Plan is to be implemented during the construction and operation of the facility, and that restoration must be undertaken as soon as possible after completion of construction activities to reduce the amount of habitat converted at any one time and to speed up the recovery of disturbed areas to healthy natural habitats. The Rehabilitation Plan must be included in the amended project Environmental Management Programme (EMPr).

Rehabilitation refers to the measures that are undertaken to "as far as it is reasonably practicable, rehabilitate the environment affected by the development back to its natural or a predetermined state, or to a land use which conforms to the generally accepted principle of sustainable development". Where the intention is to return the land to its natural state, the objective will be to establish a self-sustaining, healthy indigenous ecosystem.

For the purposes of this project, the aim of the rehabilitation measures will be to return the land to its natural, pre-disturbance, state.

1.1 Rehabilitation Approach

It is vital to ensure that natural areas are correctly and sufficiently rehabilitated to re-establish proper ecosystem functioning. Rehabilitation measures are however generally costly and thus there needs to be financial assurance that these costs will be met, at the risk of harming the ecosystem more than supporting it.

The revegetation process that forms part of the larger rehabilitation process not only attempts to restore the natural ecosystem processes of the affected area, but also aims to impede the encroachment of Alien Invasive Plants (AIPs) and prevent erosion. The following general guidelines are recommended with regards to this process:

- The affected area must be re-shaped to a suitable topography and covered with a suitable naturally nutrient rich local topsoil material;
- Plants that are well-adapted to the prevailing local climatic conditions must be used. This essentially dictates that only locally indigenous species are to be used;
- Perennial species (plants that continue to grow each spring) must form the main component of the revegetation programme. Annual species (plants that only survive one growing season) do have a role, but only in providing rapid temporary cover in the initial stage of revegetation, or as a component within mixtures containing perennials;
- Good quality and local planting material and seed must be readily available with an assured source of supply;
- A combined approach to revegetation, i.e., both seed sowing and direct planting, is the best strategy to achieve the intended results of a suitable plant density and diversity; and
- Fauna tend to be overlooked in rehabilitation programmes but play critical roles in ecosystems and the introduction of specific indigenous fauna may be useful in certain cases.

In accordance with Mentis (2019), Figure 1-1 below illustrates a quick guide that may be used when selecting a site-specific re-vegetation method.

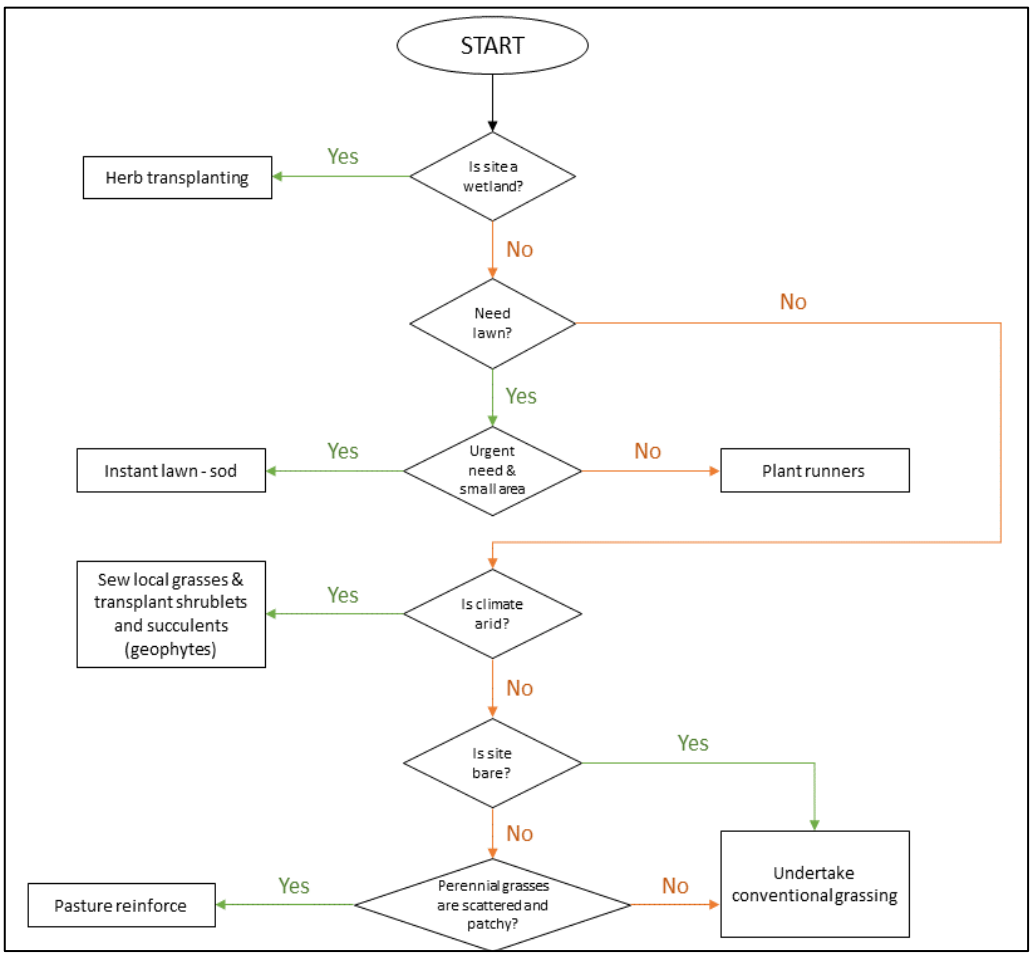

Figure 1-1 Selecting a re-vegetation method, adapted from Mentis (2019)

1.2 Terms of Reference

The following is applicable:

- Review of existing information related to the development;
- Compilation of a report detailing the results of the site visit; and
- Compilation of a rehabilitation plan, including a monitoring plan.

1.3 Assumptions and Limitations

The following limitations should be noted for the study:

- The assessment area was based on the spatial file provided by the client and any alterations to the development area presented may affect the results;
- The biodiversity assessments associated with the approved project EIA did not list any focus areas for rehabilitation; and
- All regional and site-specific environmental information is contained within original (submitted) documents, and this is therefore not repeated within this document. This document focuses only on the specific mandate as assigned.

2 Project Area

The Mulilo Struisbult PV2 solar energy facility is adjacent to the town of Copperton, between the larger towns of Prieska to the northeast and Vanwyksvlei to the southwest, in the Northern Cape. The project area overlaps with both the Bushmanland Arid Grassland and Bushmanland Basin Shrubland vegetation communities, known for their excessively hot and dry summers and very cold, frosty winters. Soils are typically 300 mm deep consisting of red-yellow apedal freely drained soils.

Figure 2-1 below presents of map of the project area overlayed with the associated planned project infrastructure.

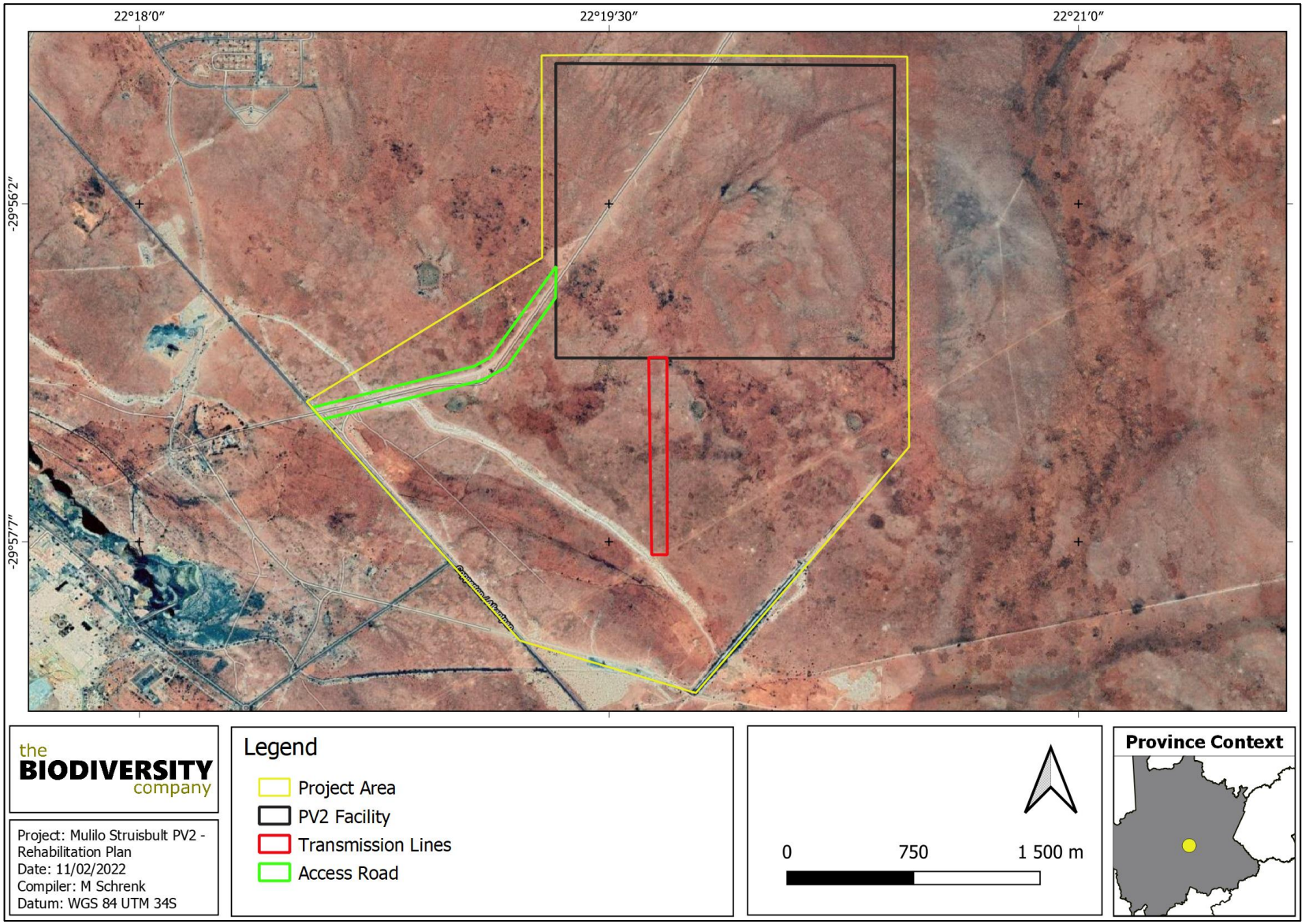

Figure 2-1 The location of the Mulilo Struisbult PV2 project area, including associated infrastructure

3 Methodology

3.1 Desktop Assessment

The following dataset, and its accompanying source, was reviewed for this study:

- The Vegetation of South Africa, Lesotho & Swaziland (SANBI, 2018).

The 2011 specialist botanical assessment (Bergwind, 2011), as well as the 2022 terrestrial ecology baseline assessment (TBC, 2022), both completed for the Mulilo Struisbult PV2 project and associated infrastructure, were both used for guidance on the state of the habitat and baseline species present in the area.

4 Results & Discussion

4.1 Desktop Vegetation Assessment

The project area is situated in the Nama-Karoo biome, which consists of three naturally fragmented Bioregions: Bushmanland & West Griqualand, Upper Karoo, and Lower Karoo. Together these make up a total of fourteen regional naturally fragmented vegetation types. The region is arid, where most rain falls in late summer thunderstorms and low rainfall is unreliable and droughts are unpredictable. Temperature extremes range from –5°C in winter to 43°C in summer and frost occurs widely across the region. (Mucina & Rutherford, 2006).

The soils, derived *in situ* under arid conditions from sedimentary rock, igneous intrusions (mainly Jurassic dolerites) and lime-rich evaporite, are generally base-rich, weakly structured and skeletal. The Nama-Karoo is a complex biome of extensive plains, dominated by dwarf shrubs (generally <1 m tall) intermixed with grasses, succulents, geophytes, and annual forbs – and small trees generally occur only along drainage lines or on rocky outcrops. (Mucina & Rutherford, 2006).

Rainfall intensity can be high in the Nama-Karoo with its predominantly convective rain. This, coupled with the generally low vegetation cover associated with aridity and with grazing pressure by domestic stock, raises the potential for soil erosion. In semi-arid environments most of the nutrients are located near the soil surface where they are vulnerable to loss through erosion actions. (Mucina & Rutherford, 2006).

On a finer scale the project area overlaps with both the Bushmanland Arid Grassland and the Bushmanland Basin Shrubland vegetation types (Figure 4-1).

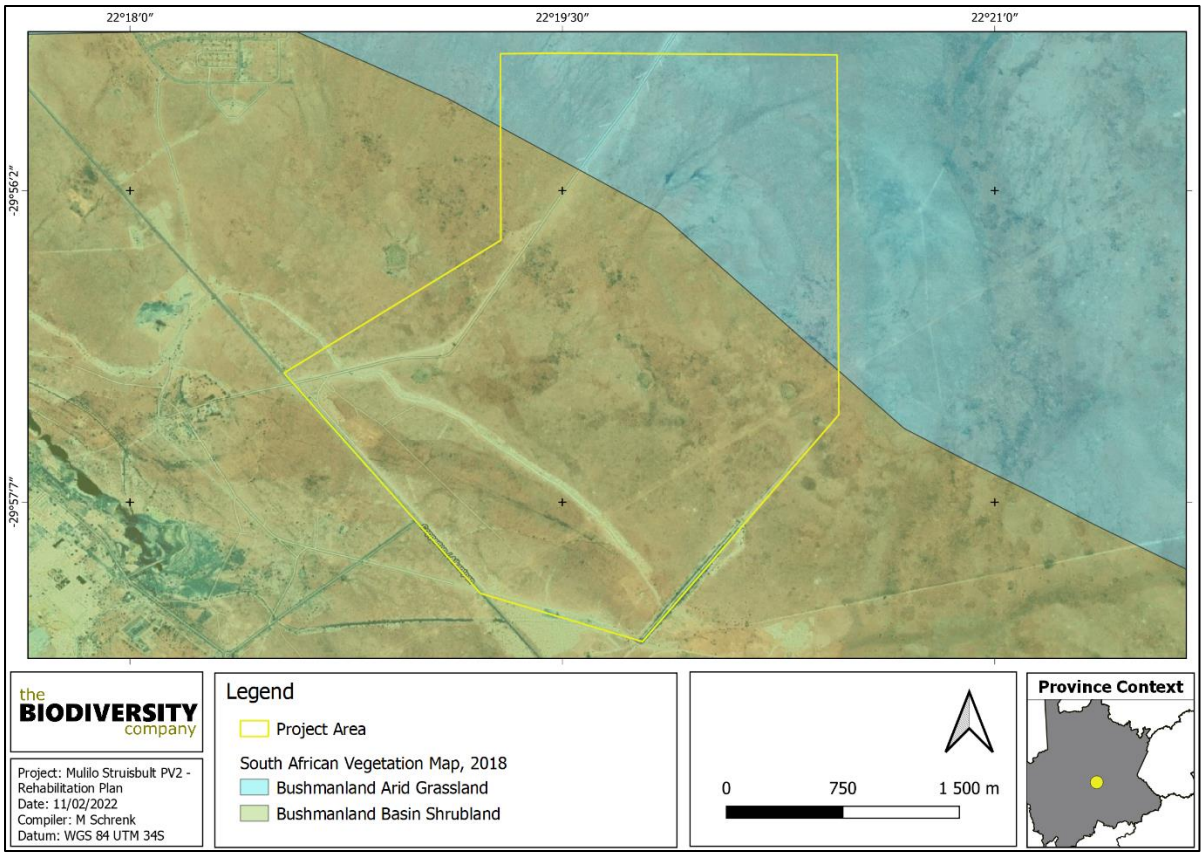

Figure 4-1 ***A map of the project area showing the local vegetation types based on the Vegetation Map of South Africa, Lesotho & Swaziland (SANBI, 2018)***

4.1.1 Bushmanland Arid Grassland

The Bushmanland Arid Grassland is made up of extensive to irregular plains on a slightly sloping plateau sparsely vegetated by grassland dominated by white grasses (*Stipagrostis* species) giving this vegetation type the character of semidesert 'steppe'. In places low shrubs of *Salsola* spp. change the vegetation structure. In years of abundant rainfall rich displays of annual herbs can be expected. The soils of most of the area are red-yellow apedal soils, freely drained, with a high base status and <300 mm deep. Rainfall occurs largely in late summer/early autumn and Mean Annual Precipitation (MAP) is around 200 mm. (Mucina & Rutherford, 2006).

Important Plant Taxa:

Graminoids: *Aristida adscensionis, A. congesta, Enneapogon desvauxii, Eragrostis nindensis, Schmidtia kalahariensis, Stipagrostis ciliata, S. obtusa, Cenchrus ciliaris, Enneapogon scaber, Eragrostis annulata, E. porosa, E. procumbens, Panicum lanipes, Setaria verticillata, Sporobolus nervosus, Stipagrostis brevifolia, S. uniplumis, Tragus berteronianus, T. racemosus.*

Small Trees: *Senegalia mellifera subsp. detinens, Boscia foetida subsp. foetida.*

Tall Shrubs*: Lycium cinereum, Rhigozum trichotomum, Cadaba aphylla, Parkinsonia africana.*

Low Shrubs*: Aptosimum spinescens, Hermannia spinosa, Pentzia spinescens, Aizoon asbestinum, A. schellenbergii, Aptosimum elongatum, A. lineare, A. marlothii, Barleria rigida,*

Berkheya annectens, Blepharis mitrata, Eriocephalus ambiguus, E. spinescens, Limeum aethiopicum, Lophiocarpus polystachyus, Monechma incanum, M. spartioides, Pentzia pinnatisecta, Phaeoptilum spinosum, Polygala seminuda, Pteronia leucoclada, P. mucronata, P. sordida, Rosenia humilis, Senecio niveus, Sericocoma avolans, Solanum capense, Talinum arnotii, Tetragonia arbuscula, Zygophyllum microphyllum.

Succulent Shrubs*: Kleinia longiflora, Lycium bosciifolium, Salsola tuberculata, S. glabrescens.*

Herbs: *Acanthopsis hoffmannseggiana, Aizoon canariense, Amaranthus praetermissus, Barleria lichtensteiniana, Chamaesyce inaequilatera, Dicoma capensis, Indigastrum argyraeum, Lotononis platycarpa, Sesamum capense, Tribulus pterophorus, T. terrestris, Vahlia capensis.*

Succulent Herbs*: Gisekia pharnacioides, Psilocaulon coriarium, Trianthema parvifolia.*

Geophytic Herb: *Moraea venenata.*

Biogeographically Important Taxon:

Succulent Herb: *Tridentea dwequensis.* (Endemic to Bushmanland).

Endemic Taxa:

Succulent Shrubs: *Dinteranthus pole-evansii, Larryleachia dinteri, L. marlothii, Ruschia kenhardtensis.*

Herbs: *Lotononis oligocephala, Nemesia maxii.*

4.1.2 Bushmanland Basin Shrubland

The Bushmanland Basin Shrubland is made up slightly irregular plains with dwarf shrubland dominated by a mixture of low sturdy and spiny (and sometimes also succulent) shrubs (*Rhigozum, Salsola, Pentzia, Eriocephalus*), 'white' grasses (*Stipagrostis*) and in years of high rainfall also by abundant annuals such as species of *Gazania* and *Leysera.* Soils are shallow Glenrosa and Mispah forms, and, to a lesser extent, red-yellow apedal, freely drained soils with a high base status and usually <15% clay are also found. The salt content in these soils is very high. Rainfall occurs in late summer and early autumn and MAP ranges from about 100–200 mm. (Mucina & Rutherford, 2006).

Important Plant Taxa:

Tall Shrubs: *Lycium cinereum, Rhigozum trichotomum.*

Low Shrubs: *Aptosimum spinescens, Hermannia spinosa, Pentzia spinescens, Zygophyllum microphyllum, Aptosimum elongatum, A. marlothii, Berkheya annectens, Eriocephalus microphyllus var. pubescens, E. pauperrimus, E. spinescens, Felicia clavipilosa subsp. clavipilosa, Limeum aethiopicum, Osteospermum armatum, O. spinescens, Pegolettia retrofracta, Phaeoptilum spinosum, Plinthus karooicus, Polygala seminuda, Pteronia glauca, P. inflexa, P. leucoclada, P. mucronata, P. sordida, Rosenia humilis, Selago albida, Senecio niveus, Tetragonia arbuscula, Zygophyllum lichtensteinianum.*

Succulent Shrubs: *Salsola tuberculata, Aridaria noctiflora subsp. straminea, Brownanthus ciliatus subsp. ciliatus, Galenia sarcophylla, Lycium bosciifolium, Ruschia intricata, Salsola*

namibica, Sarcocaulon patersonii, S. salmoniflorum, Tripteris sinuata var. linearis, Zygophyllum flexuosum.

Semiparasitic Shrub: *Thesium hystrix.*

Herbs: *Gazania lichtensteinii, Leysera tenella, Amaranthus praetermissus, Chamaesyce inaequilatera, Dicoma capensis, Indigastrum argyraeum, Lepidium desertorum, Monsonia umbellata, Radyera urens, Sesamum capense, Tribulus terrestris, T. zeyheri.*

Succulent Herbs: *Mesembryanthemum crystallinum, M. stenandrum, Trianthema parvifolia, Zygophyllum simplex.*

Graminoids: *Aristida adscensionis, Enneapogon desvauxii, Stipagrostis ciliata, S. obtusa, Aristida congesta, Enneapogon scaber, Stipagrostis anomala, Tragus berteronianus, T. racemosus.*

Biogeographically Important Taxon:

Succulent Herb: *Tridentea dwequensis.* (Endemic to Bushmanland).

Endemic Taxa:

Herb: *Cromidon minutum*.

Geophytic Herbs: *Ornithogalum bicornutum, O. ovatum subsp. oliverorum*.

4.2 Field Survey Summary

The vegetation assessment conducted by Bergwind (2011) proposes that the project area may be categorised by three distinct local vegetation covers: *Rhigozum trichotomum* Shrubland (southwestern portion of the project area), Asteraceous Shrubland (most extensive, covering all other portions), and *Stipagrostis* Grassland (occurring mostly within the centre of the planned PV2 facility).

Bergwind (2011) discussed the substrate of each cover as an additional consideration, such that:

- *Rhigozum trichotomum* Shrubland is made up of Sandy soil at least 150 mm deep;
- Asteraceous Shrubland is made up of shallow soil over bedrock, often calcrete; and
- *Stipagrostis* Grassland is made up of deep (> 200 mm) red sandy soil.

The extensive Asteraceous Shrubland has the highest species richness of all vegetation covers in the project area, consisting of low shrubs with patchy grasses and some additional herbaceous species (Bergwind, 2011). The invasive *Prosopis glandulosa* has invaded large areas, but its occurrence is relatively dispersed.

A full list of the species recorded by Bergwind (2011), and TBC (2022), is shown in Table 4-1 below. This is by no means a comprehensive species list for the area but should rather be seen as highlighting the dominant species that occur. As noted by Mucina and Rutherford (2006), consistent rain in the region often leads to the sprouting of rich varieties of annual herbs, and therefore the indigenous seedbank for the area may be considered to be of a high quality and diversity.

The purpose of providing this list is to assist with the compilation of the required species for the revegetation of the rehabilitated areas. More information on the specific species to be used for particular instances can be found in Section 5.4 below.

Table 4-1 Plant species recorded within the indigenous vegetation community (Bergwind (2011) & TBC (2022))

Family	Taxon	Red-List Status (SANBI, 2016)	Ecology
Hyacinthaceae	*Albuca sp.*		Indigenous
Scrophulariaceae	*Aptosimum sp.*	LC	Indigenous
Amaranthaceae	*Atriplex vestita*	LC	Indigenous
Asteraceae	*Berkheya annectens*	LC	Indigenous
Hyacinthaceae	*Dipcadi sp.*	LC	Indigenous
Poaceae	*Enneapogon desvauxii*	LC	Indigenous, Endemic
Asteraceae	*Eriocephalus microphyllus var. pubescens*	LC	Indigenous
Aizoaceae	*Galenia africana*	LC	Indigenous
Asteraceae	*Geigeria filifolia*	LC	Indigenous
Hyacinthaceae	*Ledebouria sp.*		Indigenous
Solanaceae	*Lycium cinereum*	LC	Indigenous
Solanaceae	*Lycium sp.*	LC	Indigenous
Acanthaceae	*Monechma sp.*	LC	Indigenous
Asteraceae	*Pentzia incana*	LC	Indigenous
Aizoaceae	*Plinthus karooicus*	LC	Indigenous
Asteraceae	*Pteronia incana*	LC	Indigenous, Endemic
Asteraceae	*Pteronia sp.*		Indigenous
Bignoniaceae	*Rhigozum trichotomum*	LC	Indigenous
Aizoaceae	*Ruschia intricata*	LC	Indigenous
Aizoaceae	*Ruschia sp.*		Indigenous
Amaranthaceae	*Salsola sp.*		Indigenous
Amaranthaceae	*Salsola tuberculata*	DDT	Indigenous
Amaranthaceae	*Sarcocaulon sp.*		Indigenous
Poaceae	*Stipagrostis ciliata*	LC	Indigenous
Poaceae	*Stipagrostis obtusa*	LC	Indigenous
Poaceae	*Stipagrostis sp.*	LC	Indigenous
Zygophyllaceae	*Zygophyllum microphyllum*	LC	Indigenous, Endemic

Figure 4-2 below highlights the areas that should be avoided during construction (unless delineated for approved infrustructure such as the roads, powerlines, and PV2 facility), these are the same areas that must be prioritised for revegetation and rehabilitation after the construction phase has ended (ideally before operational phase start). After the operational phase, and as part of project closure, all impacted areas must be prioritised for rehabilitation.

All areas that are disturbed or denuded as a result of construction activities must be rehabilitated as soon as possible and ideally before the operational phase commences.

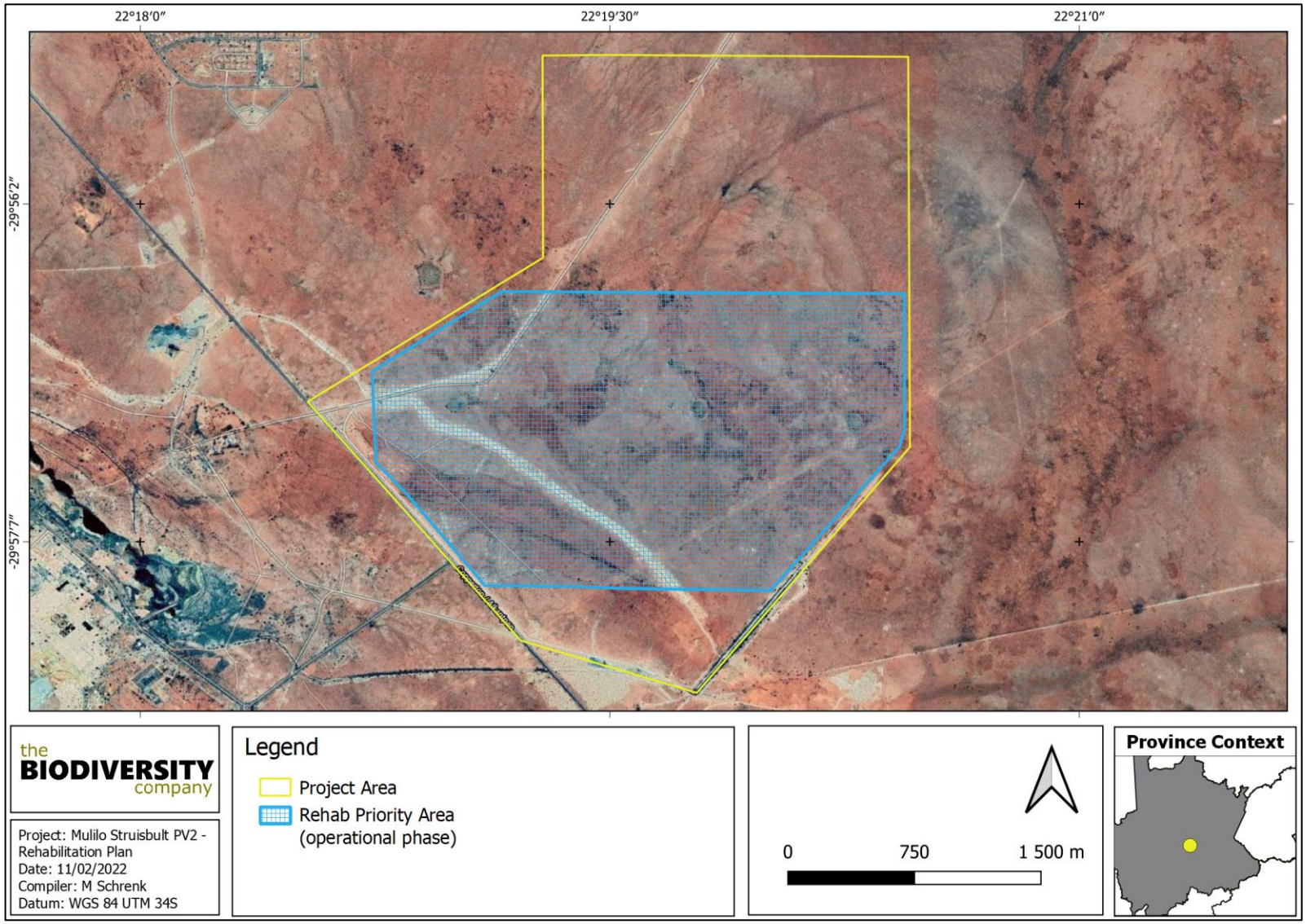

Figure 4-2 The areas that should be prioritised for rehabilitation as soon as possible, once clearing and construction commences

5 Rehabilitation Plan

5.1 Purpose of the rehabilitation plan

The purpose of this report is to establish sound environmental principles and guidelines that ensure the rehabilitation and revegetation of cleared areas within the project area, in order to achieve the following:

- Restore the natural topography and landscape shape of the area to support the natural runoff of water and growth of local vegetation;
- Reduce the risk of soil erosion in order to achieve the long-term stability of the natural landscape and nutrient bearing top-soil;
- Re-establish the vegetation cover with suitable indigenous plant species; and
- Restore a healthy level of ecosystem functioning to the rehabilitated area.

Timing is one of the main factors that have an influence on the restoration process of an area, and it often takes several years for an area to restore itself to its original state once the correct rehabilitation procedures have been followed.

This Re-vegetation and Habitat Rehabilitation Plan should be closely aligned with other site-specific plans developed as per the project EMPr, including the Erosion Management Plan, Storm Water Management Plan, Alien Invasive Plant Management Plan, and Plant Rescue and Protection Plan.

5.2 Shaping of the natural topography

The natural slope or topography of the area that has been affected by the clearing and development activities (for example, as a result of the large earth moving machinery) needs to be restored in order to ensure that the flow of water and the growth of vegetation can re-occur naturally. The re-adjustment of the topography will also improve the general aesthetics of the area.

No existing or emerging vegetation should be destroyed or damaged during this process and where plants are emerging sloping should be done in a carefully controlled manner such as through the use of a hand shovel. In instances where heavy machinery will be used, the areas where indigenous plants occur, and are emerging, should be avoided as far as possible. To support the rapid emergence of the natural vegetation the rehabilitation must be performed progressively as the construction continues.

The following are methods that can be used to reshape and maintain the slope of the area:

Sandbags

Only biodegradable bags are to be used, this includes Geojute sacks or similar. No plastic bags may be utilised. The bags must be filled with a sand or rock mixture and under no circumstances may any contaminants be put into the bags (i.e., cementitious material, soil with chemical spill or fuel etc.). This must be checked by the Environmental Control Officer (ECO).

Terracing and Soil Stabilisation

Rows of straw, hay, or bundles of cut vegetation or logs may be used for this process. The hay, straw or vegetation is dug into the soil in contours at strategic points, in order to help slow surface wash and capture eroded soil. The spacing between rows would be dependent on slope and the specific area features (refer to Figure 5-1 below for the slope found in the project area). Sections with steeper gradients should be the priority for the application of soil stabilisation techniques. Only use biodegradable untreated twine to bind bundles.

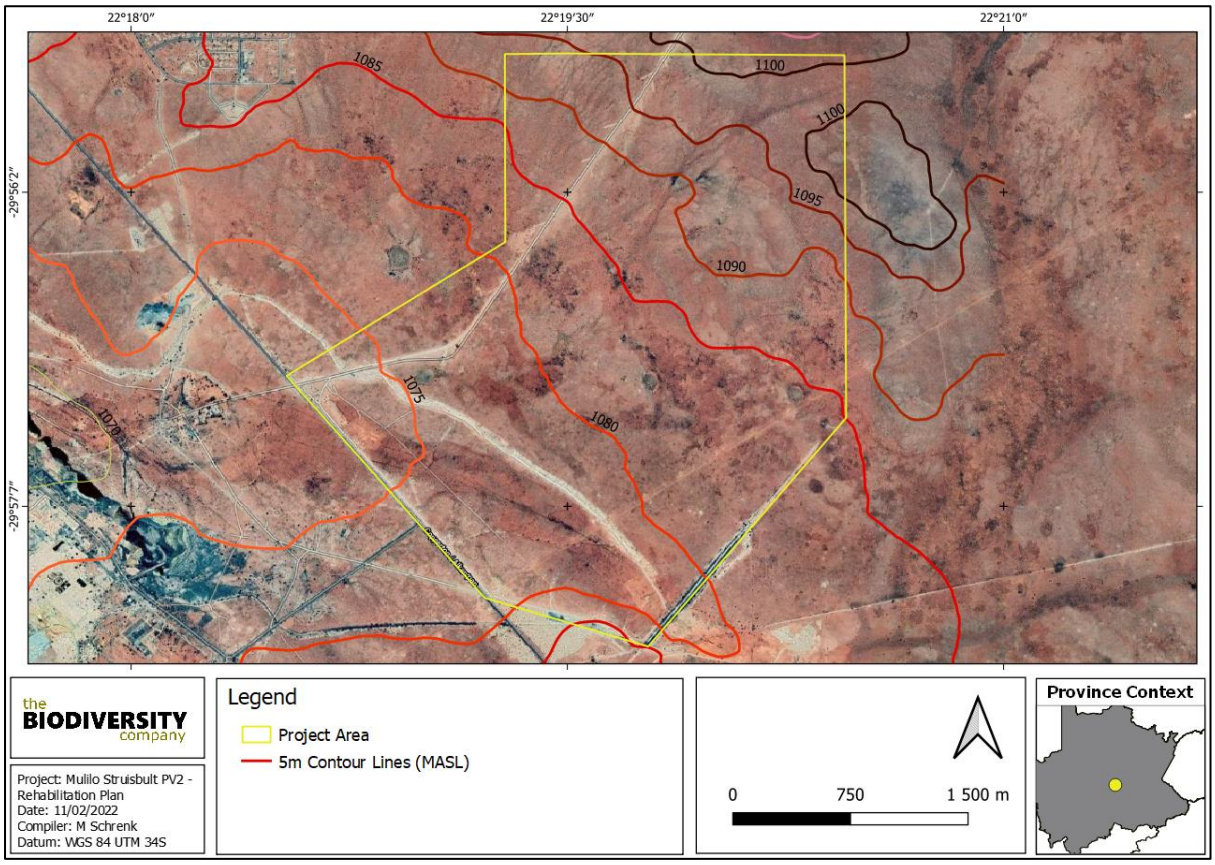

Figure 5-1 The 5m contour lines of the project area, illustrating the slope of the various sections

Fascine Work

During the site clearing process logs and/or branches must be kept so that they may be later utilised in the rehabilitation process. These can form the vertical peg supports for the fascine system, which are driven into the ground leaving approximately one third of the total length exposed. Horizontal pieces of wood and/or tree stem cuttings are then bundled together with biodegradable untreated twine and secured behind the vertical peg supports, or the net rolls may be used as described below. Bundles can be approximately 25 cm in diameter, and the trenches that support each bundle should be slightly wider and deeper. The spacing of rows of fascine is site specific and their layout might differ in the various parts of the project area based on the slope. Spacing generally varies from 0.9 to 2.5 m, with erosion prone sites requiring closer spacing. It is important that water channelling be prevented by using alternatively placed pegs. An example of this system is shown in Figure 5-2.

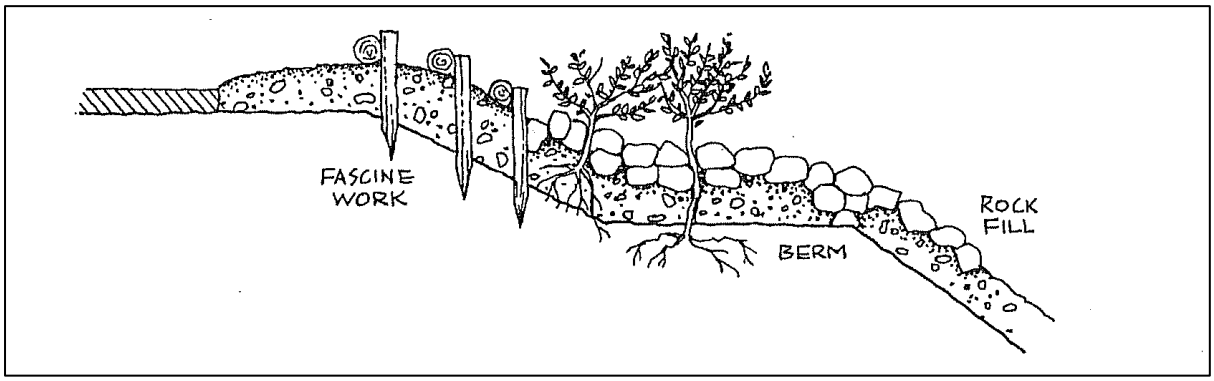

Figure 5-2 Slope stabilization (eThekweni Municipality Generic EMP for Construction Activities, 2002)

Fascines are highly useful for slopes experiencing light to moderate erosion, where individual cuttings, seedlings, or seeds would quickly wash away, thereby severely impeding rehabilitation work (AWES, 2020).

Geojute Netting

Biodegradable netting or matting can also be utilised on slopes to protect the soil from wind and water erosion. This assists with soil retention, weed control and vegetation establishment. Plants can be installed by making small incisions for planting. This would be an effective method in this area due to the high level of wind present over open sections of land. It is however important that this cannot be placed over existing vegetation growth and can only be used right after the sloping has been performed.

Geojute Rolls

Cylindrical rolls of Geojute fabric filled with sand (as described in the sandbag section) are effective on slopes and over large cleared areas. This method is very effective in assisting with erosion control. Geojute rolls are kept in place with the use of pegs (dead Alien Invasive Plant material can be utilised for this).

Gabion Baskets and Reno Mattresses

These represent hard engineering solutions to be applied over steep slopes and banks; in this instance the solution is not relevant within the project area as there are no steep slopes and none are likely to be created. A steep slope may considered one that has a gradient of 1:1 (vertical: horizontal) or greater.

These methods may be utilised in areas where drainage and flooding is a priority concern. Gabion baskets are 1m x 1m x 1m wire baskets that are filled with uniform sizes rocks. Reno mattresses are generally used to cover a larger area and are made of flat baskets filled with uniformly sized rocks. These two features are often used to enhance and support one another.

Note

Each of the solutions presented above are only effective and successful when a qualified and experienced contractor is appointed to build and install the systems. Many systems fail, resulting in environmental damage and wasted budget, due to poor and/or rushed installation.

5.3 Soil Management

Following responsible soil management guidelines is very important and this involves the correct storage of the topsoil layer to ensure that the subsequent rehabilitation process can be done successfully. The topsoil must be properly retained so that the seedbank and nutrients can be conserved for the rehabilitation process. The management of the topsoil must follow all mitigations stipulated in the EMPr, the following points serve as general guidelines only:

- The correct depth of topsoil needs to be stored. It is generally recommended that the top 25 cm be stored. Unless otherwise advised by a soil specialist;
- Topsoil may not be mixed with other soil layers as this will dilute the nutrient level and reduce the number of seeds per square meter. This could also hinder seed germination;
- Topsoil must only be handled twice, once to strip and stockpile and once for rehabilitation (laydown and landscaping);
- Topsoil must be stored separately, away from overburden, and must be reapplied progressively and these application areas demarcated as no go areas. Topsoil must ideally be stored for no more than 3 months;
- The topsoil heaps should not exceed 1 m in height, ensuring that micro-organisms are not lost;
- Topsoil should not be stripped when wet as compaction will occur;
- The topsoil must be stored away from drainage lines or flood plains;
- Sediment fencing is to be placed down slope and upslope of the stockpile, to prevent the runoff of sediment of the stockpile and runoff of the upslope natural area onto the stockpile; and
- The stockpile must be protected from wind erosion, especially in this highly wind prone area. Wind nests must be erected to avoid the erosion of the topsoil stockpile, and once the topsoil is replaced.

5.4 Re-vegetation of the area

The area to be revegetated should follow an appropriate indigenous landscaping approach. Locally occurring indigenous vegetation is usually sourced from nurseries and not from the natural landscape, this is with the exception of important plants and seeds that should have been collected prior to the removal of vegetation (according to the Plant Rescue and Protection Plan). Post-construction, any plants that were stored in the temporary nursery must be appropriately replanted. Before the revegetation can take place, the soil consistency must be improved (through amelioration techniques) and matched to adjacent areas. The following general guidelines must be followed:

- Before seeding, any topsoil and mulched vegetation should be spread across the bare soil areas to a depth of 50 mm and should not be thicker than 100 mm;

- The project area contains certain indigenous pioneer species that can be left (or re-planted) to create an initial plant cover, ensure short-term soil stability, and create appropriate fine-scale conditions for the future planting and sowing of indigenous plants. These species comprise of:
    - *Salsola tuberculate*;
    - *Rhigozum trichotomum*;
    - *Pentzia incana*; and
    - *Pteronia incana*.
- Indigenous grass species should be used for initial revegetation purposes. These should include species that are local to the area including:
    - *Stipagrostis ciliate*;
    - *Stipagrostis obtusa*; and
    - *Enneapogon desvauxii.*
- Re-grassing should be undertaken during the summer months, as germination and establishment is optimum at this time of year;
- Re-grassing can be done by hand broadcasting and/or hydro-seeding, the best approach must be decided by the ECO once the local conditions are closely examined and budgeting is finalised;
- Grass species must be used in conjunction with perennial species as well as those plants that were rescued during the plant relocation programme. *Rhigozum trichotomum* was ubiquitous within the landscape and appeared to be tolerant of disturbance. Consequently, those individuals that had been displaced during the construction activity can be used for revegetation;
- Shrubs indigenous, and ideally endemic to the area should also be used for rehabilitation purposes. However, it is unlikely that these plants are available commercially and a permit should be obtained from the provincial department to collect seed material to propagate these species for rehabilitation. These should include some dominant species in the area such as:
    - *Zygophyllum microphyllum;*
    - *Eriocephalus microphyllus var. pubescens;*
    - *Plinthus karooicus; and*
    - *Lycium cinereum.*
- Should plants be acquired from nurseries, they must adhere to a specific set of specifications: locally indigenous, plant size, height, and overall health. Final decisions must be made by the ECO or a specialist botanist. It is important that the plants sourced do not carry pests or diseases that could spread to the local flora;

- The planting of all plant species must be according to standard horticultural best practices. If the ECO is unfamiliar with these then a specialist horticulturalist must be consulted;
- The entire area will have to be irrigated on a regular basis over the first three months at least, in order to increase the vegetation yield. Irrigation should be regular enough to ensure that the soil layer is saturated, but without causing erosion or surface run and without oversaturating the soil which will cause root rot and kill off many sensitive small shrub and geophyte species;
- General maintenance must be performed. This will involve alien and weed control as well as the regular thinning of unwanted plant encroachment. Continuous weed control is critical to ensure the success of revegetation and should be a high priority. Weeding around indigenous plants may be necessary to avoid competition and stress. This should be carried out as required; and
- The project area under rehabilitation is to be left undisturbed and all access prohibited, except when maintenance is being undertaken; livestock and domestic animals must be kept out of the area as far as possible. In order to allow the movement of indigenous fauna, the use of closed face fences must be restricted, and brush cut should rather be used.

5.5 Alien Invasive Vegetation

The process of rehabilitation and revegetation, along with the original disturbances, will lead to a reoccurrence of alien invasive species as their seed bank becomes activated. It is thus very important to continue implementing the Alien Invasive Plant Management Plan and to continue the monitoring of all areas. The two main AIP species of concern recorded within the area include:

- *Prosopis glandulosa* (Honey Mesquite); and
- *Salsola kali* (Tumbleweed).

5.6 Monitoring

Regular monitoring and maintenance (such as removing all alien species and encroachment) is required for successful and sustainable revegetation/rehabilitation projects. Monitoring includes the capturing of photo points (always at the same GPS Location and in the same direction) and the documentation of observations. Monitoring of the rehabilitation must be conducted by an independent party that specialises in botany or ecology, along with the ECO. A simple example of a monitoring report can be found in Appendix A. The following are the principles and features that need to be followed:

- Rehabilitated areas must be monitored continuously for AIP growth;
- It is recommended that monitoring occurs every three (3) months for the first two (2) years, and subsequently every six (6) for a further 3 years. This is due to the high sensitivity of some of the ecosystems within the landscape;

- The moisture levels must be monitored to ensure that neither drought nor overwatering is the cause for failed revegetation attempts;
- The disturbance level in the area must be monitored;
- The decrease in bare soil (as indigenous vegetation spreads) must be recorded by photographs and reported;
- The stability, health, and nature of the soil must be assessed;
- The composition and density of replanted vegetation, distinguishing between species introduced for initial revegetation only, and species that are part of the pre-determined desirable end state, must be monitored and recorded;
- Any areas showing erosion should be re-contoured and seeded with indigenous grasses or other locally occurring species which grow rapidly (pioneer species);
- Re-vegetated areas showing inadequate surface coverage (less than 20% within 12 months after revegetation) should be prepared once again and re-vegetated; and
- The monitoring of rehabilitation success, follow-up adaptive management, and the clearing of emerging AIPs should continue until acceptable plant cover has been reached. This must be confirmed by a botanical, horticultural, or ecological specialist.

5.7 Rehabilitation Plan Instructions

The step-by-step instructions for the rehabilitation plan are presented below and will ultimately assist in clarifying the end-to-end process:

1. Shaping of the natural slope:
    a) Remove all building rubble and general litter;
    b) Stabilise the slope utilising the most appropriate method for the area e.g., sandbags, create fascine work, or use Geojute netting/rolls; and
    c) Level healthy topsoil over the chosen slope correction methods. Ensure that the soil is organic and in a good natural state.
2. Re-vegetation:
    d) Mulch and manure the topsoil (apply organic amelioration techniques);
    e) Irrigate the area with clean water;
    f) Seed the area with indigenous pioneer grass and shrub species using an appropriate technique, replant perennial species and relocated species;
    g) Brush pack over the area, irrigate the area again (frequently but carefully); and
    h) Demarcate the rehabilitation area, use signage, and prevent access.

3. Monitor:

    i) Capture before and after photos;

    j) Compile a report of the species used, and their corresponding revegetation success;

    k) Monitor the weed and AIP species and encroachment; and

    l) Re-adjust the revegetation programme if the area does not reach adequate coverage, consult an appropriate specialist.

6 Conclusion

The Re-vegetation and Habitat Rehabilitation Plan must be implemented with care in this sensitive natural environment. Impacts such as erosion, soil movement, and habitat loss must be minimised and mitigated as far as possible, and the rehabilitation must aim to repair and assist in this regard. The goals of the rehabilitation plan are set out to be:

- Restore the natural topography and shape of the area;
- Reduce the risk of soil erosion in order to achieve the long-term stability of the landscape;
- Re-establish the natural vegetation cover with suitable indigenous plant species; and
- Restore a healthy level of ecosystem functioning to the rehabilitated area.

The plan is considered to have been successfully implemented when the above aspects have been sustainably achieved.

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Appendix A: Monitoring Report Example

DATE	PERSON PERFORMING THE MONITORING	ASPECT	ACTION	PROGRESS	EXPECTED DEADLINE	PHOTOS
		E.g., Topography	E.g., The natural slope or topography of the area has been restored: 1. Removal of all the building material and rocks and gravel lying around; 2. Backfilling and sloping of the area.	Partially completed		
		E.g., Vegetation and soil cover	E.g., The soil layer must be stabilised, and the vegetation community restored: 1. The bare soil areas need to be re-seeded, and brush piled; 2. Monitoring of the woody plant species emerging; 3. Density of vegetation and relation to grass species; 4. Soil wetness.	To be initiated		