

APPENDIX N: PLANTS SPECIES AND RELOCATION PLAN



SCIENTIFIC AQUATIC SERVICES

Reg No. 2003/078943/23
VAT Reg No. 4020235273
PO Box 751779
Gardenview
2047
Tel: 011 616 7893
Fax: 086 724 3132
Email: admin@sasenvgroup.co.za
www.sasenvironmental.co.za

**PLANT SPECIES PLAN, FLORAL/FAUNAL SEARCH AND
RESCUE PLAN AND LANDSCAPE MAINTENANCE PLAN
FOR THE PROPOSED MOKALA MANGANESE MINE (PTY)
LTD EXPANSION ACTIVITIES NEAR HOTAZEL,
NORTHERN CAPE**

Prepared for:

SLR Consulting (South Africa) (Pty) Ltd

August 2021

Prepared by:	Scientific Aquatic Services
Report author:	A. Mileson
Report Reviewer:	S. Staden (Pr. Sci. Nat.)
Report Reference:	SAS 202177
Date:	August 2021
Revised:	February 2022



SAS Environmental Group of Companies

TABLE OF CONTENTS

LIST OF FIGURES	iii
LIST OF TABLES	iii
1 INTRODUCTION	1
2 REFERENCE DOCUMENTATION	4
3 SCOPE OF THIS REPORT	4
4 METHOD OF ASSESSMENT	5
5 GA-MOGARA RIVER SYSTEM CHARACTERISATION	6
5.1 Ecological Status of the Sub-Quaternary Catchment [Department of Water and Sanitation (DWS) Resource Quality Services (RQS) PES/EIS Database].....	8
5.2 Ecological Status of the Study Area	9
6 CURRENT AND ANTICIPATED RISK TO THE GA-MOGARA RIVER	11
6.1 Local Impacts on the Ga-Mogara River.....	11
6.2 Anticipated Impacts of the proposed activities in the vicinity of the Ga-Mogara River	11
7 REHABILITATION FRAMEWORK	12
7.1 Objectives of the Rehabilitation Plan.....	13
7.2 Key Aspects of the Rehabilitation Plan.....	13
8 RESCUE AND RELOCATION PLAN	15
8.1 Principles of the Rescue and Relocation Plan	15
8.2 Legislative Requirements	16
8.3 Key Rehabilitation Challenges	17
8.4 Field Trials	18
8.5 Plant Species Plan.....	18
8.6 Landscape Plan	40
8.7 Faunal Species Plan	44
9 MONITORING REQUIREMENTS	45
9.1 Monitoring Philosophy and Requirements	45
10 CONCLUSION.....	48
11 REFERENCES	49
APPENDIX A: LEGAL REQUIREMENTS	51
APPENDIX B: ROLES & RESPONSIBILITIES, TRAINING	54
APPENDIX C: RECOMMENDED REVEGETATION REQUIREMENTS	55
APPENDIX D: RECOMMENDED FLORAL SPECIES.....	58
APPENDIX E: ALIEN FLORAL SPECIES CONTROL	61
APPENDIX F: GENERAL GUIDELINES FOR SPECIES TRANSLOCATION AND PROPAGATION	64



LIST OF FIGURES

Figure 1:	The study area, illustrating the proposed activities in relation to the delineated river for the plant rescue and relocation plan in relation to the surrounding areas.	3
Figure 2:	Portions of the assessed reach of the Gamagara River in February 2021. The alien invasive <i>Prosopis sp.</i> is illustrated in the photograph on the left.	7
Figure 3:	Representative photographs of various sections of the portion of the Ga-Mogara River assessed for rehabilitation in 2018. Top photos: Riparian zone. Bottom photos: River bed.....	7
Figure 4:	Cross section of the Plant Rescue and Relocation for the Ga-Mogara River....	40
Figure 5:	Landscape Plan for the relocation of rescued plants in the realigned Ga-Mogara River.	43

LIST OF TABLES

Table 1:	Summary of the ecological status of the sub-quaternary catchment (SQ) reach, D41K-02068 (Ga-Mogara River) based on the DWS RQS PES/EIS database.....	9
Table 2:	Summary of the conservation characteristics for the study area – falling within the Quarter Degree Square (QDS) 2722BB.	10
Table 3:	The rehabilitation plan (EMS, 2016), as pertaining to the rescue and relocation of flora within the affected Ga-Mogara River realignment, and relevant to the proposed expansion activities.....	12
Table 4:	Planned monitoring activities and report content.....	46



1 INTRODUCTION

Scientific Aquatic Services (SAS) was appointed to develop a Rescue and Relocation Plan, which includes a Plant Species Plan, Floral/Faunal Search and Rescue Plan and Landscape Maintenance Plan as part of the Water Use Licence Application (WULA) process for the proposed Mokala Mine expansion activities in the vicinity of the Ga-Mogara River, on the remaining extent of the farm Gloria 266 and the farms Kipling 271 and Umtu 281 near Hotazel, in the Northern Cape.

Mokala Manganese (Pty) Limited (Mokala) is an open cast manganese mine with approved infrastructure components comprising a dry crushing and screening plant; Waste Rock Dumps (WRDs), Run of Mine (ROM) stockpiles; topsoil stockpiles; water storage facilities; stormwater management infrastructure and mine-related support facilities such as workshops, stores, and offices. Additional approved activities include:

- The realignment of the R380 road on the farm Kipling 271 and across the remaining extent of the farm of Gloria 266;
- Upgrading of the intersection to the mine on portion 1 of the farm Gloria 266 also serving the existing Gloria Mine;
- The realignment of a section of the Ga-Mogara drainage channel within the existing river channel. This realignment extends onto the farm Umtu 281.

Scientific Terrestrial Services (STS) previously compiled a Rescue and Relocation Plan for the realignment of a section of the Ga-Mogara River (STS, 2018). The Rescue and Relocation Plan (RRP) prepared by STS (2018) is not superseded by this Plan, which is intended to complement the RRP developed by STS (2018).

In addition to preparing this RRP, SAS undertook a freshwater ecosystem ecological assessment to ascertain the Present Ecological State (PES) and Ecological Importance and Sensitivity (EIS) of the affected reach of the Ga-Mogara River. The portion of the Ga-Mogara River assessed for rehabilitation will be referred to as the “study area”.

The study area is located approximately 2.4 km northwest of the town of Hotazel and can be accessed via the R380 which crosses the Ga-Mogara River (Figures 1 & 2). The study area is located in a relatively undeveloped location, albeit one in which mining activities are expanding, contributing to cumulative impacts on the receiving freshwater environment.



Mokala is located in a semi-arid region, where water is valued as a scarce resource. The study area is situated in the catchment of the Ga-Mogara River, an ephemeral tributary of the Kuruman River in the Lower Vaal Water Management Area (Quaternary Drainage Region D41K). The episodic Ga-Mogara River and the associated aquifer have been the major source of water supply for a number of water users in the region. Episodic systems generally only flow or flood once in several years in response to extreme rainfall events, usually within their catchment.

This report serves to provide guidelines for the rescue and relocation of flora and fauna species, recommended Plant Species and a Landscape Maintenance Plan to ensure that the direct, indirect and cumulative impacts of the existing and proposed mining-related activities on the river are reduced in extent and severity. Rehabilitation techniques and designs form a key part of the proposed project and will be a critical component in ensuring that present conditions are maintained and that, where feasible, will be an improvement in the ecological functioning of the Ga-Mogara River. The RRP further advocates the use of several environmental management tools and mitigatory measures that are appropriate for the specific development. The RRP is a system that seeks to achieve a required end state and will describe the activities required for the rescue and relocation of flora and fauna currently found along the river.



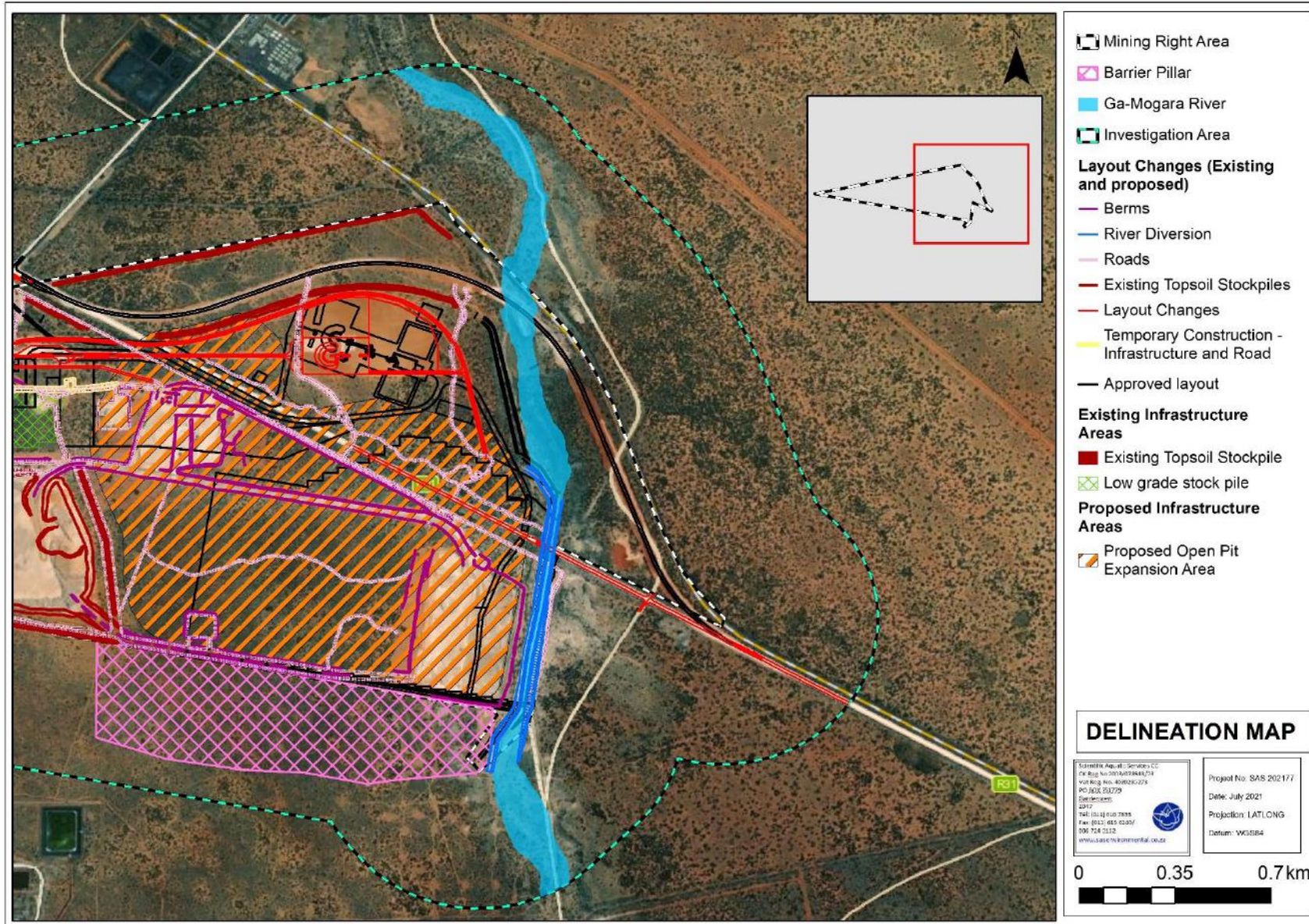


Figure 1: The study area, illustrating the proposed activities in relation to the delineated river for the plant rescue and relocation plan in relation to the surrounding areas.



2 REFERENCE DOCUMENTATION

This report is to be read in conjunction with the following documentation, which contains background to previous Biodiversity Specialist studies, the Rehabilitation plan for the Ga-Mogara River realignment and details pertaining to the designs and workings of the river realignment:

- Ecological Management Services (2015). Biodiversity survey report for the proposed Mokala Manganese Mine, Hotazel Northern Cape.
- Ecological Management Services (2016). Rehabilitation Plan for the proposed Gamogara Drainage channel in support of Section 21 (c) and (i) water uses for the Mokala Manganese Mine, Hotazel, Northern Cape.
- SLR Consulting (Africa) (Pty) Ltd. (2016). Integrated Storm Water Management Plan SWMP in support of WULA. SLR Project No.: 710.14003.00015. Report No.: Doc. no.1 Revision No.0, January 2017.
- SLR Consulting (South Africa) (Pty) Ltd. 2021. Scoping report for the changes to infrastructure at The Mokala Mine. Report Available for Public Review.
- Scientific Terrestrial Services (STS). 2018. Plant Species Plan, Floral/Faunal Search and Rescue Plan and Landscape Maintenance Plan for Mokala Manganese (Pty) Ltd Mine Near Hotazel, Northern Cape.
- Scientific Aquatic Services (SAS). 2021. Freshwater Ecological Assessment as Part of the Environmental and Water Use Authorisation Processes for the Proposed Mokala Mine Expansion Activities Near Hotazel, Northern Cape.

3 SCOPE OF THIS REPORT

Specific outcomes in terms of this report are outlined below. It is not the scope of this report to supersede the rehabilitation plan for the diverted reach of the Ga-Mogara River prepared by Ecological Management Services (2016) but rather to supplement it and provide additional rehabilitation guidelines for the adjacent riparian zones, and the sections of the river upstream and downstream of the diversion which may be indirectly impacted by activities other than the diversion.

- Development and implementation of a Floral and Faunal Search and Rescue Plan that includes:
 - The identification of species within the 100 m river Zone of Regulation (in terms of GN 704 as it relates to the National Water Act, 1998) suitable for removal. This



includes plant species lists, plant sizes, planting densities as well as total areas to be planted. Special attention will be given to protected floral species and species of conservation concern (SCC);

- Identification of areas within the river and 100 m Zone of Regulation within the Mokala Mine property where protected species can be relocated;
 - Development of a monitoring programme to evaluate the success of relocation; and
 - Development of a record keeping procedure to ensure the location of relocated protected species is documented.
- A Landscape Maintenance Plan will be developed to guide the relocation of the species within the disturbed portion of the river. A planting list will be indicated on the landscaping plan with reference to each area earmarked for revegetation;
- The location and habitat requirements of key identified floral and faunal species that require relocation will be compiled; and
- The report will include recommendations, action plans, relocation permits requirements (where necessary) and rescue and relocation processes.

It is the responsibility of the proponent to procure the required plants and hydroseeding mixtures and to appoint a suitable contractor to cost and implement the landscaping plan once it has been approved.

4 METHOD OF ASSESSMENT

In order to develop suitable mitigation and rescue and relocation measures for the proposed project, a field assessment was undertaken during February 2021. The extent of the floodline of the Ga-Mogara River was used as part of the investigation, within which species were identified, their approximate densities within the 100 m Zone of Regulation recorded, and notes taken on habitat requirements such as aspect and slope where these species occur. Any floral or faunal species of conservation concern (SCC) encountered during the field assessment were also identified for relocation.

To enhance the biodiversity and aesthetics of the area and for their specific function in the landscape such as erosion control, soil stabilisation and flood management, plant species were selected based on their suitability to the specific area and underlying surface and their compatibility with the surrounding region. Moreover, the use of indigenous species was prioritised as far as possible and feasible.



5 GA-MOGARA RIVER SYSTEM CHARACTERISATION

The following section contains data accessed from the freshwater report prepared by SAS (2021) as well as the biodiversity assessment (Ecological Management Services, 2015) the latter of which relied on databases such as the National Freshwater Ecosystem Priority Areas (NFEPA, 2011) database, National Protected Areas Expansion Strategy (2009), the Mining and Biodiversity Guidelines (2013) database and Mucina and Rutherford (2012). Additional databases were used to supplement the below information where deemed necessary, e.g. including information from the Department of Water and Sanitation (DWS) Resource Quality Services (RQS) PES/EIS Database. The background information, which forms part of a desktop assessment is summarised below and partly presented as a “dashboard” report (Tables 1-3).

The study area falls within the D41K catchment and forms part of the Ga-Mogara/Kuruman/Molopo/Orange River catchment. The river is episodic in spite of its large catchment (8100km²) due to the arid nature of the climate in the Northern Cape, as well as various landuses which have impacted on the recharge of the river. According to NFEPA, the section of the Ga-Mogara River associated with the Mokala Mine falls within an area that is classified as an upstream management area (Table 3), i.e. sub-quaternary catchments in which human activities need to be managed to prevent degradation of downstream river FEPAs and Fish Support Areas.

Within this section of the Ga-Mogara River, two zones can be distinguished, i.e. the river bed (containing a thick grass sward, dominated by *Cynodon* spp. and a tree/shrub layer consisting of *Prosopis* spp.) and the riparian zone¹ (refer to Figures 2 and 3 for photographic representation).

¹ According to the South African National Water Act (Act 36 of 1998), riparian zones are “the physical structure and associated vegetation of the areas associated with a watercourse which are commonly characterised by alluvial soils, and which are inundated or flooded to an extent and with a frequency sufficient to support vegetation of species with a composition and physical structure distinct from those of adjacent areas”.





Figure 2: Portions of the assessed reach of the Gamagara River in February 2021. The alien invasive *Prosopis sp.* is illustrated in the photograph on the left.



Figure 3: Representative photographs of various sections of the portion of the Ga-Mogara River assessed for rehabilitation in 2018. Top photos: Riparian zone. Bottom photos: River bed.

5.1 Ecological Status of the Sub-Quaternary Catchment

[Department of Water and Sanitation (DWS) Resource Quality Services (RQS) PES/EIS Database]

The PES/EIS database, as developed by the DWS RQS department, was utilised to obtain additional background information on the project area. The information from this database is based on information at a sub-quaternary catchment reach (subquat reach) level with the descriptions of the aquatic ecology based on the information collated by the DWS RQIS department from all reliable sources of reliable information such as SA River Health Program (RHP) sites, Ecological Water Requirements (EWR) sites and Hydro WMS sites.

In this regard information for the following sub-quaternary catchment reaches (SQRs) within the Southern Kalahari Aquatic Ecoregion are applicable. From the assessment of the PES/EIS data the following points are highlighted which summarise the data:

- D41K-02068 (Ga-Mogara River)

Key information on background conditions associated with the portion of the Ga-Mogara River to be diverted, as contained in this database and pertaining to the Present Ecological State (PES), Ecological Importance (EI) and Ecological Sensitivity (ES) for the various systems are tabulated in Table 2.

Results for the quaternary catchment and sub-quaternary catchments (Table 1) indicate that the Ga-Mogara River is characterised by very low ecological sensitivity because no instream vertebrates or riparian-wetland vegetation are present that are sensitive to flow changes, given the highly episodic character of the river (the database estimates that the river flows once every 13 years; however, prior to January 2021, the last documented year of flow was 1988). The Ga-Mogara River is not perceived to harbour vertebrate species that are rare or threatened, nor is species diversity very high; however, the vegetation is considered to be mostly natural with the exception of densification of *Prosopis sp.*, has a high integrity score and forms an important migratory link due to the continuity of the habitat. Therefore, the river is classified to be of moderate ecological importance. Finally, the moderately modified present ecological state of the Ga-Mogara River is attributed to moderate alterations to the riparian vegetation connectivity and riparian zones from the reference state.

The Ecological Importance (EI) data for SQR D41K-02068 (Ga-Mogara River) indicates that since the river is considered episodic, it is not able to support populations of fish or aquatic invertebrates. Summaries of the EI data for these three sub-quaternary reaches are presented in the tables below.



Table 1: Summary of the ecological status of the sub-quaternary catchment (SQ) reach, D41K-02068 (Ga-Mogara River) based on the DWS RQS PES/EIS database.

Synopsis SQR D41K-02068 (Ga-Mogara River)					
PES ¹ category median	Mean EI ² class	Mean ES ³ class	Length	Stream order	Default EC ⁴
C	Moderate	Very Low	21,28	3	C
PES details					
Instream habitat continuity MOD		None	Riparian/wetland zone MOD		Moderate
RIP/wetland zone continuity MOD		Moderate	Potential flow MOD activities		Small
Potential instream habitat MOD activities		None	Potential physico-chemical MOD activities		Small
EI details					
Fish spp/SQ		NA	Fish average confidence		NA
Fish representivity per secondary class		NA	Fish rarity per secondary class		NA
Invertebrate taxa/SQ		NA	Invertebrate average confidence		NA
Invertebrate representivity per secondary class		NA	Invertebrate rarity per secondary class		NA
EI importance: riparian-wetland-instream vertebrates (excluding fish) rating		Low	Habitat diversity class		Very Low
Habitat size (length) class		Very Low	Instream migration link class		NA
Riparian-wetland zone migration link		High	Riparian-wetland zone habitat integrity class		High
Instream habitat integrity class		NA	Riparian-wetland natural vegetation rating based on percentage natural vegetation in 500m		Very High
Riparian-wetland natural vegetation rating based on expert rating					Very Low
ES details					
Fish physical-chemical sensitivity description		NA	Fish no-flow sensitivity		NA
Invertebrates physical-chemical sensitivity description		NA	Invertebrates velocity sensitivity		NA
Riparian-wetland-instream vertebrates (excluding fish) intolerance water level/flow changes description					Very Low
Stream size sensitivity to modified flow/water level changes description					Low
Riparian-wetland vegetation intolerance to water level changes description					Very Low

¹ PES = Present Ecological State; confirmed in database that assessments were performed by expert assessors;

² EI = Ecological Importance;

³ ES = Ecological Sensitivity

⁴ EC = Ecological Category; default based on median PES and highest of EI or ES means.

5.2 Ecological Status of the Study Area

The following table contains data accessed as part of the desktop assessment. It is important to note that although all data sources used provide useful and often verifiable, high-quality data, the various databases do not always provide an entirely accurate indication of the actual biodiversity characteristics present within the site being investigated.



Table 2: Summary of the conservation characteristics for the study area – falling within the Quarter Degree Square (QDS) 2722BB.

DETAIL OF THE STUDY AREA IN TERMS OF THE NATIONAL FRESHWATER ECOSYSTEM PRIORITY AREA (NFEPA) (2011) DATABASE						
FEPACODE	The study area is considered to be an Upstream Management Area. FEPACODE 4: Upstream Management Catchments in which anthropogenic activities need to be managed to prevent the degradation of downstream river FEPAS and Fish Support Areas.					
NFEPA Wetlands	According to the NFEPA Database there is a natural channelled valley-bottom wetland to the east of the central section of the Ga-Mogara River to be diverted.					
NFEPA Rivers	The Ga-Mogara River runs parallel with the eastern border of the study area. The Ga-Mogara is considered to be in a moderately modified ecological condition (RIVCON C). The DWA's Present Ecological State 1999 indicates the Ga-Mogara River to be a Class B river that is largely in a natural state.					
Wetland vegetation Type	The study area is located within the Kalahari Duneveld (Least Threatened) Wetland Vegetation type.					
DETAILS OF THE STUDY AREA IN TERMS OF MUCINA & RUTHERFORD (2006)			DESCRIPTION OF THE VEGETATION TYPE(S) RELEVANT TO THE STUDY AREA (MUCINA & RUTHERFORD 2006)			
Biome	According to Mucina and Rutherford (2012), the study area is located within the Savanna Biome .	Vegetation Type	Gordonia Duneveld			
Bioregion	The proposed study area is situated within the Kalahari Duneveld Bioregion .	Climate	Summer and autumn rainfall with very dry winters.			
Vegetation Type	The proposed study area falls within the Gordonia Duneveld vegetation type.		Altitude (m)	MAP* (mm)	MAT* (°C)	MFD* (Days)
CONSERVATION DETAILS PERTAINING TO THE STUDY AREA (VARIOUS DATABASES)						
NBA (2011)	The study area is located within an area considered to be moderately protected .	Distribution	800–1 200 m	128	18.6	21
National Threatened Ecosystems (2011)	The study area falls within the remaining extent of the Gordonia Duneveld Ecosystem , which is considered to be a Least Concern Ecosystem .	Geology & Soils				2912
NPAES (2009)	According to the National Protected Areas Expansion Strategy (2009) database, the study area does not fall within a protected area or nature reserve, nor is it situated within 10km of a formal protected area.	Conservation				86
Centre of Endemism	The study area occurs within the Griqualand West Centre of Endemism – an area that could conserve a significant number of plant species that are restricted to the particular area.	Vegetation & landscape features	Northern Cape Province: Areas with dunes comprising the largest part of the South African side of the Kgalagadi Transfrontier Park.			
Ecological Support Area (ESA)	According to the 2016 Northern Cape Critical Biodiversity Areas database, the proposed section of the Ga-Mogara River that will be diverted falls within an Ecological Support Area. ESAs, together with Critical Biodiversity Areas (CBA's) and protected areas, are important for the persistence of a viable representative sample of all ecosystem types and species as well as the long-term ecological functioning of the landscape as a whole.		Aeolian sand underlain by superficial silcretes and calcretes of the Cenozoic Kalahari Group. Fixed parallel sand dunes, with Af land type almost exclusively.			
			Least threatened. Target 16%. Some 14% statutorily conserved in the Kgalagadi Transfrontier Park. Very little transformed. Generally low erosion, but some areas with spectacular destabilisation of normally vegetated dunes (through local overstocking) favoured by photographers. Erosion is normally very low.			
			Parallel dunes about 3–8 m above the plains. Open shrubland with ridges of grassland dominated by <i>Stipagrostis amabilis</i> on the dune crests and <i>Acacia haematoxylon</i> on the dune slopes, also with <i>A. mellifera</i> on lower slopes and <i>Rhigozum trichotomum</i> in the interdune straten.			
			Biogeographically Important Taxa (Kalahari endemics) Tall Shrub: <i>Vachellia haematoxylon</i> (d). Graminoids: <i>Stipagrostis amabilis</i> (d), <i>Anthephora argentea</i> , <i>Megaloprotachne albescens</i> . Herbs: <i>Helichrysum arenicola</i> , <i>Kohautia ramosissima</i> , <i>Neuradopsis austro-africana</i> .			
IMPORTANCE OF THE STUDY AREA ACCORDING TO THE MINING AND BIODIVERSITY GUIDELINES (2013)						
In terms of the mining and biodiversity guideline the study site does not fall into any biodiversity priority areas and is therefore not deemed a risk for mining. However, the river area above the planned mine is considered to be of the highest biodiversity importance.						

CBA = Critical Biodiversity Areas; ESA = Ecological Support Area; IBA = Important Bird and Biodiversity Areas; MAP – Mean annual precipitation; MAT – Mean annual temperature; MAPE – Mean annual potential evaporation; MFD = Mean Frost Days; MASMS – Mean annual soil moisture stress (% of days when evaporative demand was more than double the soil moisture supply); NBA = National Biodiversity Assessment; NPAES = National Protected Areas Expansion Strategy; SACAD = South African Conservation Areas Database, SAPAD = South African Protected Areas Database.



6 CURRENT AND ANTICIPATED RISK TO THE GA-MOGARA RIVER

6.1 Local Impacts on the Ga-Mogara River.

According to the Environmental Impact Assessment (EIA) undertaken in 2015 by SLR Consulting (South Africa) (SLR, 2015)² historic agricultural and mining activities have occurred that have impacted the Ga-Mogara River to some extent. SAS (2021) noted that impacts to the assessed reach of the river are relatively minimal, with the exception of the previously authorised river diversion, however, upstream impacts including mining and other river diversions. The most significant impact on the reach of the river within the study area is the loss of hydraulic connectivity as a result of the swallet formation upstream of the study area. Following heavy rainfall during February 2006, landowners in the vicinity of Sishen Mine (\pm 60 km south of the study area) noticed that the flow of the Ga-Mogara River had been interrupted, which prevented further downstream flow. Investigations found that river-bed swallets (sinkholes) had formed, as a result of dewatering activities³. These swallets have subsequently intercepted all surface flow, thus resulting in loss of recharge of the Ga-Mogara River downstream of Sishen Mine. Nevertheless, following above-average rainfall in the region over December 2020 and January 2021, the Ga-Mogara River flowed, resulting in parts of the town of Deben (situated north of Sishen Mine) becoming flooded, although the floodwaters did not reach as far north as Mokala.

Other modifiers of the system include altered vegetation communities, including alien floral proliferation which is attributed to past disturbances possibly cause by agricultural activities, small areas of localised erosion and bank incision, and road and bridge crossings.

6.2 Anticipated Impacts of the proposed activities in the vicinity of the Ga-Mogara River

SAS (2021) assessed the following activities associated with the proposed expansion:

- Expansion of the open pit;
- Proposed berms between the extended pit and the Ga-Mogara River,
- The Plant Area, High Grade and Run of Mine (ROM) stockpiles; and

² Environmental Impact Assessment and Environmental Management Programme Report for the Development of the Proposed Mokala Manganese Mine. Prepared for Mokala Manganese (Pty) Ltd, by SLR Consulting (Africa) (Pty) Ltd.



- An internal haul road located in the north-eastern portion of the Mokala Mining Right Area.

All other proposed activities are located to the west of the open cast pit which will intercept any potential impacts arising as a result of those activities, thus they were not assessed. SAS (2021) found that the majority of these activities are likely to be of very low to medium significance, provided that appropriate mitigation measures are implemented, including the implementation of this RRP in conjunction with the RRP developed by STS (2021).

7 REHABILITATION FRAMEWORK

The sections below serve to present a summary of the rehabilitation and management plan framework (EMS, 2016) that was developed for the portion of the Ga-Mogara River (and its associated riparian zone) affected by the proposed river diversion. It is included here as it remains relevant to the proposed expansion activities.

To identify and direct an optimal rehabilitation process, or to adopt the best possible/practicable rehabilitation approach, the desired outcomes of rehabilitation should be clear from the start. Therefore, it will be important to define a **reference ecosystem** that can aid in the planning, monitoring and evaluation of the rehabilitation activities.

A **reference ecosystem** is a model or benchmark to be achieved by the target(s) of the rehabilitation plan and should be representative of a non-degraded, local indigenous ecosystem. Often rehabilitation is required for ecosystems with a changing environment, e.g. ecosystems within urban settings, and a more achievable goal would be to define a reference ecosystem that is a version of the ecosystem if no degradation or disturbance have occurred, i.e. not the historic, pristine version of an ecosystem. It will additionally be important for a reference ecosystem to be of such a nature that it will be able to adapt to current, as well as anticipated, changes within the environment. *Standards Reference Group SERA (2017)*.

Table 3: The rehabilitation plan (EMS, 2016), as pertaining to the rescue and relocation of flora within the affected Ga-Mogara River realignment, and relevant to the proposed expansion activities.

Rehabilitation aim	The aim of this specific rehabilitation project would be to restore the section of river to its pre-diversion and pre-disturbance state in terms of morphology, hydrology and biodiversity.	
Management Units	River bed and riparian zone	
Rehabilitation target (i.e. reference ecosystem) according to the River Channel Realignment Rehabilitation Plan – Mokala Mine (EMS, 2016)	The target outcome for the planned realignment should be rehabilitation towards restoration.	
	River bed	Riparian Zone
	The current structure of the plant composition of the river bed contains a thick grass sward, dominated by <i>Cynodon dactylon</i> , and a tree/shrub layer consisting of <i>Prosopis</i> spp. These trees/shrubs have extensively invaded parts of the river bed. Thus, post	The vegetation found within the riparian zone consists of a grassy layer interspersed with dwarf shrubs, 350mm – 1m in height and a tree/shrub layer 4m-6m in height. This structural composition will have to be replicated for all areas disturbed by the proposed expansion



	disturbance structure would necessitate the absence of these alien invader trees/shrubs and therefore a thick grass sward (60% aerial coverage) dominated by <i>Cynodon dactylon</i> is the rehabilitation target for the river bed.	activities. However, the slow growth of the <i>Vachellia erioloba</i> trees will result in the structural composition not being replicated within the rehabilitation area within the life of the mine.
Long-term responsible authority:	Environmental Control Officer	

7.1 Objectives of the Rehabilitation Plan

Key objectives of the Rehabilitation Plan for the affected reach (excluding the diversion) of the Ga-Mogara River are:

- It should contain characteristic species that occur in the reference system;
- It should comprise indigenous species, although non-invasive exotic species may be utilised if absolutely required;
- The physical environment must be favourable for the establishment of species that will lead to stability;
- It functions normally for its stage of development;
- Potential threats to the system's stability are eliminated;
- It is self-sustaining to the same degree as the reference system;
- It should meet the requirements of relevant local and regional authorities;
- A range of mitigation measures should be identified which could reduce and mitigate the potential impacts on the receiving environment to minimal or acceptable levels (refer to SAS, 2021 for recommended mitigation measures);
- To maximise the service provision of Ga-Mogara River;
- To provide improved and more suitable habitat for faunal species;
- Ensure as far as is practicable that the measures contained in the report are implemented; and
- Propose mechanisms for monitoring compliance with the Rehabilitation Plan and reporting thereon.

7.2 Key Aspects of the Rehabilitation Plan

- Replanting activities are recommended to occur during the months of November – March as these months have the highest rainfall for the region. However, given the unreliable rainfall it may be necessary to supplement the natural precipitation in order to ensure that growth occurs. This can be done from groundwater sources, however boreholes should be used which show no contamination and with nitrate and sulphate values within the South African Water Quality Guidelines: Volume 7 Aquatic Ecosystems (DWAF1996);



- To ensure that the rehabilitated reach of the river resembles the reference state, the use of species that are present within the current river bed and riparian areas should be used for rescue and relocation as far as possible;
- Prior to any disturbance:
 - Plan topsoil stripping to take place after plant harvesting;
 - Seed collection should be done preferably between April and May. Grass seeds in particular should be harvested as well as any pods from *V. erioloba*. A suitable seed store will have to be established on site;
 - Geophytes, succulents, and suitable plants can be harvested and moved to a holding nursery for later use;
 - With respect to the tree and shrub species, particularly the pods from *V. erioloba*, it will be necessary to begin germinating these as soon as possible to ensure that there will be sufficient stock to replant;
- Perennial species should be prioritised to achieve vegetation cover over several seasons. Some annual species will also be required as they are often well adapted to stabilise soils and can grow well in poorer quality substrates;
- The footprint area of the opencast pit must remain as small as possible whilst allowing for economical and optimal extraction of the ore. Throughout the life of mine, non-essential personnel and non-essential vehicles are not to be permitted within the demarcated riparian zone. Special care must be taken to ensure that no waste relating to the construction or mining process is disposed of within the riparian habitat or the active channel of the Ga-Mogara River;
- Revegetation will need to take place following construction activities, to ensure soil stability and prevent erosion within the system and sedimentation of the system further downstream. It is preferable to establish as many perennial species as possible to ensure continued vegetation cover from season to season. However, a number of annual species will be required, as they are often more adept at stabilising soil and utilizing poorer quality substrate;
- If one has not already been developed, an alien and invasive plant (AIP) management plan should be developed during the planning stages to manage alien vegetation in all areas of disturbance, but particularly within the riparian zone, prior to the commencement of construction. This management plan must be implemented as soon as construction begins; and
- Upon finalisation and completion rehabilitation works along the river, the ECO must sign off on the diversion plan and execution thereof.



8 RESCUE AND RELOCATION PLAN

The proposed mining development will necessitate the construction of infrastructure, with specific mention of the proposed expansion of the open pit and diversion structure, which will encroach on the 100 m Zone of Regulation and on a portion of the Ga-Mogara River respectively, resulting in loss of riparian habitat, and increased risk of further modifications to the characteristics of the watercourse. Of particular concern is the potential for further loss of protected floral and faunal species present within the riparian habitat. According to the baseline ecological reports (EMS, 2016), the only plant species of concern are *Vachellia erioloba*, *Vachellia haematoxylon* and *Moraea longistyla*. However, during the field investigation undertaken by STS in 2018 additional species of concern were identified. No additional species were identified by SAS in February 2021. Furthermore, according to the Rehabilitation Plan (EMS, 2016), no faunal species of concern were observed; however, a number were listed as possible occurrences. Of these, only *Atelerix frontalis* (South African Hedgehog) is considered to be suitable for rescue and relocation. The remaining faunal species are large and free moving and as such will relocate on their own.

8.1 Principles of the Rescue and Relocation Plan

To assist in achieving the objectives of the Rescue and Relocation Plan, a set of principles were applied which contributed to formulating action plans and specific management measures, which include:

- Ensuring the persistence of the habitat within the Ga-Mogara River by maintaining ecological processes – i.e., the Rescue and Rehabilitation Plan will aim to achieve the Rehabilitation target set out in the Rehabilitation Plan (EMS, 2016) and RRP (STS, 2018);
- To maintain genetic diversity of vegetation associated with the Ga-Mogara River, indigenous species that are represented within the currently undisturbed Ga-Mogara River and associated riparian zone will be targeted for rescue and relocation;
- Meeting legislative requirements by ensuring no species of conservation concern or that are protected under the National Forest Act of 1998, or the Northern Cape Nature Conservation Act of 2009, may be removed, relocated or propagated without first obtaining the relevant permits or licences;
- Avoiding unnecessary loss of species and species diversity by appointing suitably qualified persons to perform the activities of the Rescue and Relocation Plan;
- Avoiding impacts by not performing environmentally detrimental actions;



- Minimising impacts by limiting aspects of an action, optimising processes, structural elements and other design features;
- Rectifying impacts through rehabilitation, restoration, etc. of the affected environment, including:
 - The removal of waste and construction rubble;
 - Rectifying bank incision and overall erosion of the system through stormwater management measures to avoid sedimentation;
 - Re-sloping of steep areas to an acceptable (safe and stable) slope;
 - Re-vegetation of steep areas and other rehabilitated areas;
 - Improvement of habitat diversity and the ecological niches available and the general improvement of available resources in the system; and
 - Enhancement of the visual character of the Ga-Mogara River.
- Providing ongoing monitoring and management of environmental impacts of a development and documenting of any digressions /good performances;
- As far as possible, flow continuity must be retained, and no structures may be placed within the active channel which prevent recharge of the downstream system; and
- Rehabilitation activities – such as revegetation, reprofiling /re-shaping of slopes and alien vegetation control may be necessary immediately downstream of directly disturbed areas. The ECO should monitor all downstream areas for evidence of impacts arising from the upstream activities and make recommendations for rehabilitation as deemed necessary.

8.2 Legislative Requirements

The following legislative requirements were considered during the assessment:

- National Environmental Management Act (NEMA) (Act No. 107 of 1998);
- National Environmental Management: Biodiversity Act (NEMBA) (Act No. 10 of 2004);
- Conservation of Agricultural Resources Act (CARA, Act No. 43 of 1983);
- The National Forests Act (NFA) (Act No.84 of 1998); and
- The Northern Cape Nature Conservation Act (NCNCA) (Act. No. 9 of 2009).

According to the Northern Cape Nature Conservation Act of 2009 (NCNCA), permits are required for the picking, import, export, transport, cultivation or the trade in a protected plant. The following floral families were present and are of relevance to the Rescue and Relocation Plan for the Ga-Mogara River: Aizoaceae, Amaryllidaceae and Iridaceae (see section 8.7). Additionally, in terms of the National Forests Act (NFA) of 1998, protected tree species may not be cut, disturbed, damaged, destroyed and their products may not be possessed,



collected, removed, transported, exported, donated, purchased or sold without a license granted by the Department of Water Affairs and Forestry (or a delegated authority). Only two protected tree species listed under the NFA was observed within the study area, i.e *Vachellia erioloba* and *Vachellia haematoxylon*.

Permit applications for the removal, translocation and/or propagation of protected plant species should be made to the responsible official in each province at least a month prior to the planned activities.

8.3 Key Rehabilitation Challenges

The Rehabilitation Plan titled “Rehabilitation Plan for the proposed Ga-Mogara drainage channel in support of section 21 (c) and (i) water uses for the Mokala Manganese Mine, Hotazel, Northern Cape.” was compiled by (ESM, 2016). The following key rehabilitation challenges (EMS, 2016) were identified and have the potential to impact the success of the rescue and relocation including revegetation of the reach of the Ga-Mogara River within the study area.

- **Establishing Seedlings:** There are numerous factors limiting the establishment and survival of seedlings in arid and semi-arid areas, these include nutrient deficiency, lack of moisture, predation, sand movement etc. It is usually increased moisture events that triggers rapid seedling recruitment. Access to ground water is also an important factor in this ecosystem. The deep-rooted species such as *Vachellia erioloba*, are thought to provide water and nutrients to shallower-rooted plants via hydraulic lift and are therefore considered important in ecological processes by making available resources for the biodiversity in an area that would otherwise not be available. Thus, the absence of these keystone species can have a detrimental impact on seedling recruitment;
- **Low Rainfall:** Hotazel receives a low annual rainfall (just more than 200 mm a year). This area has therefore been described as a semi-arid environment. A limiting factor in arid and semi-arid environments for seedling establishment is moisture availability, which is directly related to rainfall timing and quantity. Rehabilitation in this area is therefore likely to be a slow process due to the restrictions imposed by water availability;
- **Low soil nutrient content:** Soils that have been through processing plants or stored incorrectly or for an excessive period are also devoid of nutrients (Carrick and Kruger, 2007). Successful vegetation establishment is linked to nutrient availability. Low soil



nutrient content may restrict the rehabilitation process by retarding or inhibiting new growth;

- **Sand Burial:** Burial in sand is an important factor that controls vegetation distribution and composition in arid and semi-arid areas. Sand deposition can continue to a point but if it continues in excess even sand-tolerant species are likely to be eliminated and bare ground will result once again. Thus, whilst reducing sand movement to allow seedling establishment is important, it is not necessary (nor desirable) to try and eliminate sand movement altogether;
- **Sand stabilisation:** Sand stabilisation is an important aspect of rehabilitation in many arid and semi-arid areas (Weber et al., 1989). Various mechanical windbreaks such as nets, brushwood barriers and other such features provides some stabilisation of the soil, minimising the impact of wind erosion and sandblasting of transplants, and also serving to trap seed and aide in the germination and establishment of seedlings (van der Merwe, 2004). Windbreaks serve their purpose in sand stabilisation, but when used in a rehabilitation strategy it must be realised that, as soon as suitable cover has been established, the windbreaks must be removed (van der Merwe, 2005);
- **Wind Erosion:** A primary erosive force in arid and semi-arid areas is wind (Carrick and Kruger, 2007). Stabilisation of bare slopes and the prevention of wind erosion is therefore another challenge in this area.

8.4 Field Trials

It is of the utmost importance to implement field trials during the revegetation process. This will be an ideal time to set out different quadrats to test the effectiveness of different methods of replanting different species. Refer to Appendix F for further detail on trial quadrats.

8.5 Plant Species Plan

The proposed expansion, particularly of the open pit, will lead to the loss of vegetation and requires the rescue and relocation of species necessary for the rehabilitation of the river. The plants should be relocated the same day as removal and therefore suitable planning is required prior to removal. It is recommended that as much of the current species found within the riparian zones to be rescued and relocated to sections which will not be disturbed for establishment. Not all plants are suitable for translocation, e.g. deep rooted species such as *Vachellia erioloba* and other tree species will require reestablishment via seeds or seedlings. Seedlings can be harvested from species on the site or from local nurseries (where available). The seedbank at the SANBI Kirstenbosch Botanical garden (<https://www.sanbi.org/documents/kirstenbosch-seed-catalogue/>) should also be consulted to obtain the species diversity found on site. Please refer to species-specific information in the



dashboards below. Refer to Appendix C under the Plant Procurement section for further information regarding plant sourcing. It is important to note that minimal disturbance of the vegetation should take place when rehabilitation work commences.


Refer to Appendix F for general guidelines to follow when species are chosen for translocation. Where translocation will not be possible, or where it is not recommended or tested, plants can be propagated within a nursery or in a suitable location within close proximity to the species' current growing location. General guidelines for propagation, e.g. recommended sowing methods, are also presented in Appendix F of this report.

Species that were identified during the field investigation, as suitable for the rehabilitation of the affected reach of the river are presented in the dashboards below. Species are grouped according to families since translocation and propagation methods are, at times, very similar. For revegetation densities, refer to the Landscape Plan (section 8.7).

SCHEDULE 2 PROTECTED SPECIES

- Species listed under the Northern Cape Nature Conservation Act (Act. No. 9 of 2009).

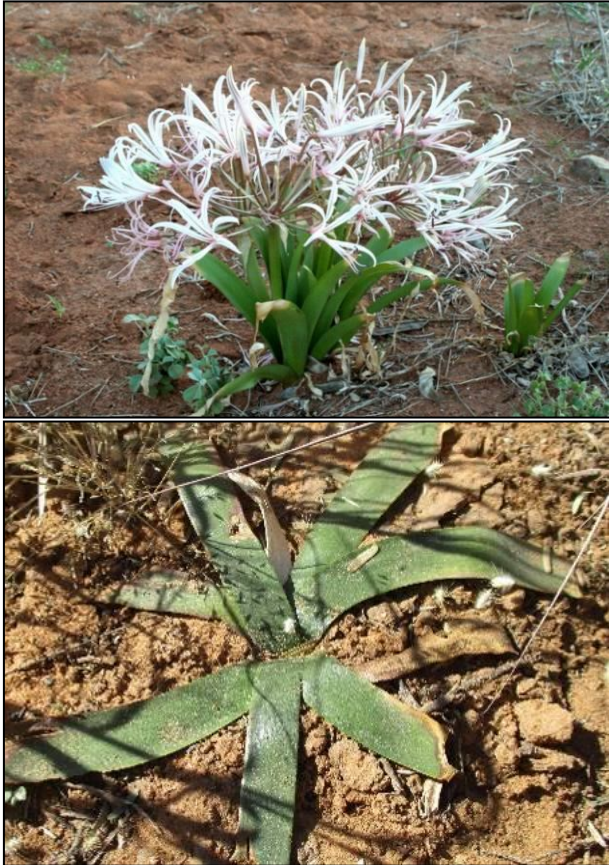
AIZOACEAE - All species of the Aizoaceae family are protected under the Northern Cape Conservation Act (Act. No.9 of 2009).

Scientific name	Common Name	Photo	
<i>Psilocaulon junceum</i>	Asbos (ash bush)		
Growth form	Succulent shrub.		
Location in river diversion (Landscape Plan)	Western side of the river <ul style="list-style-type: none"> • Terrestrial zone • Embankment Eastern side of the river <ul style="list-style-type: none"> • Terrestrial zone 		
Soil requirements	Whitish sandy soils		
Uses	The plant is burned to produce an alkali ash that is used for soups.		
Rehabilitation activities	Details of Rehabilitation Activities	Timeframe	
Rescue and relocation	<i>Not suitable for transplanting.</i> Succulents are best propagated by leaf cuttings or offsets; however, using seeds for propagation is very time-consuming.	Early Spring	
Harvesting method			
Propagation	<u>Seed collection:</u> Not recommended for succulents. <u>Cuttings:</u> <ul style="list-style-type: none"> • Leaf cuttings to be made with a sterile or clean, sharp knife. • Leaves from the base of the plant / stems with visibly less damage are to be used. • Allow the cuttings to heal for approximately four days in a warm, dry area. Cuttings can then be placed on top of a moist commercial seedling mix within a tray or potting medium. 		Summer



	<ul style="list-style-type: none"> • Use a spray bottle to mist leaves when the soil is dry. • Cuttings to be kept in a warm place with plenty of bright light, but not direct sun. • Keep cuttings moist (not wet) and warm. • Roots will emerge within approximately 3 – 8 weeks. <p><u>Offsets:</u></p> <ul style="list-style-type: none"> • Offsets are the small succulents that sprout up around the base of the parent plant. • As the offsets have already established a root system, propagating time is reduced. • The offset should be removed very carefully from the parent plant with little damage to the roots. 	
Soil preparation	None specified, but soils should be well-drained to prevent waterlogging.	
Planting	<p><u>Sowing from seed:</u></p> <ul style="list-style-type: none"> • Seeds to be sown while fresh and dry in the beginning of spring to ensure a long growing season for establishment before the winter dormancy period. <p><u>Planting from cuttings:</u></p> <ul style="list-style-type: none"> • Once the leaf cutting starts to turn brown and wither, with roots already emerged, the succulent is ready to be transplanted. <p><u>Planting from offsets:</u></p> <ul style="list-style-type: none"> • No special requirements but care should be taken not to disturb the roots. 	Early spring
Considerations	N/A	


AMARYLLIDACEAE

Scientific name	Common Name	Pictures
<i>Nerine laticoma</i>	Vleilelie, gifbol, jeukui, seeroogblom	
Growth form	Geophyte	
Location in river diversion (Landscape Plan)	Western side of the river <ul style="list-style-type: none"> • Terrestrial zone • Embankment Eastern side of the river <ul style="list-style-type: none"> ➢ Terrestrial zone ➢ Embankment 	
Soil requirements	Sandy soils. PH: Alkaline, Neutral	
Uses	<i>Nerine</i> bulbs contain alkaloids, and <i>Nerine laticoma</i> has the common name gifbol (Afr.), but no traditional uses are recorded for this species. Together with other species such as <i>Nerine sarniensis</i> and <i>Nerine masoniorum</i> , these plants are valued primarily for their horticultural potential.	
Rehabilitation activities	Details of the Rehabilitation Activities	Timeframe?
Rescue and relocation	<i>Likely to be worth transplanting, particularly in sand plain habitat.</i> Trails are recommended. Propagate using bulbs or seeds.	Late Summer - Winter
Harvesting method		
Propagation	<p><u>Seed collection:</u> Can easily be grown from seed. Seeds can be purchased from plant nurseries if necessary.</p> <p><u>Bulb collection:</u></p>	

	<ul style="list-style-type: none"> • Bulbs should be removed carefully to ensure the bulb is still attached to the rest of the plant. • Some of the species grow down to 30 cm below the ground surface and some parallel to the ground about 10cm from the surface. They should be dug up, from the leaves down, using a small spade. • Care should be taken with transport to ensure the bulb is not separated from the rest of the plant. It should be noted how the plant grew in its natural environment and then transplanted to mimic these circumstances as close as possible. • Damage to bulbs will result in a point of entry for parasites, bacteria and fungi that could result in rotting of the bulb. • It is also helpful to look at the corms and bulbs before planting. The position of old roots indicates the bottom of the organ. Germination and sprouting may be inhibited if corms and bulbs are planted upside down. 	
Soil preparation	Plant in a sandy medium with a little compost and water heavily in summer while the plant is growing but allow the soil to dry out between watering. The soil needs to be turned over and dug down to about 30 centimetres in order to aerate it sufficiently.	
Planting	<u>Sowing from seed:</u> <ul style="list-style-type: none"> • When the seed is ripe, sow it in deep seed trays in a sandy medium. Just cover the seed. • Leave the seedlings in the trays for at least two seasons, after which they can be grown on in larger containers or planted outdoors. • The flat, semi-winged seeds should be sown as quickly as possible or else seed lose their viability. If seed is collected when fresh and stored in a cool place at 2–4°C, it can be kept for about one growing season. • Generally, the seeds of bulbs germinate readily. Seeds should be sown in autumn in deep seed trays or pots. A good general medium is equal parts sand and fine compost or loam. Seeds should be sown thinly and covered with a thin layer of sand. • Seedlings should remain in the seed tray or pot at least one full season and in some species two or three before being planted out into permanent containers or into open veld. 	March - May
	<u>Planting from bulbs:</u> <ul style="list-style-type: none"> • Bulbs should be planted with their necks just below the soil level. These bulbs require well-drained, compost-rich soil in sun or light semi-shade. Water well in summer but keep as dry as possible in winter. The large bulbs need to be planted at least 10 to 15 centimetres apart, while the smaller ones can be planted between three and five centimetres apart. • The advised time to plant most bulbs is when night temperatures drop, and the soil cool down, during the onset of winter. Bulbs planted out during hot weather have a good chance of aborting the flower embryos. 	June / July
Considerations	<p>Amaryllis lily borer and mealy bugs are common pests. Furthermore, slugs and snails can do great damage to the leaves and are responsible for transmitting viral disease. Thrips are less of a threat but can occur under leaves.</p> <ul style="list-style-type: none"> • Remove the pests by hand or use a bait or repellent such as broken eggshells or tobacco dust in a ring around the base of the plants. • Thrips to be controlled using a pesticide spray but only for severe infestations. 	During propagation and after transplanting to the wild.



IRIDACEAE



Scientific name	Common Name	Photo
<i>Babiana hypogaea</i>	Dwarf Babiana	
Growth form	Perennial forb	
Location in river diversion (Landscape Plan)	Western side of the river <ul style="list-style-type: none"> • Terrestrial zone • Embankment Eastern side of the river <ul style="list-style-type: none"> ➢ Terrestrial zone 	
Soil requirements	Kalahari Sand or stony laterite	
Uses ⁴	The corms are edible when cooked. It has a nutty flavour.	
Rehabilitation activities	Details of Rehabilitation Activities	Timeframe
Rescue and relocation	<ul style="list-style-type: none"> • Seeds can be collected and used for propagation; • Corms (2-3cm in diameter) should be dug out during end of winter and replanted as soon as possible. • The corms should be planted 20 -25cm deep in a sunny area with well drained sandy soil. 	Winter
Harvesting method		
Propagation	<ul style="list-style-type: none"> • Seeds should be sowed lightly in seeds trays and should not be disturbed within the first year; • The seeds germinate between 4-8 weeks at 20 degrees Celsius and should get as much light as possible; • Liquid feed should be given occasionally to ensure that the soil does not become nutrient poor; • Small bulbs should be potted out (2-3 bulbs) into pots when they are dormant. These bulbs should be left in the pots till they are large enough to be transplanted (preferably when dormant). 	Summer
Soil preparation	Sandy soil that drains easily should be used.	
Planting	When the corms are large enough (2-3cm) they can be transplanted preferably still in a dormant stage. The area where the hole is going to be dug to plant the corm should be drenched with water to ensure that the soil is saturated. The hole should be planted at a depth of 20-25cm and covered lightly with sand.	Spring
Considerations	The corms should preferably be in a dormant stage when transplanted.	

⁴ <http://tropical.theferns.info/viewtropical.php?id=Babiana+hypogaea>

SCHEDULE A PROTECTED SPECIES

- Species listed under the National Forests Act (Act No.84 of 1998)


FABACEAE

Scientific name	Common Name	Photo
<i>Vachellia erioloba</i>	Camelthorn	
Growth form	Evergreen to semi-deciduous tree	
Location in river diversion (Landscape Plan)	Western side of the river <ul style="list-style-type: none"> • Terrestrial zone • Embankment Eastern side of the river <ul style="list-style-type: none"> • Terrestrial zone • Embankment Active River Channel	
Soil requirements	Sandy loam soil and in deep Kalahari sand.	
Uses	Leaves and pods are used as food source for livestock and game. Wood very dense and is a popular fire wood. Gum is eaten by people, birds and animals. The inner bark is used to make rope. Burnt and powdered bark is used to treat headaches and dried and powdered pods are used to ear ailments. Roasted seeds are used as a substitute for coffee.	
Scientific name	Common Name	Photo
<i>Vachellia haematoxylon</i>	Grey Camel Thorn	
Growth form	Tree or shrub	
Location in river diversion (Landscape Plan)	Western side of the river <ul style="list-style-type: none"> • Terrestrial zone 	
Soil requirements	Sandy loam soil and in deep Kalahari sand.	
Uses	Leaves and pods are used as food source for livestock and game. The wood dense and is a popular fire wood and also used for timber and construction.	
Rescue and relocation	It is not advised to transplant large trees as the trees taproot are very deep and any damage to the taproot may cause the tree to die. Smaller saplings should be used for relocation purposes.	
Harvesting method (both species)		
Propagation	<ul style="list-style-type: none"> • Seed pods should be collected and cleaned to store the seeds. The seeds must be stored in a cool dry place and be kept free of any insects as they are susceptible to infestation of beetles and other insects. • The seeds must be soaked in hot water and be left over night. The following day the seeds must be placed in polythene tubes (20cm deep and 7cm diameter) filled with river sand and lightly covered with sand. • Germination of seeds tend to be erratic. 	Seeds should be sown in May
Soil preparation	None specified refer to general procedures.	

Planting	Seedlings must be planted out as soon as they are 40mm in height. When the seedling is taller the taproot becomes too long and damaging the taproot may cause the seedling to die.	
Considerations	<i>Acacia erioloba</i> is a slow grower (300mm to 500mm per year) and well adapted to very dry and heavy frost conditions. It is also a protected tree species in South Africa.	


SPECIES THAT ARE NOT PROTECTED (NATURALLY OCCURRING IN THE AREA)

ACANTHACEAE





Scientific name	Common Name	Photo
<i>Monechma genistifolium</i> subsp. <i>australe</i>	Perdebossie	
Growth form	Shrub	
Location in river diversion (Landscape Plan)	Western side of the river <ul style="list-style-type: none"> • Terrestrial zone • Embankment Eastern side of the river <ul style="list-style-type: none"> • Terrestrial zone • Embankment Active River Channel	
Soil requirements	All southern African <i>Monechma</i> species show a preference for lime and are most commonly found on substrates containing it.	
Uses	Palatable bush. Tea is made from the roots for stomach problems.	
Rehabilitation activities	Details of Rehabilitation Activities	Timeframe
Rescue and relocation	No known information on transplanting success, thus any transplanting attempts should first be tested with trials. Alternatively, the plant can be propagated from seeds or cuttings, with cuttings known to have a high success rate amongst most species within the Acanthaceae family.	Rain season – Spring to summer
Harvesting method		
Propagation	<u>Seed collection:</u> <ul style="list-style-type: none"> • Seeds of the whole species within the Acanthaceae family has a capsule containing 2-4 seeds that are dispersed when the capsule splits open longitudinally. Seed texture between species vary but seeds are typically round and flat. • Capsules to be collected from plants that have finished flowering and that have started to change colour from green to a tawny straw colour. • Seeds are to be placed in paper seed bags (for sufficient aeration) and left in a warm environment until "artillery barrage" commences. <u>Cuttings:</u> <ul style="list-style-type: none"> • Most members of this family grow successfully from cuttings. • Harvest tip cuttings from actively growing species • Cuttings from more mature species should be used since soft-tip cuttings of species from drier conditions are more prone to rotting. <u>Seedlings or individuals from the wild:</u> <ul style="list-style-type: none"> • Could attempt on trial basis, but no evidence/record of success for this species. 	Summer
Soil preparation	None specified, but soils should be well-drained to prevent waterlogging.	
Planting	<u>Sowing from seed:</u> <ul style="list-style-type: none"> • Once seeds have been dropped from the capsule, a tray can be used to sow species into a seed mixture that is free-draining (prevent waterlogged roots). • <i>In situ</i> (in the wild or in orchids) germination is preferred in good light conditions, where seeds are to be scattered in their own habitat. • If grown <i>ex situ</i>, once seedlings emerge they can easily be pricked out and planted back into the wild. Care should be taken not to damage the roots of seedlings. <u>Planting from cuttings:</u>	Summer; just before the rain season.


	<ul style="list-style-type: none"> Prepared cuttings can be dipped in a rooting hormone and placed directly into pots (<i>ex situ</i> germination) or the eventual area where they will be growing (<i>in situ</i>). For <i>ex situ</i> germination, rooting takes place within 10 - 14 days if the bed is bottom-heated and there is mist to keep the shoots cool. Once cuttings have rooted, they can be dug up and planted in their permanent location. 	
Considerations	The Australian and Mealy Bug are common pests of this family. Chemical application is not advised for <i>in situ</i> germination etc. Plants under less stress perform better against these pests.	

AMARANTHACEAE


Scientific name	Common Name	Pictures
<i>Salsola rabieana</i>	Blouganna	
Growth form	Low spreading shrub about 0.1–2m high	
Location in river diversion (Landscape Plan)	Western side of the river <ul style="list-style-type: none"> Terrestrial zone Embankment 	
Soil requirements	On limestone rocks and slopes in or near pans. Sandy soil in Acacia scrub at bottom of valley.	
Uses	N/A	
Rehabilitation activities	Details of the Rehabilitation Activities	Timeframe
Rescue and relocation	No known information on transplanting success, thus should first be tested with trials. Alternatively, propagation can occur by using cuttings or seeds. A combination is also desired to ensure seedlings of different ages are planted.	Early Spring
Harvesting method		
Propagation	<u>Seed collection:</u> None specified. Standard seed collecting methods apply. <u>Cuttings:</u> <ul style="list-style-type: none"> Propagation from soft-tip cuttings works well in bottom-heated or ordinary mistbeds. Rooting takes place within 10–14 days. 	Summer
Soil preparation	None specified, but soils should be well-drained to prevent waterlogging.	
Planting	<u>Sowing from seed:</u> <ul style="list-style-type: none"> Some species require the seeds to be soaked for a day, and only then sown in trays in a warm, sunny place. Heated beds are useful. Alternatively, use a plastic tunnel or even a cold frame that will raise the temperature to be higher than outside and maintain it there for a longer period at night. <u>Planting from cuttings:</u> <ul style="list-style-type: none"> Standard procedures recommended on trial basis. It is expected that most of the woody shrubs will be able to be propagated with cuttings, therefore it is recommended that these species be included in the nursery. However, no literature is available, therefore trials with different species will have to be undertaken to determine species specific methodology. <u>Wild seedlings:</u> Standard procedures recommended on trial basis.	
Considerations	N/A	

ASTERACEAE

Scientific name	Common Name	Photo
<i>Amellus tridactylus</i> <i>subsp. arenarius</i>	N/A	
Growth form	Perennial herb	
Location in river diversion (Landscape Plan)	Western side of the river <ul style="list-style-type: none"> • Terrestrial zone Eastern side of the river <ul style="list-style-type: none"> • Terrestrial zone • Embankment 	
Soil requirements	Found in dry washes and streambeds	
Uses	N/A	
Scientific name	Common Name	Photo
<i>Dicoma capensis</i>	Koorsbossie; Wilde karmedik	
Growth form	A small perennial herb with trailing branches growing from a woody rootstock	
Location in river diversion (Landscape Plan)	Western side of the river <ul style="list-style-type: none"> • Terrestrial zone 	
Soil requirements	Sandy soils – along dry riverbeds in the Kalahari	
Uses	Used to treat fevers, colds, flu, mosquito bites, hypertension, influenza, diarrhoea and cancer.	
Scientific name	Common Name	Photo
<i>Geigeria ornativa</i> subsp. <i>ornativa</i>	Common geigeria; Vermeerbos	
Growth form	Low-growing, perennial herb	
Location in river diversion (Landscape Plan)	Western side of the river <ul style="list-style-type: none"> • Terrestrial zone 	
Soil requirements	N/A	
Uses	N/A	
Scientific name	Common Name	Photo
<i>Hirpicium echinus</i>	Botterblom	
Growth form	A prickly, tufted or bushy, somewhat aromatic perennial herb.	
Location in river diversion (Landscape Plan)	Western side of the river <ul style="list-style-type: none"> • Terrestrial zone 	
Soil requirements	Sandy soils in the Kalahari	
Uses	N/A	
Scientific name	Common Name	Photo

<i>Pentzia calcarea</i>	Meerkatkaroo	
Growth form	An unpalatable dwarf shrub.	
Location in river diversion (Landscape Plan)	Western side of the river <ul style="list-style-type: none"> • Terrestrial zone • Embankment Eastern side of the river <ul style="list-style-type: none"> • Terrestrial zone • Embankment Active River Channel	
Soil requirements	Occurs in calcareous soils.	
Uses	N/A	
Rehabilitation activities	Details of the Rehabilitation Activities	Timeframe?
Rescue and relocation	Very little information on rescue and relocation is available for the Asteraceae family, therefore seed of all Asteraceae species should be harvested for two seasons prior to site clearing. Alternatively, propagation using cuttings are possible for woody Asteraceae species, e.g. <i>Pentzia calcarea</i> , but trials are recommended in this case.	Two seasons prior to site clearing
Harvesting method		
Propagation	<u>Seed collection:</u> <ul style="list-style-type: none"> • Species from the Asteraceae family have parachute seeds and the parachutes need to be removed before sowing – this will allow more moisture absorption. • To prevent germination or deterioration while storing seeds, keep them in a cool place, e.g. a cool room or the bottom of a fridge, where temperatures range between 2°C and 4°C. These plants germinate relatively easily, and they can be stored for about a year under normal room conditions, as long as a small quantity of insecticide or fungicide is placed in the storage containers. • Asteraceae seeds are closely packed together and therefore insect seed predators can damage the whole flower head. Therefore, flower heads should be examined to ensure undamaged seed heads are harvested. • A simple and effective, non-toxic (to humans), method of keeping insects at bay is to place well-ground, grey wood ash from a fire in with the seeds. Use about one-part ash to two parts seed by volume. Shake the mixture together to allow the ash to mix properly with the seeds in the container. 	During the flowering season (species specific)
	<u>Cuttings:</u> <ul style="list-style-type: none"> • Softwood cuttings can be effective and should be harvested during spring and in the growing season from species that are actively growing and disease free (follow standard procedures). 	
Soil preparation	Soil from the original habitat should be added to the standard soil mix since this helps to inoculate the soil mix with soil organisms, which promotes healthy growth (Straker, 1989).	
Planting	<u>Sowing from seed:</u> <ul style="list-style-type: none"> • Seeds to be sown in a tray and covered with 1 mm of seedling mix to hold the species in place. • General procedures to be followed. 	
Considerations	N/A	


ASTERACEAE CONTINUED

Scientific name	Common Name	Photo	
<i>Tarchonanthus camphoratus</i>	Wild camphor bush		
Growth form	Tree / woody species		
Location in river diversion (Landscape Plan)	Western side of the river <ul style="list-style-type: none"> • Terrestrial zone • Embankment 		
Soil requirements	Tolerant of a range of soils, preferring deep soils but also commonly found on stony soils in the wild. Soil type: Clay, Loam, Brack/saline. PH: Alkaline, Neutral (prefers 5.5 - 6.5, tolerating 5 - 7)		
Uses	The plant has several medicinal properties. Problems such as blocked sinuses and headache can be healed by inhaling the smoke from the burning green leaves. Drinking boiled mixture of leaves and water can help to treat coughing, toothache, abdominal pain and bronchitis. Leaves can also be used for massaging body stiffness and also as a perfume. The cotton wool-like seed heads were used to stuff cushions.		
Rehabilitation activities	Details of the Rehabilitation Activities	Timeframe?	
Rescue and relocation	The plant is propagated from seeds or soft-wood cuttings. Transplantation of young plants is easy. No special nurturing is required for this tree *This tough tree can shoot from the base after fire. This species requires no special care and does well even in challenging landscapes.	Early Spring	
Harvesting method			
Propagation⁵	<u>Seed collection:</u> <ul style="list-style-type: none"> • Species from the Asteraceae family have parachute seeds and the parachutes need to be removed before sowing – this will allow more moisture absorption. • To prevent germination or deterioration while storing seeds, keep them in a cool place, like a cool room or the bottom of a fridge, where temperatures range between 2°C and 4°C. <u>Cuttings:</u> Cuttings to be made from the hard wood of the last season's growth.		
Soil preparation	None specified		
Planting	<u>Sowing from seed:</u> <ul style="list-style-type: none"> • No special techniques required • Seeds will germinate within 8 weeks. • Traditionally sown in situ. <u>Planting from cuttings:</u> <ul style="list-style-type: none"> • Softwood cutting very successful for propagation of this species. • Basic guidelines can be followed as this species requires no special care. • Rooting hormone to be applied for root growth encouragement. <u>Wild seedlings:</u> Seedlings taken from the wild can easily be transplanted.		
Considerations	N/A		


⁵ <http://pza.sanbi.org/tarchonanthus-camphoratus>




BIGNONIACEAE

Scientific name	Common Name	Photo
<i>Rhigozum trichotomum</i>	Threethorn	
Growth form	Shrub	
Location in river diversion (Landscape Plan)	Western side of the river <ul style="list-style-type: none"> • Embankment 	
Soil requirements	Sandy soil	
Uses	Young roots are chewed as a remedy for diarrhoea.	
Rehabilitation activities	Details of Rehabilitation Activities	Timeframe
Rescue and relocation	No known information on transplanting success is available. The plant should be propagated from seeds as per the recommendations stated in the general procedures.	Spring
Harvesting method		
Propagation	Propagation is best done by seed collection and planting of seeds	Spring
Soil preparation	Prefers well-drained sandy and calcareous soils.	
Planting	None specified, refer to general procedures.	
Considerations	The species is known to have the potential to become a weed in area where mismanagement and overgrazing is taking place.	

FABACEAE

Scientific name	Common Name	Photo	
<i>Vachellia hebeclada</i> subsp. <i>hebeclada</i>	Candle Thorn		
Growth form	Shrub to small tree		
Location in river diversion (Landscape Plan)	Western side of the river <ul style="list-style-type: none"> • Terrestrial zone • Embankment 		
Soil requirements	Sandy soils		
Uses	N/A		
Rehabilitation activities	Details of Rehabilitation Activities		Timeframe
Rescue and relocation	It is not advised to transplant large trees as the trees taproot are very deep and any damage to the taproot may cause the tree to die. Smaller saplings should be used for relocation purposes.		
Harvesting method			
Propagation	<ul style="list-style-type: none"> • Seed pods should be collected and cleaned to store the seeds. The seeds must be stored in a cool dry place. • The seeds must be soaked in hot water and be left over night. The following day the seeds must be placed in polythene tubes (20cm deep and 7cm diameter) filled with river sand and lightly covered with sand. • Germination of seeds tend to be erratic. 		Seeds should be sown in December
Soil preparation	None specified refer to general procedures.		
Planting	Seedlings must be planted out as soon as they are 40mm in height. When the seedling is taller the taproot becomes too long and damaging the taproot may cause the seedling to die.		
Considerations	N/A		

MALVACEAE



Scientific name	Common Name	Photo
<i>Grewia flava</i>	Velvet raisin	
Growth form	Woody	
Soil requirements	Grows in deep sand and sandy calcareous soil, as well as in silty soils in the dry river beds of the Kalahari. ⁶	
Location in river diversion (Landscape Plan)	Western side of the river <ul style="list-style-type: none"> • Terrestrial zone Eastern side of the river <ul style="list-style-type: none"> • Terrestrial zone • Embankment Active River Channel	
Uses	Stems are strong, elastic and used for making hunting bows and arrow shafts. Rope can be made from the strong bark fibre – also used to weave baskets. Fruits are edible and can be used as a basis for brewing beer or as a potent alcoholic drink. The plant is of cultural value for the Kalahari people.	
Rehabilitation activities	Details of the Rehabilitation Activities	Timeframe?
Rescue and relocation	No information available on transplanting. Suggested that species be rescued and relocated after successful trials have established the possibility of transplanting. The Malvaceae family is relatively easy to propagate from seed. Some species are also successfully grown from semi-hardwood cuttings. Seed should be harvested, and cuttings made. <i>Grewia flava</i> is stocked in nurseries.	Early spring
Harvesting method		
Propagation	<u>Seed collection:</u> <ul style="list-style-type: none"> • Seeds to be collected as the capsules start to split. • General guidelines for seed collection apply. <u>Cuttings:</u> Not all species are successfully grown from cuttings – not the preferred method for propagation.	Summer months
Soil preparation	None specified	
Planting	<u>Sowing from seed:</u> Standard procedures. <ul style="list-style-type: none"> • Seed of most indigenous trees and shrubs (with the exception of Proteaceae) are best sown in spring or summer. • Sow the seed and place the trays in a warm, sheltered area with light shade. Seedlings should be potted into half-litre containers and kept in light shade⁷. <u>Planting from cuttings:</u> <ul style="list-style-type: none"> • Standard procedures recommended on a trial basis. • It is expected that most of the woody shrubs will be able to be propagated with cuttings, therefore it is recommended that these species be included in the nursery. • However, no literature is available, therefore trials with different species will have to be undertaken to determine species specific methodology. <u>Wild seedlings:</u> Standard procedures recommended on trial basis.	Spring - Summer
Considerations	N/A	

⁶Van Rooyen, N., Bezuidenhout, H., & De Kock, E. (2001). *Flowering plants of the Kalahari dunes*. Ekotrust.




⁷ <http://www.sanbi.org/sites/default/files/documents/documents/seedcatalogue2008.pdf>






PEDALIACEAE

Scientific name	Common Name		
<i>Sesamum triphyllum</i>	Wild sesame	 	
Growth form	Erect, sparsely branched herb (annual).		
Location in river diversion (Landscape Plan)	Western side of the river <ul style="list-style-type: none"> • Terrestrial zone 		
Soil requirements	Sandy soils. Growing in limestone gravel and calcareous soils		
Climate requirements	Requires full sun for optimal growth. Flowers summer – autumn.		
Uses	The plant is used medicinally as an aphrodisiac or as a remedy against snake bites. Seeds are edible and rich in oils.		
Rehabilitation activities	Details of the Rehabilitation Activities	Timeframe?	
Rescue and relocation	Annuals are not recommended for transplanting. Propagate with seeds on a trial basis.	Rain season (spring and summer)	
Harvesting method			
Propagation	<u>Seed collection:</u> <ul style="list-style-type: none"> • Annuals will require seed collecting every growing season, so to collect seed, watch the plants closely and make notes so that seed collection can be repeated the following season. 	Summer - autumn	
Soil preparation	None specified		
Planting	<u>Sowing from seed:</u> <ul style="list-style-type: none"> • The seeds of <i>Sesamum</i> do not germinate when sown immediately. Let the seed dry out during the dormant season (winter) and sow it in the new growing season (just before the rain season). These plants tend to be annuals and may need a cool dormant period before germinating. 	Early spring	
Considerations	N/A		

POACEAE

Scientific name	Common Name	Photo
<i>Aristida stipitata</i>	Long-awned Grass ⁸	
Growth form	Weak perennial tufted grass	
Location in river diversion (Landscape Plan)	Western side of the river <ul style="list-style-type: none"> • Terrestrial zone Eastern side of the river <ul style="list-style-type: none"> • Terrestrial zone 	
Soil requirements	Mostly in sandy soil (Especially red sand)	
Uses	Indicator of overgrazed veld	
Scientific name	Common Name	Photo
<i>Cenchrus ciliaris</i>	Foxtail Buffalo Grass ⁹	
Growth form	Perennial tufted grass	
Soil requirement	Grows in all sand types, mostly in well drained sandy soil types. Often found along roadsides, where rainwater collects from the road.	
Location in river diversion (Landscape Plan)	Western side of the river <ul style="list-style-type: none"> • Terrestrial zone • Embankment Eastern side of the river <ul style="list-style-type: none"> • Terrestrial zone • Embankment Active River Channel	
Uses	Soil stabilisation because of the deep root system.	
Scientific name	Common Name	Photo
<i>Cymbopogon pospischilii</i>	Narrow-leaved Turpentine Grass	 https://www.ispotnature.org/communities/southern-africa/view/observation/697340/turpentine-grass
Growth form	Perennial tufted grass	
Location in river diversion (Landscape Plan)	Western side of the river <ul style="list-style-type: none"> • Terrestrial zone • Embankment Eastern side of the river <ul style="list-style-type: none"> • Terrestrial zone • Embankment 	
Soil requirements	Grows in most soil types but prefers heavier soils.	
Uses	Poor grazing grass but contains essential oils.	
Scientific name	Common Name	Photo




⁸ http://www.southernafricanplants.net/plantdata_sub.php?Mspec_ID=567⁹ <https://www.prota4u.org/database/protav8.asp?g=psk&p=Cenchrus+ciliaris+L.>

<i>Cynodon dactylon</i>	Couch Grass ¹⁰	
Growth form	Mat-forming grass by means of stolons and rhizomes	
Location in river diversion (Landscape Plan)	Active River Channel	
Soil requirements	Grows in all soil types especially in sandy soil and often in damp places.	
Uses	The stolons and rhizomes makes the grass an excellent soil stabiliser.	
Scientific name	Common Name	Photo
<i>Eragrostis echinochloidea</i>	Tick Grass ¹¹	
Growth form	Sparse tufted grass	
Location in river diversion (Landscape Plan)	Western side of the river <ul style="list-style-type: none"> • Terrestrial zone • Embankment Eastern side of the river <ul style="list-style-type: none"> • Terrestrial zone • Embankment 	
Soil requirements	Usually grows in disturbed places, mostly in shallow lime soils and sandy soil. Also often present in the vicinity of pans.	
Uses	Average palatability	
Scientific name	Common Name	Photo
<i>Eragrostis lehmanniana</i>	Lehmann's Love Grass ¹²	
Growth form	Perennial tufted grass	
Location in river diversion (Landscape Plan)	Western side of the river <ul style="list-style-type: none"> • Embankment Eastern side of the river <ul style="list-style-type: none"> • Embankment 	
Soil requirements	Usually grows in areas where disturbance took place such as overgrazed veld and road reserved, mostly in sandy soil. Is also present in undisturbed sandveld in arid regions.	
Uses	It is often used to resow an area with exposed sandy and loam soil in arid regions	
Scientific name	Common Name	Photo

¹⁰ <https://www.teline.fr/en/photos/poaceae/cynodon-dactylon>

¹¹ http://www.kyffhauser.co.za/Plants1/Eragrostis_echinochloidea/Image2.htm


¹² <https://www.ispotnature.org/communities/southern-africa/view/observation/726949/grass-11>

<i>Fingerhuthia africana</i>	Thimble grass ¹³	
Growth form	Perennial tufted grass	
Location in river diversion (Landscape Plan)	Western side of the river <ul style="list-style-type: none"> • Embankment Eastern side of the river <ul style="list-style-type: none"> • Embankment 	
Soil requirements	Usually grows in gravelly soil and often present in eroded places.	
Uses	Important subclimax to climax grass in eroded places and plays an important role in stabilising soil in such places.	
Scientific name	Common Name	Photo
<i>Schmidtia kalahariensis</i>	Kalahari Sour Grass ¹⁴	
Growth form	Annual tufted grass	
Location in river diversion (Landscape Plan)	Western side of the river <ul style="list-style-type: none"> • Terrestrial zone • Embankment Eastern side of the river <ul style="list-style-type: none"> • Terrestrial zone • Embankment 	
Soil requirements	Usually grows in disturbed sandy soil in arid to very arid areas.	
Uses	Very important pioneer grass and forms dense stands after overgrazing or droughts occurred. Grows quickly and protect bare soil from wind erosion.	
Scientific name	Common Name	Photo
<i>Schmidtia pappophoroides</i>	Sand Quick ¹⁵	
Growth form	Perennial tufted grass	
Location in river diversion (Landscape Plan)	Western side of the river <ul style="list-style-type: none"> • Terrestrial zone • Embankment Eastern side of the river <ul style="list-style-type: none"> • Terrestrial zone • Embankment Active River Channel	
Soil requirements	Grows in areas with a relatively low rainfall, mostly sandy, loam and gravelly soil.	
Uses	It is drought resistant and can form dense stands.	
Scientific name	Common Name	Photo


¹³ http://www.southernafricanplants.net/plantdata_sub.php?Extern_ObsID=S39&Mspec_ID=2589

¹⁴ http://www.southernafricanplants.net/plantdata_sub.php?Mspec_ID=5668

¹⁵ https://www.zimbabweflora.co.zw/speciesdata/image-display.php?species_id=104450&image_id=1


<i>Stipagrostis uniplumis</i>	Silky Bushman Grass	 <p><i>Stipagrostis uniplumis</i> var. <i>uniplumis</i></p> <p><i>Stipagrostis uniplumis</i> var. <i>necii</i></p>
Growth form	Perennial tufted grass	
Location in river diversion (Landscape Plan)	Western side of the river <ul style="list-style-type: none"> • Terrestrial zone • Embankment Eastern side of the river <ul style="list-style-type: none"> • Terrestrial zone • Embankment 	
Soil requirements	Grows in sandy soil in arid regions. Often encountered in gravelly places especially where disturbance has taken place.	
Uses	Relatively palatable grass and aids in soil stabilization	
Rehabilitation activities	Details of Rehabilitation Activities	Timeframe
Rescue and relocation	<ul style="list-style-type: none"> • Grass seeds should be collected and used for revegetation purposes; • <i>Cynodon dactylon</i> present within the riparian zone can be cut out in patches and these patches can be used to line the realigned river. 	
Harvesting method		
Propagation	Propagation of grass within arid areas are not advised. For revegetation purposed it is best to use hydro seeding on the areas that will be rehabilitated.	
Soil preparation	<ul style="list-style-type: none"> • The soil should be lightly loosened to a depth of 6cm. The grass seeds should be lightly covered with soil and the use of brushpacking should be used to limit soil erosion. • The use of hydroseeding is recommended as this will aid in seed dispersal and the germination of seeds will start immediately after the application. 	
Planting	Seed mixtures are commercially available. The Sweet and Mixed Bushveld Biosome mixture from Mayford is recommended for the area. The mixture will consist of pioneer species that will stabilise the soil and over time will create micro-habitat for sub-climax to climax grasses.	
Considerations	Reseeding should be done if the desired grass cover is not achieved within the two years. The use of brushpacking on the riparian slopes will lower the potential for soil erosion and create cover to grass species to establish.	

RHAMNACEAE

Scientific name	Common Name	Photo
<i>Ziziphus mucronata</i>	Buffalo thorn	
Growth form	Woody	
Location in river diversion (Landscape Plan)	Western side of the river <ul style="list-style-type: none"> • Terrestrial zone • Embankment Eastern side of the river <ul style="list-style-type: none"> • Terrestrial zone • Embankment 	
Soil requirements	Sandy, Clay, Loam. PH: Neutral Able to survive in nearly all soil types, including slightly saline, but preferring a pH in the range 5.5 – 9.	
Uses	Roots, bark or leaves used separately or in combination for medicinal purposes. For coughs and chest problems, warm bark infusions – sometimes with roots and leaves added – are used as expectorants (or emetics). Root infusions are popular for diarrhoea or dysentery. Healing and pain relief of boils, sores and glandular swellings are treated with decoctions of roots and leaves.	
Rehabilitation activities	Details of the Rehabilitation Activities	Timeframe
Rescue and relocation	No information available on transplanting. Suggested that species be rescued and relocated after successful trials have established the possibility of transplanting. ** Small trees are often available at nurseries selling indigenous plants. The species is very easily raised from seed or hardwood cuttings, growing in just about any soil type and withstanding heat and cold equally well. Seed propagation could be risky due to poor seed keeping properties of this plant; therefore, cuttings are recommended.	Summer rain months
Harvesting method		
Propagation	<u>Seed collection:</u> <ul style="list-style-type: none"> • Seeds are nuts and can be cracked carefully with a vice or nutcracker until seeds are released. • Seeds need to be stripped of their hard and fleshy outer layers, thus should be covered in hot water, allowed to cool, soaked for two days and then sown. <u>Cuttings:</u> No species-specific information available. Follow standard procedures.	Summer
Soil preparation	None specified	
Planting	<u>Sowing from seed:</u> <ul style="list-style-type: none"> • Seeds should be sown fresh due to their poor keeping properties. • Sow the seeds in a tray with a mixture of fine river sand and compost (2:1), then place in a warm, bright area and keep moist. • Seeds usually germinate in 2 – 3 weeks at a rate of 75%. • Once they have reached the two-leaf stage, they can be transplanted, but care must be taken to not damage the long taproot, as this will severely stunt development. <u>Planting from cuttings:</u> Standard procedures recommended on trial basis. <ul style="list-style-type: none"> • It is expected that most of the woody shrubs will be able to be propagated with cuttings, therefore it is recommended that these species be included in the nursery. However, no literature is available, therefore trials with different species will have to be undertaken to determine species specific methodology. 	Summer months

	<u>Irrigation</u> : Seedlings and small plants need moderate water, full sun and efficient drainage or they will damp off. Mulch well and water regularly until established. Continue watering and feeding if you wish to speed up the growth process.	
Considerations	This plant rarely experiences some fungal growths. Larvae of the butterflies black pie (<i>Tuxentius melaena</i>), common dotted blue and (<i>Tarucus sybaris sybaris</i>), Hintza pie (<i>Zintha hintza</i>) feed on the leaves. ¹⁶	

SOLANACEAE


Scientific name	Common Name	Photo
<i>Lycium cinereum</i>	Kriedoring	
Growth form	Woody	
Location in river diversion (Landscape Plan)	Western side of the river <ul style="list-style-type: none"> • Terrestrial zone • Embankment Eastern side of the river <ul style="list-style-type: none"> • Terrestrial zone 	
Soil requirements	Sandy clay soils	
Climate requirements	Flowers in the summer	
Uses	All parts of this plant can be powdered and used to make perfume. Also serves as a good barrier plant.	
Rehabilitation activities	Details of the Rehabilitation Activities	Timeframe?
Rescue and relocation	No information available on transplanting. Suggested that species be rescued and relocated after successful trials have established the possibility of transplanting. <i>Lycium</i> species are known to root easily and like <i>Solanum</i> species, are easily propagated from soft tip and semi-hardwood stem cuttings. Propagating from seed also possible.	Spring and Summer (rain season)
Harvesting method		
Propagation	<u>Seed collection</u> : <ul style="list-style-type: none"> • No species-specific information available. However, species from the Solanaceae family can easily be grown if seeds are available. • Seed collection requires that fruit be harvested when ripe and then seeds need to be cleaned and dried to be left for the remainder of the dry or dormant season. <u>Cuttings</u> : <ul style="list-style-type: none"> • <i>Lycium cinereum</i> can root well from cuttings with special treatment, i.e. root hormone application, adequate watering (not overwatering), some shading and the presence of nutrients in rooting medium once rooting has been initiated. 	Late Summer
Soil preparation	None specified	
Planting	<u>Sowing from seed</u> :	

¹⁶Orwa C, A Mutua, Kindt R, Jamnadass R, S Anthony. 2009 Agroforestry Database: a tree reference and selection guide version 4.0 (<http://www.worldagroforestry.org/sites/treedbs/treedatabases.asp>).



	<ul style="list-style-type: none"> • Seeds to be sown in the following spring or the start of the season. • Use trays on the usual seedling mix, placing the trays in full sun and heating the trays. • Seedlings take 10-14 days to germinate and can then be pricked out and placed in individual bags (or planted in their permanent location). <p><u>Planting from cuttings:</u> Not specified but species from the Solanaceae family are known to root well. Standard procedures recommended on trial basis.</p> <ul style="list-style-type: none"> • It is expected that most of the woody shrubs will be able to be propagated with cuttings, therefore it is recommended that these species be included in the nursery. • However, no literature is available, therefore trials with different species will have to be undertaken to determine species specific methodology. 	
Considerations	N/A	

THYMELAEACEAE

Scientific name	Common Name	Photo
<i>Gnidia polycephala</i>	Karoo Broom	
Growth form	Shrub	
Location in river diversion (Landscape Plan)	Western side of the river <ul style="list-style-type: none"> • Terrestrial zone • Embankment 	
Soil requirements	Sandy soil	
Uses	A decoction of the roots is used for a number of ailments.	
Rehabilitation activities	Details of Rehabilitation Activities	Timeframe
Rescue and relocation	Very little information on rescue and relocation is available for <i>Gnidia polycephala</i> , therefore seed should be harvested and used for propagation purposes. Propagation using cuttings have proven unsuccessful for other members of this genus which was attributed to incorrect use of fertilisers. For successful propagation by using cuttings, many trials will be required to establish the correct fertiliser use and, thus, cuttings are not recommended.	
Harvesting method		
Propagation	None specified. Trials are needed to determine best approach for this species.	
Soil preparation	None specified.	
Planting	Seedlings should be planted on cool, cloudy days and roots should be kept moist.	
Considerations	The plant invades overgrazed land	

8.6 Landscape Plan

The plant species to be used are indicated on the landscaping plan with reference to each area earmarked for revegetation (Figure 5)¹⁷. The areas represented on the Landscape Plan include the Terrestrial Areas, River Embankment and the (previously approved, now existing) Diversion Channel / Active River Channel. A cross section is provided in Figure 4.

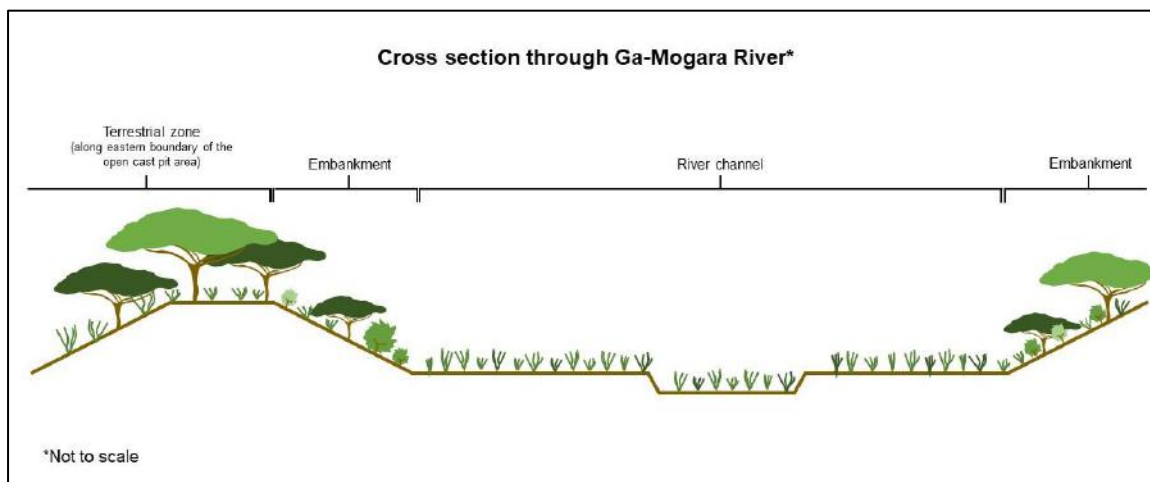


Figure 4: Conceptual cross section of the Plant Rescue and Relocation for the Ga-Mogara River. Proportions are conceptual for illustration purposes only and are not a depiction of actual site characteristics.

Apart from the Active River Channel, the remaining areas earmarked for revegetation are divided into an eastern and western section as species composition differed between the two river bank slopes. The terrestrial areas refer to the upper slope and crest of the river channel, where tree and shrub densities are significantly higher than within the adjacent river bank and river bed. The grass cover is also slightly lower. The River Embankment refers to the slopes of the river bank where tree and shrub densities are lower than what is observed within the terrestrial areas. For the Active River Channel, grass species dominate (Ecological Management Services, 2016).

The following section provides recommended revegetation densities that should be achieved by different time frames for the different sections of the diverted channel. For further detail on recommended revegetation requirements, refer to Appendix C. If the densities are not achieved, the revegetation of specific areas that is affected by the lower densities should be implemented.

¹⁷ Although the landscaping plan is presented in Figure 5 of this report for illustration purposes, due to the original file size, it is not practical to present a high-resolution reproduction thereof within this document. The standalone file supplied should be consulted for detail.

Riparian area:

- In terms of trees and shrubs, *Vachellia erioloba* seeds are also commercially available as are seedlings and saplings. Other common trees and shrub species such as *Tarchonathus camphoratus* and *Ziziphus mucronata* are not readily available commercially and thus would need to be propagated for rehabilitation purposes. However, as the *Vachellia erioloba* are considered keystone species in this ecosystem; the establishment of these trees are of primary importance as, once established they will provide a suitable environment for the recruitment of other species. An array of size classes should be planted as the seedlings and saplings have different survival rates under varying conditions (EMS, 2016).
- These trees should be planted at a density of 10 trees/ha (EMS, 2016).

Terrestrial area

- On flatter terrain: rolling the soil before and after planting creates a firm bed for planting the seed and increases seed-to-soil contact (EMS, 2016)¹⁸.
- On side slopes: it is recommended that rows of shade-cloth be established for erosion control measures. These are to be spaced at 5m intervals and at 450mm height. Custom made wind nets with steel droppers at 5m spacing must be used. These wind rows can be reused but must stay in place until the grass sward has been firmly established. This will also help prevent seeds from being washed downhill during rainfall events and improve soil moisture retention.

	Species	Planting density per ha (year 1)	Density / ha achieved for year 3	Density / ha achieved for year 5
Woody species (trees and shrubs)	<i>Vachellia erioloba</i>	10	10	10
	<i>Grewia flava</i>	15	15	15
	<i>Lycium cinereum</i>			
	<i>Ziziphus mucronata</i>			
Dwarf shrubs	<i>Monechma genistifolium</i> subsp. <i>australe</i>	15	15	15
Forbs	<i>Amellus tridactylus</i> subsp. <i>arenarius</i>	10	10	10
	<i>Babiana hypogaea</i>			
	<i>Pentzia calcarea</i>			
	<i>Nerine laticoma</i>			
Grass	Focus should be on grass cover, rather than species composition. Whenever reseeding needs to take place, the species composition mix as recommended in the Rehabilitation Plan (EMS, 2016)	60% aerial cover	90% aerial cover	90% aerial cover

¹⁸ Ecological Management Services (2016). Rehabilitation Plan for the proposed Gamogara Drainage channel in support of Section 21 (c) and (i) water uses for the Mokala Manganese Mine, Hotazel, Northern cape.



River Embankment:

- On side slopes: it is recommended that rows of shade-cloth be established for erosion control measures. These are to be spaced at 5m intervals and at 450mm height. Custom made wind nets with steel droppers at 5m spacing must be used. These wind rows can be reused but must stay in place until the grass sward has been firmly established. This will also help prevent seeds from being washed downhill during rainfall events and improve soil moisture retention.

	Species	Planting density per ha (year 1)	Density / ha achieved for year 3	Density / ha achieved for year 5
Woody species (trees and shrubs)	<i>Vachellia erioloba</i>	10	10	10
	<i>Grewia flava</i> <i>Lycium cinereum</i> <i>Ziziphus mucronata</i>	10	10	10
Dwarf shrubs	<i>Monechma genistifolium</i> subsp. <i>australe</i> (d)	15	15	15
Forbs	<i>Amellus tridactylus</i> subsp. <i>arenarius</i> <i>Babiana hypogaea</i> <i>Pentzia calcarea</i> <i>Nerine laticoma</i>	5	5	5
Grass	Focus should be on grass cover, rather than species composition. Whenever reseeding needs to take place, the species composition mix as recommended in the Rehabilitation Plan (EMS, 2016)	60% aerial cover	90% aerial cover	90% aerial cover

Active River Channel:

- On flatter terrain: rolling the soil before and after planting creates a firm bed for planting the seed and increases seed-to-soil contact (EMS, 2016).

	Species	Planting density (year 1)	Cover achieved for year 3	Cover achieved for year 5
Grasses	Focus should be on grass cover, rather than species composition. Whenever reseeding needs to take place, the species composition mix as recommended in the Rehabilitation Plan (EMS, 2016)	60% aerial cover	90% aerial cover	90% aerial cover



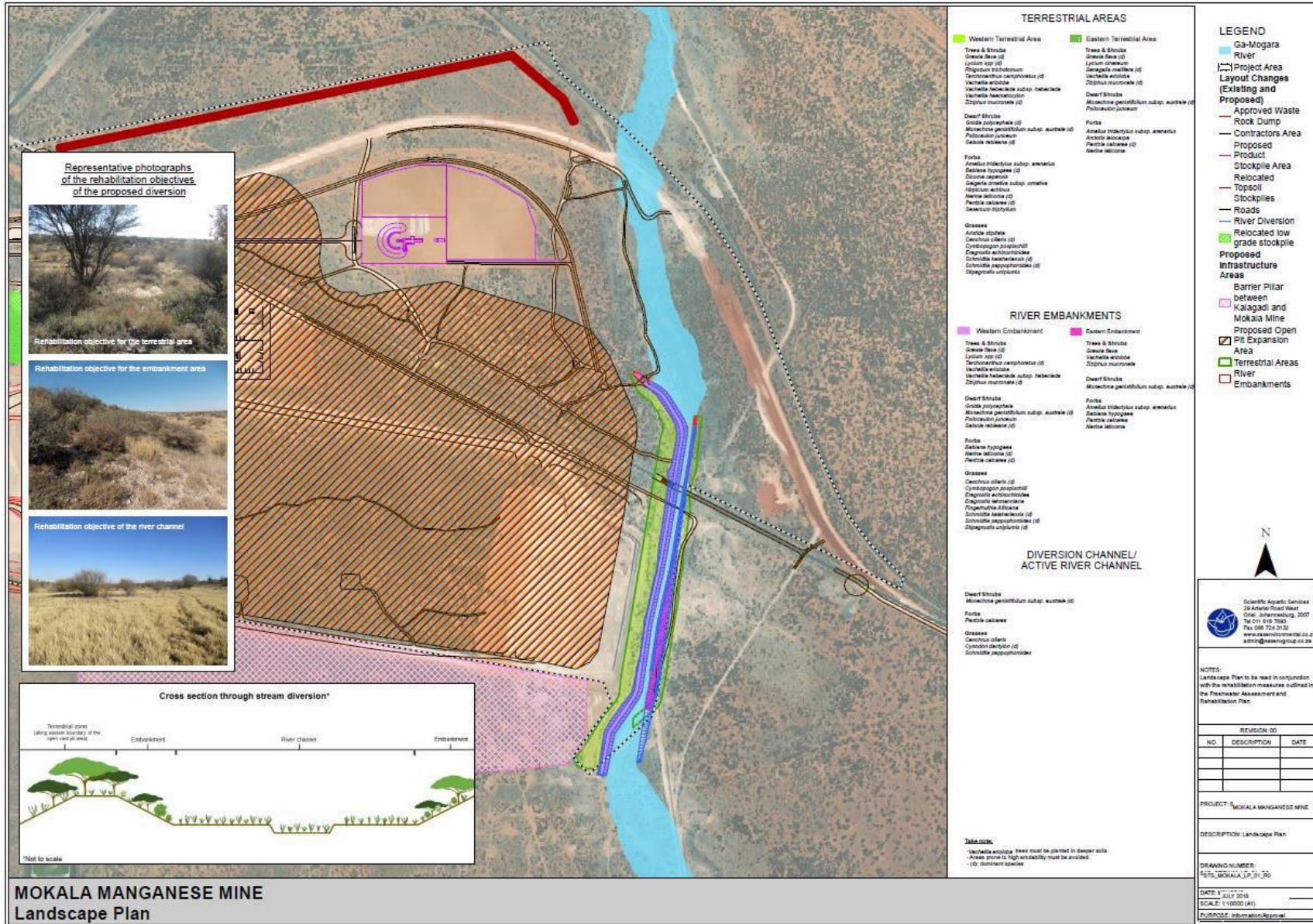



Figure 5: Landscape Plan for the relocation of rescued plants in the affected reach of the Ga-Mogara River provided for illustration purposes. Please refer to the standalone document provided for detail.



8.7 Faunal Species Plan

Whilst the reinstatement of floral communities associated with the river will contribute to restoration of habitat for less sensitive faunal species occurring within the MRA, only one faunal species of conservation concern was identified by STS (2018) and specifically addressed in this plan. The below is taken from the RRP developed by STS (2018), as it remains relevant to the proposed expansion activities.

Scientific name	Common Name	Photo ¹⁹
<i>Atelerix frontalis</i> ²⁰	South African Hedgehog	
Habitat requirements	<p>They require ample ground cover, for cover, nesting and insect food sources. Northern Upper Karoo vegetation is also one of the important vegetation types for the species. It occurs in areas where mean annual rainfall ranges between 200–800 mm, mean annual temperature ranges between 10–25 °C and altitude ranges between 800–2000 m asl. On a local scale, the species appears to prefer dense vegetation habitats and rocky outcrops that may provide food, cover and nesting materials. It is nocturnal.</p>	
Food requirements	They are omnivorous, where invertebrates (such as beetles, earwigs, grasshoppers, termites, slugs, snails, centipedes, moths and earthworms) form the bulk of the diet, but they also consume eggs, mice, lizards, fungus and even dog food.	
Uses	This species is a delicacy (food source) in some African cultures and is harvested locally (Skinner & Chimimba 2005). This species is also locally and commercially sold as pets, although many tenrecs are sold masquerading as South African Hedgehogs. Their spines and bones are also sold locally and are commonly seen in multi markets. Hedgehogs have often been referred to as an eco-friendly form of pest control.	
Rescue and relocation	Details of Rescue and Relocation Activities	
	Rehabilitation activities should take place in a phased manner and working from one side to the other side. By doing this, the disturbance will cause the species to move naturally away from the disturbance. When individuals are found, they should be move to an area that is still in a natural state in in the immediate surrounding area where enough vegetation cover is still present.	

¹⁹ This file is licensed under the Creative Commons Attribution-Share Alike 3.0 Unported license.

²⁰ Light J, Pillay N, Avenant NL, Child MF 2016. A conservation assessment of *Atelerix frontalis*. In Child MF, Roxburgh L, Do Linh San E, Raimondo D, Davies-Mostert HT, editors. The Red List of Mammals of South Africa, Swaziland and Lesotho. South African National Biodiversity Institute and Endangered Wildlife Trust, South Africa.

9 MONITORING REQUIREMENTS

Although the proposed mining expansion will not encroach directly on the riparian zone of the Ga-Mogara River, edge effects, especially those relating to the expansion of the open pit and the construction of berms between the open pit and the river, will likely have an indirect impact on the riparian zone. Edge effects may potentially lead to loss or alteration of riparian habitat, which has already been impacted by existing activities, in particular the river diversion. Monitoring of edge effects as well as rehabilitation is therefore considered essential.

9.1 *Monitoring Philosophy and Requirements*

Prudent monitoring of the riparian area in the vicinity of the existing diversion as well as the proposed open pit expansion and berms is of utmost importance, as this will ensure a continual flow of data, enabling all parties involved to accurately assess and manage water resource related impacts and issues. To ensure the accurate gathering of data, the following techniques and guidelines should be followed:

- Site walk through surveys should be applied as the preferred method of monitoring with specific focus on:
 - Erosion monitoring;
 - Sedimentation; and
 - Alien and invasive vegetation proliferation.
- General habitat unit overviews should also be undertaken;
- Stability and appropriateness of stormwater controls;
- All data gathered should be measurable (qualitative and quantitative);
- Monitoring actions should be repeatable;
- Data should be auditable; and
- Reports should present and interpret the data obtained.

The table below illustrates data capturing for the monitoring plan. This monitoring plan must be implemented by a competent person and submit the findings to the responsible authority for evaluation.



Table 4: Planned monitoring activities and report content.

Aspect	Monitoring Location	Frequency of sampling	Frequency of Reporting	Report Content	Equipment
Faunal assessment	The portion of the Ga-Mogara River within the study area, but with specific reference to those areas directly impacted by the diversion, open pit and berms.	Assessments must be conducted annually during summer and winter seasons.	Annual report will be compiled through all phases.	<ul style="list-style-type: none"> Report <i>ad hoc</i> sightings as part of awareness program; Camera trapping; and Sherman trapping for small mammals. 	<ul style="list-style-type: none"> GPS; Camera; Camera traps; Sherman traps; Field Form.
Vegetation monitoring	The rehabilitated areas where revegetation and the reestablishment of the identified rescue and relocation floral species are planted.	<ul style="list-style-type: none"> First month after revegetation, weekly inspection should be undertaken to determine the success rate of plant species relocation; After first month of revegetation inspection should be done on a monthly basis during the growing season; After first year, monitoring should be carried out on an annual basis during the growing season; and Fixed point photography plots must be undertaken along a transect of the rehabilitated area. This must be done on the same place and time of year on an annual basis. 	<ul style="list-style-type: none"> Monthly report will be compiled by the appointed Environmental Manager during the first year after revegetation and thereafter on an annual basis for the Life of Mine. 	<ul style="list-style-type: none"> Species diversity; Percentage cover; Ratio of indigenous to alien and invasive species; Survival rate of plant species that were relocated, including the height class; Highlight problem areas where plant diversity and cover are not sufficient. 	<ul style="list-style-type: none"> GPS; Camera; Tripod; Field Form; and Measuring tape.
	The portion of the Ga-Mogara River within the study area, but with specific reference to those areas directly impacted by the diversion, open pit and berms.	Must be conducted on an annual basis during the growing season.	<ul style="list-style-type: none"> Annual report to be compiled by the appointed Environmental Manager during the construction and operational phase for the duration of the Life of Mine. 	<ul style="list-style-type: none"> Species composition; Basal cover; Survival rate of translocated plants; Alien and Invasive Plants (AIP) present, including status of control within the area; Impact of grazing; and Results of an annual Citizen scientist day in which employees and local 	<ul style="list-style-type: none"> GPS; Camera; and Field Form.



Aspect	Monitoring Location	Frequency of sampling	Frequency of Reporting	Report Content	Equipment
				community participate to create awareness.	
Erosion and Sedimentation	Along cleared areas where construction of planned infrastructure areas has taken place along the Ga-Mogara River within the study area.	<ul style="list-style-type: none"> Monitoring of erosion should occur on a weekly basis during construction by the contractor, and after every major rainstorm. Any evidence of erosion should be recorded photographically /diagrammatically and reported during the ECO site visit; Monitor sequential placement of soils during rehabilitation activity; Erosion monitoring must be done after a heavy rainstorm throughout all phases of development. 	<ul style="list-style-type: none"> Monthly monitoring report compiled by the appointed Environmental Manager during the construction phase; and After every major rainstorm and / flood. 	<ul style="list-style-type: none"> Brief indication of the method of assessment; Assumptions and Limitations must be listed; Photos and GPS point locations taken of existing erosion in the freshwater features and adjacent banks must be incorporated into the report; Monitor sequential placement of topsoil during rehabilitation activities; Any erosion observed must be discussed in detail and management recommendations made; Map indicating where erosion is present; and Recommended mitigation and remediation actions should be presented. 	<ul style="list-style-type: none"> GPS; Camera; Field Form; and Measuring Tape.
Alien and Invasive Species Control	The portion of the Ga-Mogara River within the study area, but with specific reference to those areas directly impacted by the diversion, open pit and berms.	<ul style="list-style-type: none"> Monitoring will be done during and after growing season; Regrowth of AIP should be monitored monthly during the construction phase; and Thereafter monitoring will be done for three months' post construction, and during maintenance activities. 	<ul style="list-style-type: none"> Monthly monitoring report will be compiled by the appointed Environmental Manager during the construction phase; and During operational phase an annual report will be developed for three years following the completion of construction. 	<ul style="list-style-type: none"> Provide a list of species occurring within the study area; Discuss the density of species; Watercourse integrity and risk to be discussed; Fixed point photo (Taking photo at specific points within the priority area to show the effect of AIP control); Map indicating where AIP is present; and Control measures undertaken to be reported. 	<ul style="list-style-type: none"> GPS; Field Form; Camera.



It is the opinion of the consultant that should the activities as presented in this plan be executed in a cogent and well managed fashion that the area of disturbance can be returned to an acceptable level of function and stability in support of the resource management objectives of the Ga-Mogara River and its associated catchment.

10 CONCLUSION

The proposed mining activity will necessitate the construction of additional infrastructure, with specific mention of the expansion of the open pit and berms between the pit and river. Although these activities will not directly encroach on the Ga-Mogara River, edge effects relating to these activities may potentially result in alterations to or some loss of riparian habitat, and increased risk of further modifications to the characteristics of the watercourse. Of particular concern is the potential for further alteration to the hydraulic connectivity, which has already been affected by upstream impacts. Therefore, to assist in minimising the significance of potential impacts a Rehabilitation Plan was developed by EMS in 2016. Scientific Aquatic Services (SAS) was appointed to develop a Rescue and Relocation Plan for protected species identified and to incorporate a Landscape Plan to rehabilitate the disturbed area associated with the proposed open pit expansion and berms.

The Rescue and Relocation Plan fits into the overall planning process of the activities and should be incorporated into the approved EMP and implemented by the proponent in conjunction with the Rehabilitation Plan (EMS, 2016) and the RRP (STS, 2018) as soon as the development commences, provided that the plan has been approved by the relevant authorities.

It is the opinion of the consultant that should the activities as presented in this plan be executed in a cogent and well managed fashion that the area of disturbance can be returned to an acceptable level of function and stability in support of the resource management objectives of the Ga-Mogara River and its associated catchment.



11 REFERENCES

- Bromilow, C. (2001).** Revised Edition, First Impression. Problem Plants of South Africa. Briza Publications, Pretoria, RSA.
- Department of Water Affairs and Forestry (DWAF). (1996).** South African Water Quality Guidelines. Volume 7: Aquatic Ecosystems.
- Carrick, P.J. and Kruger, R. (2007).** Restoring degraded landscapes in lowland Namaqualand: Lessons from the mining experience and from regional ecological dynamics. *J. Arid Environ.* 70: 767–781.
- Delta-H, (2016).** Kudumane Transient Groundwater Model for York and Hotazel pits. Prepared for SLR Consulting (Africa) (Pty) Ltd. Unpublished.
- Department of Water and Sanitation (DWS) Resource Quality Services (RQS) PES, EI and ES database for desktop assessment.**
<https://www.dwaf.gov.za/iwqs/rhp/eco/peseismodel.aspx>.
- Ecological Management Services (2015).** Biodiversity survey report for the proposed Mokala Manganese Mine, Hotazel Northern Cape.
- Ecological Management Services (2016).** Rehabilitation Plan for the proposed Gamogara Drainage channel in support of Section 21 (c) and (i) water uses for the Mokala Manganese Mine, Hotazel, Northern Cape.
- Kleynhans C.J.** 1999. A procedure for the determination of the ecological reserve for the purposes of the national water balance model for South African River. Institute of Water Quality Studies, Department of Water Affairs & Forestry, Pretoria.
- Light J, Pillay N, Avenant NL, Child MF (2016).** A conservation assessment of *Atelerix frontalis*. In Child MF, Roxburgh L, Do Linh San E, Raimondo D, Davies-Mostert HT, editors. *The Red List of Mammals of South Africa, Swaziland and Lesotho*. South African National Biodiversity Institute and Endangered Wildlife Trust, South Africa.
- Mucina, L. & Rutherford, M.C. (Eds). (2006 & 2012).** *The Vegetation of South Africa, Lesotho and Swaziland*. Strelitzia 19. South African National Biodiversity Institute, Pretoria, RSA.
- McDonald T, Gann GD, Jonson J, and Dixon KW (2016).** International standards for the practice of ecological restoration – including principles and key concepts. Society for Ecological Restoration, Washington, D.C.
- National Environmental Management Act, 1998 (Act 107 of 1998) (NEMA).**
- National Environmental Management: Biodiversity Act, 2004 (Act 10 of 2004) and the associated Alien and Invasive Species Regulations (GN R684 of 2016).**
- National Water Act, 1998 (Act 36 of 1998).**
- NBA: Driver A., Sink, K.J., Nel, J.N., Holness, S., Van Niekerk, L., Daniels, F., Jonas, Z., Majiedt, P.A., Harris, L. & Maze, K. (2012).** National Biodiversity Assessment 2011: An assessment of South Africa's biodiversity and ecosystems. Synthesis Report. South African National Biodiversity Institute and Department of Environmental Affairs, Pretoria. Online available: <http://bgis.sanbi.org/NBA/project.asp>.
- NFEPA: Driver, A., Nel, J.L., Snaddon, K., Murray, K., Roux, D.J., Hill, L., Swartz, E.R., Manuel, J. and Funke, N. 2011.** Implementation Manual for Freshwater Ecosystem Priority Areas. Water Research Commission. Report No. 1801/1/11. Online available: <http://bgis.sanbi.org/nfepa/project.asp>.
- NPAES: DEA and SANBI (2009).** National Protected Areas Expansion Strategy Resource Document. Online available: <http://bgis.sanbi.org/protectedareas/NPAESinfo.asp>.
- Orwa C, A Mutua, Kindt R, Jamnadass R, S Anthony. (2009).** Agroforestry Database: a tree reference and selection guide version 4.0 (<http://www.worldagroforestry.org/sites/treedbs/treedatabases.asp>).
- Photo Guide to Plants of Southern Africa:**
http://www.southernafricanplants.net/plantdata_sub.php?Mspec_ID=567
- Society for Ecological Restoration Science and Policy Working Group. (2002).** *The SER Primer on Ecological Restoration*. www.ser.org.
- Scientific Aquatic Services (SAS). (2021).** Freshwater Ecological Assessment as part of the Environmental and Water Use Authorisation Processes For The Proposed Mokala Mine Expansion Activities Near Hotazel, Northern Cape. Unpublished specialist report. Prepared for SLR Consulting (South Africa) (Pty) Ltd.



-
- SLR Consulting (Africa) (Pty) Ltd. 2016.** Integrated Storm Water Management Plan SWMP in support of WULA. SLR Project No.: 710.14003.00015. Report No.: Doc. no.1 Revision No.0, January 2017.
- SLR Consulting (South Africa) (Pty) Ltd. (2021).** Scoping report for the changes to infrastructure at The Mokala Mine. Report Available for Public Review.
- Scientific Terrestrial Services (STS). (2018).** Plant Species Plan, Floral/Faunal Search and Rescue Plan and Landscape Maintenance Plan for Mokala Manganese (Pty) Ltd Mine Near Hotazel, Northern Cape. Unpublished specialist report.
- Skinner, J. D., & Chimimba, C. T. (2005).** The mammals of the southern African sub-region. Cambridge University Press.
- Standards Reference Group SERA (2017).** National Standards for the Practice of Ecological Restoration in Australia. Second Edition. Society for Ecological Restoration Australasia. Available from URL: www.seraustralasia.com.
- Useful Tropical Plants:** <http://tropical.theferns.info/viewtropical.php?id=Babiana+hypogea>.
- van der Merwe, R. (2005).** Rehabilitation following Diamond Mining in the Pocket Beach Areas, Sperrgebiet, Namibia. Unpublished B.Sc (Hons) Thesis, Rhodes University Grahamstown.
- Van Rooyen, N., Bezuidenhout, H., & De Kock, E. (2001).** Flowering plants of the Kalahari dunes. Ekotrust
- Virginia Department of Transportation (VDOT) 2007.** Maintaining stormwater pollution reduction facilities.
- Weber, F., Stoney, C. and Pytlik, E. (1989).** Understanding soil conservation techniques. Technical paper no. 58. Volunteers in Technical Assistance (VITA). United States of America, Virginia.
- WWF Report (2016):** WWF Conservation Champion Biodiversity Management Guidelines.



APPENDIX A: LEGAL REQUIREMENTS

The sections below present each legislative document and the aspects which are pertinent to water resource management including the rehabilitation of disturbed areas to a level that will promote water resource.

National Environmental Management Act, 1998 (NEMA, Act 107 of 1998)

The guiding principles of NEMA refer specifically to biodiversity management in the following Clause:

(4) (a) *Sustainable* development requires the consideration of all relevant factors including the following:

(i) That the disturbance of ecosystems and loss of biological diversity are avoided, or, where they cannot be altogether avoided, are minimised and remedied.

NEMA (Act 107 of 1998) and the associated 2014 Regulations (Listing No R. 983, No R. 984 and R. 985) as amended, states that prior to any development taking place within a wetland or riparian area, an environmental authorisation process needs to be followed. This could follow either the Basic Assessment process or the Environmental Impact Assessment (EIA) process depending on the nature of the activity and scale of the impact.

This Rehabilitation Plan has been developed in fulfilment of the requirements as defined in the EIA Regulations, 2014 (No. R. 982) where a "maintenance management plan" is defined as a management plan maintenance purposes defined or adopted by the competent authority.

National Environmental Management Biodiversity Act, 2004 (NEMBA, Act 10 of 2004)

The objectives of this act are (within the framework of the National Environmental Management Act) to provide for:

- the management and conservation of biological diversity within the Republic of South Africa and of the components of such diversity;
- the use of indigenous biological resources in a sustainable manner;
- the fair and equitable sharing among stakeholders of benefits arising from bio prospecting involving indigenous biological resources;
- to give effect to 'ratified international agreements' relating to biodiversity which are binding to the Republic;
- to provide for co-operative governance in biodiversity management and conservation; and
- to provide for a South African National Biodiversity Institute to assist in achieving the objectives of this Act.

This act alludes to the fact that management of biodiversity must take place to ensure that the biodiversity of surrounding areas is not negatively impacted upon, by any activity being undertaken, in order to ensure the fair and equitable sharing among stakeholders of benefits arising from indigenous biological resources.

Furthermore, a person may not carry out a restricted activity involving either:

- a) a specimen of a listed threatened or protected species;
- b) specimen of an alien species; or
- c) a specimen of a listed invasive species without a permit.

Permits for the above may only be issued after an assessment of risks and potential impacts on biodiversity is carried out. Before issuing a permit, the issuing authority may in writing require the applicant to furnish it, at the applicant's expense, with such independent risk assessment or expert evidence as the issuing authority may determine. The Minister may also prohibit the carrying out of any activity, which may negatively impact on the survival of a listed threatened or protected species or prohibit the carrying out of such activity without a permit. Provision is made for appeals against the decision to issue/refuse/cancel a permit or conditions thereof.



National Environmental Management Biodiversity Act (NEMBA) (Alien and Invasive Species Regulations, Notice number 864 of 29 July 2017 in Government Gazette 40166)

NEMBA is administered by the Department of Environmental Affairs and aims to provide for the management and conservation of South Africa's biodiversity within the framework of the NEMA. In terms of alien and invasive species. This act in terms of alien and invasive species aim to:

- Prevent the unauthorized introduction and spread of alien and invasive species to ecosystems and habitats where they do not naturally occur,
- Manage and control alien and invasive species, to prevent or minimise harm to the environment and biodiversity; and
- Eradicate alien species and invasive species from ecosystems and habitats where they may harm such ecosystems or habitats.

Alien species are defined, in terms of the National Environmental Management: Biodiversity Act, 2004 (Act no 10 of 2004) as:

- (a) A species that is not an indigenous species; or
- (b) An indigenous species translocated or intended to be translocated to a place outside its natural distribution range in nature, but not an indigenous species that has extended its natural distribution range by natural means of migration or dispersal without human intervention.

Categories according to NEMBA (Alien and Invasive Species Regulations, 2017):

- **Category 1a:** Invasive species that require compulsory control;
- **Category 1b:** Invasive species that require control by means of an invasive species management programme;
- **Category 2:** Commercially used plants that may be grown in demarcated areas, provided that there is a permit and that steps are taken to prevent their spread; and
- **Category 3:** Ornamentally used plants that may no longer be planted.

See **Appendix D** for further details pertaining to Alien and Invasive Vegetation control.

Conservation of Agricultural Resources Act, 1983 (CARA, Act 43 of 1983)

Amendments to regulations under the Conservation of Agricultural Resources Act (CARA), 1983 (Act No. 43 of 1983) ensures that landowners are legally responsible for the control of invasive alien plants on their properties. The CARA legislation divides alien plants into weeds and invader plants, with *weeds* regarded as alien plants with no known useful economic purpose, while *invader plants* may serve useful purposes as ornamentals, as sources of timber and may provide many other benefits, despite their aggressive nature.

The National Forest Act (1998, as amended in September 2011).

Principles to guide decisions affecting forestry resources applicable to land development management are contained in the following principle:

Principle 3

3) The principles are that—

- (a) natural forests must not be destroyed save in exceptional circumstances where, in the opinion of the Minister, a proposed new land use is preferable in terms of its economic, social or environmental benefits;
- (b) a minimum area of each woodland type should be conserved and forests must be developed and managed to -
 - (i) conserve biological diversity, ecosystems and habitats;
 - (ii) sustain the potential yield of their economic, social and environmental benefits.

This section of the Act alludes to the fact that the conservation status of all vegetation types needs to be considered when any development is taking place to ensure that the adequate conservation of all vegetation types is ensured.

Principle 6

- (6) Criteria and indicators may include but are not limited to, those for determining—
 - the level of maintenance and development of—



- (i) forest resources:
- (ii) biological diversity in forests:
- (iii) the health and vitality of forests:
- (iv) the productive functions of forests:
- (v) the protective and environmental functions of forests; and
- (vi) the social functions of forests.

The Northern Cape Nature Conservation Act (NCNCA, Act No 9 of 2009)

Restricted activities involving specially protected plants:

49(1) No person may, without a permit –

- (a) Pick;
- (b) Import;
- (c) Export;
- (d) Transport;
- (e) Possess;
- (f) Cultivate; or
- (g) Trade in,

A specimen of a specially protected plant

Restricted activities involving protected plants

50 (1) Subject to the provision of section 52, no person may, without a permit –

- (a) Pick;
- (b) Import;
- (c) Export;
- (d) Transport;
- (e) Cultivate; or
- (f) Trade in,

A specimen of a protected plant.

The National Water Act, 1998 (Act 36 of 1998)

The purpose of the National Water Act, 1998 (Act 36 of 1998) (NWA) is to ensure that the nation's water resources are protected, used, developed, conserved, managed and controlled.

The NWA, 1998 also provides for water use licences which an operation will have to apply for, before commencing with any Section 21 water use activity. Various conditions may be attached to these licences and a breach thereof will result in criminal and civil liability. The conditions attached to water use licences will function alongside the additional protective measures, duty of care and statutory liability provisions provided by the NWA and other legislation to regulate a whole array of water issues.

Accordingly, and in terms of the *Guide to the National Water Act*, “water use” refers to doing something that has an impact on the water resource, for example:

- The amount of water in the resource;
- The quality of water in the resource; and
- The environment surrounding the resource.

Section 4 governs the entitlement to use water and states that water may only be used if it is a Schedule 1 use, a continuance of an existing lawful use (ELU), or authorised in terms of a general authorisation (GA) or licence. A water use may therefore not be implemented unless it is properly authorised through one of these types of authorisations.

Furthermore, Regulation GN509 of 2016 as it relates to the NWA, states that a full 21(c) and (i) WULA is required for any activity within a 500-meter radius from the boundary of a wetland. Section 21(i), in terms of GN509 is defined as “*any change affecting the resource quality within the riparian habitat or 1:100 year floodline, whichever is the greater distance*”. A water use license is the only authorization applicable to the proposed development.



APPENDIX B: ROLES & RESPONSIBILITIES, TRAINING

Proponent

- The Proponent will be responsible for the appointment of a suitably qualified Environmental Practitioner as an independent ECO for the construction phase of the project;
- A management body must be appointed to ensure compliance with the Rehabilitation Plan;
- The Proponent will be responsible for ensuring all contractors receive a copy of this document and understand its contents; and
- Should ownership of the property change, the role and responsibility for compliance with the Rehabilitation Plan must also be transferred.

Environmental Manager (EM)

The EM is the person responsible for the monitoring of the implementation of the Rehabilitation Plan during the implementation of the activities and for reporting on the degree of compliance. The EM should ideally be appointed at the start of the rehabilitation activities and is mandated to do the following:

- Ensure that all contractors/ subcontractors/ employees are fully aware of their environmental responsibilities. This should take the form of an initial environmental awareness-training program in which requirements of this document will be explained;
- Monitor site activities on a regular basis to ensure that there is minimal environmental impact due to construction activities;
- Ensure that a 'hotline' exists for reporting incidents and resolving any problems rapidly;
- The EM has the authority to stop works if in his/her opinion there is/may be a serious threat to or impact on the environment caused directly by the construction operations; and
- Conduct a final environmental audit and a review of management and rehabilitation measures.

Contractors

- The contractor/s in this case refers to any contractor/s on site, including the building contractor/s and sub-contractors on any item of infrastructure being erected or demolished;
- Such contractor/s will take full responsibility for each of his/her employees and any penalties imposed; and
- It is the responsibility of the contractor/s to ensure that they adhere to the Rehabilitation Plan.

TRAINING AND AWARENESS REQUIREMENTS

Training of Construction Workers

Construction workers must receive basic training in environmental awareness, including minimisation of disturbance to areas of increased ecological sensitivity, as well as fauna and flora with a no poaching policy, management of waste and prevention of water pollution.

Contractor Performance

The Contractor must ensure that the conditions of the Rehabilitation Plan are adhered to. Should the Contractor require clarity on any aspect of the Rehabilitation Plan the Contractor must contact the Environmental Manager (EM) for advice.

The EM must regularly audit the operation and establish whether the measures in the Rehabilitation Plan are applied, where after the EM reports to the lead project manager. The lead project manager must ensure that the Rehabilitation Plan is implemented and that suitable penalties are in place for non-conformance to the Rehabilitation Plan by contractors. The EM should be designated authority to issue a stop work order if severe non-compliance is taking place by the contractor.



APPENDIX C: RECOMMENDED REVEGETATION REQUIREMENTS

The purpose of the development of this plant species plan is:

- To reinstate as far as practicable, a high quality, biodiverse and natural environment within areas disturbed as a result of the development of mining infrastructure and related activities;
- To ensure that revegetated areas integrate aesthetically and ecologically with the adjacent vegetation and habitat as far as possible through careful selection of suitable plant species;
- To assist in mitigating impacts on the watercourse as a result of the existing and proposed development of mining infrastructure by minimising erosion and sedimentation, stabilising streambanks where required and reinstating floral and faunal habitat; and
- To provide supplementary information pertaining to the rehabilitation of the watercourses affected by the existing and proposed activities associated with the operations of the Mokala mine, in conjunction with the recommendations and guidelines contained in EMS, 2016.

Therefore, this plant species plan must not be viewed in isolation but should be read in conjunction with the aforementioned document. Management of existing vegetation should take place in accordance with the recommendations contained in this report, where applicable. This includes minimizing the footprint areas of all future infrastructure, designating watercourses in the vicinity of existing and future development as “no go” areas as far as feasible, and limiting the removal or disturbance of existing vegetation, with the exception of invasive and/or alien plant species. Management and monitoring guidelines pertaining specifically to the control of alien invasive plant species should be developed by a suitably qualified specialist, and these measures must be implemented throughout the MRA and especially in the vicinity of the watercourse, in order to minimise the risk of further proliferation of alien plant species.

WATERCOURSE REVEGETATION STRATEGY

Landform Design

As far as possible, the topography and morphology of the watercourse areas earmarked for revegetation, should not be impacted by the proposed development activities. Where grading is required due to disturbance or the need for streambank stabilisation, the revegetation surface must be graded to resemble natural slopes to ensure easy establishment of vegetation and to maintain slope stability.

Site preparation

Due to the natural erodibility of the soils in the area, erosion control measures during the revegetation process are deemed essential. In order to ensure stability of slopes and soils, staked biodegradable hessian sheeting must be placed over soils as soon as seeding has taken place. This is of increased significance within areas where surface water may become concentrated, leading to upstream ponding and the forming of downstream erosion rills and gullies. Manual ripping with the use of handheld equipment should take place to a depth of at least 300 millimetres (mm) along the contours. This will limit compaction and encourage water infiltration into the soil profile, will reduce runoff and subsequent erosion potential and also encourage root development in establishing vegetation. Vigorous vegetative growth will in turn further limit erosion potential by protecting the soil surface from high velocity rainfall and runoff.

Topsoil Management

Topsoil is a valuable commodity and must be conserved to ensure that adequate supplies are available for longer term rehabilitation requirements. Topsoil located outside of the river is to be managed as per the commitments in the existing EMP and within the diversion as per the rehabilitation plan compiled by Ecological Management Services (2016).

Species Selection

Since the riparian vegetation will undergo significant transformation, revegetation should at minimum aim to improve the ecological status of those areas which have already been disturbed. For the purposes of this project, it is proposed that grass and naturally occurring forb species be introduced, in the expectation that natural ecological succession, leading to a further increase in forb and other species diversity, may commence once established.



A planting and seeding list for revegetation purposes has been developed based on site observation of floral communities and species present, as well as species expected to occur within the riparian vegetation community. Plant species were furthermore selected to reinstate existing floral populations and to provide appropriate foraging and nesting habitat for faunal species present and expected to occur on the site (Appendix D, Table D1). The following species characteristics have furthermore been taken into consideration in species selection, in order to encourage natural succession:

- a combination of compatible species;
- species that are indigenous to the area;
- species that will establish easily;
- species that will give way to climax species (a combination of pioneer, subclimax and climax species); and
- species that will not become a nuisance should they persist.

Plant Procurement

It is strongly recommended that locally sourced seed and plants, procured from local nurseries, be used for revegetation purposes. Ideally a nursery should be established on site in order to propagate forbs. Where and if possible, plants that are removed from the development footprint areas may also be used, and no plants from surrounding areas are to be harvested. Manure from domestic livestock and/or farmed game animals, collected from local farmers, may also be mixed in with the topsoil used during the rehabilitation process. This will not only provide additional nutrients and soil stability but is likely to contain seeds of naturally occurring plants from the area, thus contributing to the seed bank.

The seedbank at the SANBI Kirstenbosch Botanical garden (<https://www.sanbi.org/documents/kirstenbosch-seed-catalogue/>) should also be investigated to obtain the species diversity found on site

Planting and Seeding

Revegetation should ideally take place at the beginning of the rainy season (end of September/ early October, but no later than the end of January) to ensure establishment success. Planting is proposed to occur as a once-off event over the number of days required. Should no rain occur within three days of the time of planting/ seeding, all revegetated areas are to be hand watered every second day for a period of two weeks to encourage establishment.

Grasses

The recommended indigenous veldgrass mixture should be applied within targeted rehabilitation areas, particularly those areas adjacent to new infrastructure, where vegetation clearance, compaction or disturbance has occurred to prevent erosion and ensure adequate vegetation cover. It is expected that natural ecological processes such as competition between germinated plants will determine which plants survive in any given area. The addition of grasses should take place through mulching with awned seeded species and broadcasting with hard-scaled seed over ripped soil and on steep slopes over the staked hessian sheeting (where applicable), preferably by hand. Broadcasting agents such as sand may also be spread with the seed as required as fine or light seeds are particularly likely to require broadcasting agents to ensure an even distribution and protect against loss of windblown seed.

New forbs, in addition to species rescued and relocated from within the development footprint areas where applicable, are to be planted within the riparian areas, where appropriate.

It is recommended that indigenous trees (if any) and grasses that have been removed from the development footprint areas be used as mulch in areas to be revegetated, with woody species cut into smaller stumps. This will contribute to the indigenous seedbank in these areas, create suitable microclimates for germination and provide habitat for smaller faunal species. Alien vegetation should be excluded from use for this purpose.

Faunal Habitat

Faunal habitat could be improved through transferring natural habitat components from the development footprint areas to revegetated areas. Measures that may be used to enhance faunal habitat within revegetated areas include the random placement of fallen logs, felled trees, woody debris and large rocks to these areas.

LANDSCAPE MAINTENANCE

Maintenance and Monitoring Objectives

Maintenance will focus on ensuring that revegetated areas develop to a standard that meets the objectives and targets in that revegetated areas are safe, stable and self-sustaining. In practice, this



means maintenance will be undertaken in response to issues identified by regular monitoring undertaken. The following maintenance objectives are applicable to the wetland and terrestrial areas:

- Replacing dead or damaged plants and seeded areas where required in order to ensure that revegetation targets are achieved;
- Ongoing management of invasive alien vegetation expected to encroach on disturbed areas;
- Ensuring that soft erosion control methods such as brush packing and use of drift fences remain in place until vegetation cover is sufficient within eroded areas; and
- Temporary fencing around revegetation areas is to be maintained in order to avoid these areas being trampled or overgrazed by livestock or damaged by construction and ongoing operational activities.

Vegetation Establishment

The following guidelines are applicable to maintenance processes and procedures in terms of planting establishment:

- A selected mine employee with an ecological background should be appointed to conduct monthly site visits for a period of one year at all revegetated areas to ensure that establishment success of grasses has occurred and that no die-off of larger plants has taken place.
- Monitoring will continue to identify assessment points with low establishment success rates or high mortality rates and subsequent planting is to occur in these areas during the rainfall season (September to April) until the required density is established;
- Should less than 50% coverage of revegetated areas by grasses have been achieved within a period of three months since seeding, areas still devoid of vegetation should be ripped to a depth of at least 100mm, be spread with additional topsoil and re-seeded with the same species as originally specified;
- Any dead or damaged trees should be replaced within the one year maintenance period with the same or other recommended species of the same container size; and
- All plants must be checked for pests and diseases during the monthly site visits and treated accordingly.

Alien Vegetation Control

In addition to existing alien vegetation, disturbance as a result of construction activities is likely to lead to further encroachment by alien plants. Alien vegetation must be managed according to the recommendations made in the AIP management plan to be developed.

Erosion control

- All areas susceptible to erosion, such as slopes associated with the various watercourses, should be checked on a monthly basis for a period of one year as part of the general planting maintenance activities to ensure that there is no undue soil erosion resultant from activities within and adjacent to the site and it must be ensured that soft rehabilitation material such as staked hessian sheeting remain in place and that seeds sown in these areas have established; and
- All erosion damage should be repaired immediately once noted.



APPENDIX D: RECOMMENDED FLORAL SPECIES

The table below described the plant species that are recommended for use as part of the rehabilitation plan described above.

Table D1: Recommended plant species for use in the Ga-Mogara River Rehabilitation Plan. Dominant species are indicated in brackets (d).

WESTERN SIDE OF THE RIVER
<p>(1) TERRESTRIAL ZONE</p> <p>Trees and shrubs</p> <ul style="list-style-type: none"> • <i>Asparagus larycinus</i> • <i>Grewia flava</i> (d) • <i>Lycium cinereum</i> (d) • <i>Rhigozum trichotomum</i> • <i>Senegalia mellifera</i> (d) • <i>Tarchonanthus camphoratus</i> (d) • <i>Vachellia erioloba</i> • <i>Vachellia hebeclada</i> subsp. <i>hebeclada</i> • <i>Vachellia haematoxylon</i> • <i>Ziziphus mucronata</i> (d) <p>Dwarf shrubs</p> <ul style="list-style-type: none"> • <i>Gnidia polycephala</i> (d) • <i>Monechma genistifolium</i> subsp. <i>australe</i> (d) • <i>Psilocalon junceum</i> • <i>Salsola rabieana</i> (d) <p>Forbs</p> <ul style="list-style-type: none"> • <i>Amellus tridactylus</i> subsp. <i>arenarius</i> • <i>Babiana hypogaea</i> (d) • <i>Dicoma capensis</i> • <i>Geigeria ornativa</i> subsp. <i>ornativa</i> • <i>Hirpicium echinus</i> • <i>Nerine laticoma</i> (d) • <i>Pentzia calcarea</i> (d) • <i>Sesamum triphyllum</i> <p>Grasses</p> <ul style="list-style-type: none"> • <i>Aristida stipitata</i> • <i>Cenchrus ciliaris</i> (d) • <i>Cymbopogon pospischilii</i> • <i>Eragrostis echinochloidea</i> • <i>Schmidtia kalahariensis</i> (d) • <i>Schmidtia pappophoroides</i> (d) • <i>Stipagrostis uniplumis</i> <p>(2) RIVER EMBANKMENT</p> <p>Trees and shrubs</p> <ul style="list-style-type: none"> • <i>Asparagus larycinus</i> • <i>Grewia flava</i> (d) • <i>Lycium cinereum</i> (d) • <i>Tarchonanthus camphoratus</i> (d) • <i>Vachellia erioloba</i> • <i>Vachellia hebeclada</i> subsp. <i>hebeclada</i> • <i>Ziziphus mucronata</i> (d)



Dwarf shrubs

- *Gnidia polycephala*
- *Monechma genistifolium* subsp. *australe* (d)
- *Psilocaulon junceum*
- *Salsola rabieana* (d)

Forbs

- *Babiana hypogaea*
- *Nerine laticoma* (d)
- *Pentzia calcarea* (d)

Grasses

- *Cenchrus ciliaris* (d)
- *Cymbopogon pospischilii*
- *Eragrostis echinochloidea*
- *Eragrostis lehmanniana*
- *Fingerhuthia africana*
- *Schmidtia kalahariensis* (d)
- *Schmidtia pappophoroides* (d)
- *Stipagrostis uniplumis* (d)

EASTERN SIDE OF THE RIVER**(3) TERRESTRIAL ZONE****Trees and shrubs**

- *Grewia flava* (d)
- *Lycium cinereum*
- *Senegalia mellifera* (d)
- *Vachellia erioloba*
- *Ziziphus mucronata* (d)

Dwarf shrubs

- *Monechma genistifolium* subsp. *australe* (d)
- *Psilocaulon junceum*

Forbs

- *Amellus tridactylus* subsp. *arenarius*
- *Arctotis leiocarpa*
- *Pentzia calcarea* (d)
- *Nerine laticoma* (fewer than on the left side of river)

Grasses

- *Aristida stipitata*
- *Cenchrus ciliaris* (d)
- *Cymbopogon pospischilii*
- *Eragrostis echinochloidea*
- *Schmidtia kalahariensis* (d)
- *Schmidtia pappophoroides* (d)
- *Stipagrostis uniplumis*

(4) EMBANKMENT**Trees and shrubs**

- *Grewia flava*
- *Senegalia mellifera*
- *Vachellia erioloba*



- *Ziziphus mucronata*

Dwarf shrubs

- *Monechma genistifolium* subsp. *australe* (d)

Forbs

- *Amellus tridactylus* subsp. *arenarius*
- *Babiana hypogaea*
- *Pentzia calcarea*
- *Nerine laticoma* (fewer than on the left side of river)

Grasses

- *Cenchrus ciliaris* (d)
- *Cymbopogon pospischilii*
- *Eragrostis echinochloidea*
- *Eragrostis lehmanniana*
- *Fingerhuthia africana*
- *Schmidtia kalahariensis* (d)
- *Schmidtia pappophoroides* (d)
- *Stipagrostis uniplumis* (d)

ACTIVE RIVER CHANNEL

Channel trees and shrubs

- *Vachellia erioloba*

Channel dwarf shrubs

- *Monechma genistifolium* subsp. *australe* (common plant in dry river beds)

Channel forbs

- *Pentzia calcarea*

Grasses

- *Cenchrus ciliaris*
- *Cynodon dactylon* (d)
- *Schmidtia pappophoroides*



APPENDIX E: ALIEN FLORAL SPECIES CONTROL

The dominant alien floral species are predominantly associated with agricultural activities and should be identified by the ECO prior to the commencement of construction. An Alien and Invasive Plant (AIP) species control program should be developed for control of these species. The basic principles of a control program are presented below.

AIP control programs must include the following three phases (Campbell, 2000):

- **Initial Control Phase:** The existing population must be drastically reduced;
- **Follow-up Control Phase:** Control of coppice regrowth, root suckers and seedlings; and
- **Maintenance Phase:** Low AIP density and numbers with a low annual control cost. During this phase, AIP are no longer considered a problem. It is important to monitor the situation of infestation during the growing season of the plants as to avoid re-infestation and to keep the control cost at a minimum.

Control Methods

In order to control AIP successfully, one must use a number of control methods. When using herbicides, the recommendations that are stated on the label of the specific product must be adhered to (Campbell, 2000).

Integrated control strategies

A combination of the most suitable and effective methods should be used to control a specific species in a particular situation. The following selection of suitable control methods should take into account the following (Campbell, 2000):

- Species of alien and invasive weeds;
- The type of growth form (i.e. seedling, sapling, shrub or tree);
- The density of infestation;
- Terrain where the infestation is present;
- Rehabilitation requirements;
- What resources are available; and
- Speed or urgency that the control of the infestation requires – physical removal and biological control will take longer than chemical control.

Initial control phase

- **Hand pull:** saplings and seedlings must be pulled out by hand and regrowth must be controlled with herbicide (Campbell, 2000). All guidelines for the application of herbicide listed in this Rehabilitation Plan must be adhered to;
- **Frill:** a cane knife is used to cut frills into the stem. Herbicide must be applied (1-2 mm per frill) and must be done in 30min after frilling; and
- **Soil application:** herbicide is applied to the soil and taken up by the plants roots.

Methods for controlling coppice, saplings and seedlings:

AIP infestation can comprise of different growing forms, and some of the growth forms cannot be utilised. These plants need to be cut with a brush cutter and the stumps treated with herbicide that was mixed with a dye to show where treatment was done (however stumps must not be removed as they significantly contribute to soil stability).

- **Integrated strategies to control alien shrubs**
- **Alien shrubs that are less than 1 m in height:**
 - Foliar application must be used in the general control of alien shrubs that are less than 1 m in height;
 - Registered herbicide must be used and where grass is present, selective broadleaf herbicide that will not impact on the grass. When grass is not present, a selective or non-selective registered herbicide must be used;
 - For dense seedling growth that are of uniform height a flat fan nozzle with knapsack must be used; and
 - For seedling growth that are of uneven height, root suckers, short saplings, and coppice growth a cone nozzle must be used.
- **Alien shrubs that are taller than 1 m (Campbell, 2000):**



- Shrubs that are taller than 1 m must be reduced cutting using brush cutter or cane knives.
- When large areas with dense growth are present a tractor mounted gyro-motor must be used;
- For low – medium density infestation a cut stump treatment must be used. Stumps that are must be treated immediately. The best time to treat is during the active growing season;
- Medium – high density infestations must be slashed to knee height so that the plants can coppice. The best time to do this is during the winter months as the plants are dormant and the coppice will come out during the active growing period after good rain. The coppice must be sprayed when enough leaves are present to absorb the herbicide and a dye must also be used to indicate treated areas;
- Pathways must be cut to increase exposed areas so that a foliar spray treatment is more effective without compromising the indigenous vegetation; and
- Mechanical uprooting of shrubs are not always a preferred method because the soil is disturbed and this increases the risk of alien vegetation infestation. Erosion is also promoted by this activity, and soil loss will occur. Mechanical uprooting can be done in areas that have a dense grass cover, as the roots of the grass will keep the soil intact. After uprooting the soil must be levelled and if grass seeds are present, some grass seeds must be placed on these areas to promote grass regrowth.

Integrated strategies to control alien herbs (Campbell, 2000)

➤ **Chemical Control:**

- Alien herbs are soft non-woody species;
- Some of the alien herbs have registered herbicides to control them and are either pre- or post-emergent herbicides; and
- When alien herbs are associated with woody alien plant, herbicides that are registered to control woody alien species are often used to control alien herbs. Alternatively, glyphosate can be used as it is often registered for both alien herb and alien woody species.

Follow up control (Campbell, 2000)

Introduction

Follow-up control is essential to control alien saplings, seedlings and coppice regrowth to achieve and sustain the progress that was made with the initial control work in the initial phase. If the follow up control phase is neglected, the alien infestation will become worse and denser than before the eradication process started. It is essential to sustain the follow up phase because it will prevent the suppression of alien seedlings on planted grasses.

Follow up treatment control must use the following methods:

- **Chemical control methods:** Only use registered herbicides to control any alien species. Instruction on the herbicide labels must be followed carefully;
- **Mechanical control methods;** and
- **Biological control methods** that are available.

- **Control methods for dense regrowth:**
 - After initial control operations dense regrowth may arise as new regrowth will sprout in the form of stump coppice, seedlings and root suckers.
- **Chemical control / foliar application:**
 - Plants that are less than 1 m in height must be controlled by foliar application;
 - Dense seedling growth must be controlled with knapsack sprayers with a flat fan nozzle;
 - If grass is present, the use of a registered selective herbicide must be used so as to not harm the grass, and if grass is not present a registered non-selective or selective herbicide can be used; and
 - Suitable dye must be used at all times to limit over- or under spray of areas.
- **Mechanical control:**
 - Areas with dense seedlings should not be uprooted or hoed out, as these areas will result in soil disturbance and will in return promote flushes and germination of alien seedling growth; and
 - When stump density is high, plants should not be cut. This is impractical and there will be many untreated stumps. Instead cut the stumps in dense areas with brush cutters and remove the top growth. Stumps will start to coppice and foliar spray must be used to control the coppice regrowth.



- **Control methods for low-medium density regrowth**
 - Neglecting to control low-medium density regrowth will result in densification and spreading as well as additional control costs.
- **Chemical control:**
 - Cut stump method must be used and stumps must be cut up to a height of 15 cm and must be sprayed within an hour of cutting the plant with a registered herbicide. Herbicide must be applied with knapsack sprayers set to a low pressure, using cone nozzles e.g. TG1 or CE1. Hand sprayers can also be used to apply herbicide. A suitable dye must be used to ensure all stumps are treated. Only the cut surface must be treated with herbicide and the side of the stumps must not be treated; and
 - Foliar spray can be applied to regrowth that is up to the height of 1m. Herbicide must be applied using knapsacks with solid cone nozzle and must be mixed with a suitable dye to prevent over- or under spraying of treated areas.
- **Mechanical control:**
 - Seedlings can be removed from wet soil by hand pulling. Gloves can be used for hand protection during the operation.



APPENDIX F: GENERAL GUIDELINES FOR SPECIES TRANSLOCATION AND PROPAGATION

General transplanting information.

- The river diversion will lead to the loss of vegetation and requires the rescue and relocation of species necessary for the rehabilitation of the river;
- For all RDL and protected species identified for relocation the relevant permits need to be acquired in order to relocate, remove or destroy them. Permits have to be obtained from Department of Environment and Nature Conservation (DENC) one month prior to disturbance of any individuals.
- It should also be noted that transport permits may be required. Cape Nature should be notified of the distance plants will be transported. Furthermore, a permit will be required for the propagation of any of the protected species in the mine nursery.
- All species should be removed manually from the soil with as little damage to the rooting system as possible as well as minimal disturbance of the surrounding veld and vegetation.
- Special care should be taken when transporting plants to their new location. The larger vehicle, a truck or trailer, can reduce the possibility of injury from loading and unloading. Protect leaves of plants from the sun and wind by wrapping or covering while in transit. Cushion stems and branches from injury. Tie the plants down securely and avoid high speed travel²¹.
- Care should be taken with the removal, transport as well as relocation of the plants. Injury may result in introduction of fungi with special mention of bulbs.
- If smaller species such as bulbs are collected, individuals should be placed in a box side by side and not on top of each other to avoid injury to leaves and roots.
- No indiscriminate driving through open veld should be allowed, areas identified for relocation should be accessed with the use of existing roads. From vehicles, plants should be carried on trays or within boxes to the relocation site. Plants should not be stacked on top of each other as this may result in the injury of plants.
- Before plants are removed, the optimum relocation area should be identified. This will ensure no individuals are kept out of the ground for longer periods than absolutely necessary.
- The plants should be relocated the same day as it is removed. Therefore, proper planning prior to removal is vital.
- Storage and care: This should only be considered, if immediate replanting is not at all feasible. To keep the plants alive during storage requires ventilated storage facilities. Ideally, the plants should be kept in an area with environmental conditions similar to those from which they have been removed²².
- If plants are potted and kept for a few months, they will require watering and fertilising. The right watering and nutrient regime will depend on the type of plant. Observing the plant's growth patterns is important and the watering and fertilising regimes will need to be adapted according to the growth periods.
 - Plants from areas where fog has an influence require light watering (once a week) all year round.
 - Mesembs are known to survive longer periods without water and therefore should also only be watered once a week.
 - Species such as geophytes have distinct resting periods during the winter when they should not be watered.
 - Species watered all year round developing strange growth forms, will most probably be more difficult to acclimatise to their natural environment when they are replanted². It is recommended that species prone to developing growth defects should be noted and watering frequency adapted.
- Plants should be relocated to the same altitude, aspect, soil type, orientation to the sun, surrounding vegetation, and similar topography to provide similar shade conditions throughout

²¹ <http://www.extension.umn.edu/distribution/horticulture/dg3825.html>

²² Burke, A. (2005). *Best practice guidelines for minimising impacts on the flora of the southern Namib*. EnviroScience and Namibia Nature Foundation, Windhoek, 52 pp.



the day. Therefore, the original habitat of each species should be carefully documented before removing any individual².

- Plants from a specific vegetation type should be relocated to the same vegetation type. Thus, for the Ga-Mogara River, two zones have been identified, i.e. the river bed and the riparian zone.
- Within the vegetation type the habitat the individual will be taken from should be noted (pan, rocky outcrop, dune habitat) and similar habitat identified within the relocation area². For the Ga-Mogara River, rocky areas, *Tarchonanthus camphoratus* scrub, and mixed *Vachellia* Savanna were identified.
- It is important to mimic the natural floral communities within undisturbed areas; therefore, individuals should not be planted in straight lines but rather randomly. Care should also be taken with the diversity of species ensuring that representatives of all families are planted in each relocation area.
- Rescued individuals should preferably not be relocated to areas where rehabilitation was only recently initiated. Due to historical disturbance of soil, soil chemistry may have changed and could result in plants not establishing successfully. Diversity within these rehabilitated areas should be re-instated with the use of nursery propagated seedlings.
- Plants should be transplanted to areas where netting is already removed or where netting will be removed in the near future. After several years, most of the salt from the soil would have leached and the abundances and height of more common pioneer species would have increased thereby providing shelter for transplanted individuals.
- To establish the success rate of relocation of different species the locations of the relocated individuals should be noted. This will allow monitoring of individuals as well as aid with identification of species that should be propagated in the nursery due to loss of individuals after relocation.
- Care should be taken during the relocation process not to disturb surrounding areas. Disturbance of soil may result in establishment of invader species that may hamper the success of relocation.
- It is recommended that only perennial plants be rescued and relocated. However, seed should be harvested of all annuals for at least two seasons prior to site clearing.
- Initially the rescue and relocation of species will be based on trial and error. It is therefore considered very important that proper record keeping is undertaken during each relocation attempt. Records should state the size of the individual, species (at least family if flowers are absent) as well as the date it was removed. By so doing the success rate during different months as well as success for different sizes and species can be calculated over time.
- Use of fertilisers leads to a change in soil chemistry and nutrient composition, therefore the use of fertilisers in relocation areas is not recommended.
- During on-site relocation try to move as much of the roots and attached soil as possible with the plant. Do not shake off the soil, as it may contain microorganisms (such as mycorrhizal fungi spores) that are important to the plant².
- Some initial trials showed that the time of year that transplants are carried out can be critical. Although there is no information on many species, generally, transplanting and seeding during the early spring months when there is also a chance of follow-up rains, is likely to be the best time. Therefore, it is recommended that the rescue and relocation process is initiated during the rainy season (summer rainfall area). The optimum time for planting is directly after a rainfall event when the soil is still wet and preferably when rain is expected in the days that follow the relocation. To get the timing exactly right; requires observing the plants in question to determine the start of their active period which, for most species, is likely to be the best time to transplant. Transplanting during their resting periods appeared to work for some species, but not many². Species-specific requirements should be prioritised where available.
- Plants that have been kept in a nursery will need some preparation to get them accustomed to their natural environment again. Before planting, plants should be moved into the environment where they are going to be planted. Watering should be reduced. If plants were kept under shade cloth or a roof, individuals should be gradually made accustomed to full sunlight. These plants will most likely require initial watering once planted².



General relocation methods applicable to all species.

- Selected literature indicates that the relocation success rate is not necessarily increased due to the presence of soil around the roots²³. It is suggested that, where possible, all species should be relocated and transplanted with the use of the ball and burlap method²⁴, to ensure the plant is not unnecessarily damaged during removal. Species should be dug up together with an undisturbed ball of soil around the roots. The ball of soil should be wrapped in a burlap (hessian sack) which can then be bound with twine or wire.
- Loosen soil on all sides of the plant with care taken not to damage the roots.
- The hole into which the species will be transplanted should be two times the width of the soil ball and as deep as the root system to be transplanted but not much deeper, that when planted, the plant is just as deep in the new location as in the old.
- Flatten the bottom of the hole and stand in it to firm the soil so that the plant doesn't settle in deeper later.
- Always handle balled and burlapped plants by the soil ball, never by the trunk or crown of the plant.
- Backfill the hole three-fourths full. Cut all twine or wire away from the top of the soil ball and the trunk and remove burlap material very carefully to ensure some of the soil is still around the roots.
- Fill the hole with water to settle the backfill. Finish by filling the hole, but do not pack or stamp this soil.
- Carefully, make a depression around the plant so that water will drain towards the plant.
- Apply a layer of mulch around the base of the plant to help hold in moisture and keep out competing plants¹¹.

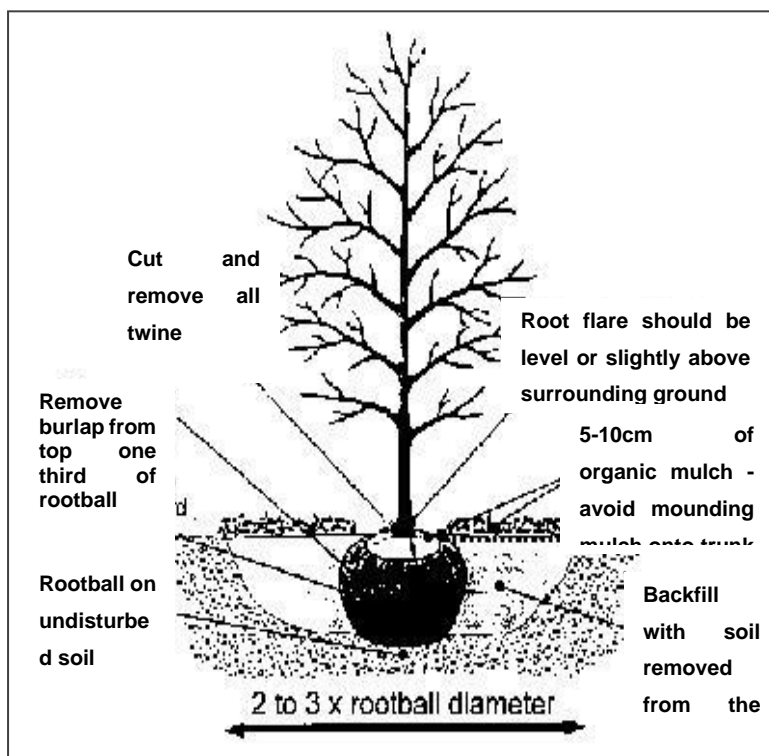


Figure f1: Ball and Burlap relocation method¹¹

²³Environmental Management Plan (2008) – *Wind Energy facility and associated infrastructure*, Western Cape Province, Appendix H

²⁴ <http://www.hort.purdue.edu/ext/HO-100.pdf>

Plant groups regarded as suitable for transplanting:

- Certain plant groups are more suitable for relocation than others such as upright vygies, creeping vygies, large succulents, bulbs, shrubs with succulent leaves.
- **Ideally suited** - Tufted mesembs are leaf-succulent, perennial plants of the family Mesembryanthemaceae (vygies) with no main stem or woody branches.
- **Species on sand plains are suited but should only be transplanted during the cool winter months** - Shrubby mesembs are leaf-succulent Mesembryanthemaceae (vygies) with a shrubby appearance.
- **Most species not suited** - Weedy mesembs are annual, short-lived plants of the family Mesembryanthemaceae (vygies), often with large, fleshy leaves and capsules that disintegrate easily. Most grow low, with long branches creeping on the ground. They are often found in disturbed habitats e.g. *Psilocalon* (asbos, ash bush, grootlidjies, little soap-bush, scorpion mesemb, seepbossie) species.
- **Difficult** – Crassulas are usually small, leafy succulents, often creeping or forming small tufts. There are also some larger stem-succulent species. Most crassulas are found in rocky habitats.
- **Reasonably to very successful, depending on the species** - Euphorbias are a diverse group of stem succulents. They can be small or large, and spiny or spineless, but all have irritating, milky sap.
- **Recommended** - Succulent daisies are shrubby leaf or stem succulents, similar to the shrubby mesembs, but not producing woody capsules. They have daisy-like flowers. Most grow no more than half a metre in height. These plants belong to the family Asteraceae e.g. *Othonna* and *Senecio* species.
- **Likely to be worth transplanting, particularly in sand plain habitat** - Bulbs are lily-like plants with underground storage organs (geophytes) and are only present above ground for short periods during the year e.g. *Nerine laticoma*.
- **Not suited** - Herbs are annual (short-lived) plants that grow from seed each year e.g. *Sesamum triphyllum* species.

When do species flower and set seed?

Information regarding the times at which species flower and set seed is scarce. In order to determine the flowering and seed set periods of species where this information is not available, it is recommended that the locations of plants located within open veld areas be marked with the use of a GPS and inspected regularly for flowers and seed until the flowering and seeding timeframes are established.

Trial quadrants

For species where rescue and relocation methods are not available, it is recommended that rescue and relocation, initially, be undertaken within trial quadrants before significant vegetation clearing is initiated. The following recommendations and principles should be considered for the trial quadrants:

- Maps and locality information provided should be used to identify species used for the trials. It is not recommended that species which are very habitat specific be used for the trials. Other species that were encountered in larger numbers and throughout the study area are considered more suitable.
- Two areas for sample plots should be identified; on the east and west aspects.
- Unless specified differently, each plant should be replanted in an area of at least 2m². This will ensure that areas surrounding transplanted individuals receive as little as possible disturbance, therefore eliminating the likelihood of the species not establishing due to increase in invader species.
- Trails should be undertaken at three times of the year, during August / September (before seasonal rain), January - March (day or two before sufficient rain is expected) and April – May (last rain of the season).
- Every plant transplanted should be noted taking a photographic record with GPS location for follow up monitoring. Labelling and record keeping should be implemented from the start and kept consistent.
- Do not water after transplanting.
- Transplant into rehabilitated areas that have been left undisturbed for several years and in which vegetation has already established to provide wind protection.
- All plots should be monitored 3 monthly to establish effectiveness of relocation efforts. Any change to individuals should be noted.



- If transplanting of any species proves to be unsuccessful, follow-up trials should be undertaken changing variables such as time of the year transplanting takes place and watering of plants e.g. water plants once during the transplanting process and water plants weekly for a month after transplanting.
- All variables (time of year, aspect and species) should be taken into consideration when official site clearing is initiated.

Precautionary measures

In order to ensure establishment of relocated species, the following criteria must be met:

- Each individual or cluster of individuals which are relocated must be clearly marked and a GPS reading noted. This is done to ensure that individuals can be found during monitoring.
- To aid with the search of plants in future, the species of plant should also be noted. If the species are unknown due to the lack of flowers, the family should be noted.
- If necessary, the transplanted individuals should be fenced off, to prevent trampling or grazing of leaves, until fully established in the new environment.
- Species specific watering may be required to ensure the optimum survival of species. During extended dry periods transplanted plants should be monitored and watered (only within the rainy season) if needed.
- Alien vegetation control should take place in areas surrounding species following their relocation in order to minimise the negative effects of contamination by alien seeds in relocated soil.
- Alien vegetation removal should take place every 3 to 6 months, with as little disturbance to surrounding areas as possible.
- Care should be taken during alien vegetation control not to spread seed to open veld areas. It may be helpful to place alien plants in plastic bags which can be closed when transported, however individuals should be removed from bags before they are discarded to prevent littering.
- Cuttings should only be taken from the plants which are to be removed.

General guidelines for plant propagation in nurseries

General information is required to guide the propagation methods for species where no record of previous trails is available and for which species-specific information is lacking.

Labelling and keeping records of collections

A plant label should impart a lot of information about the plant, including:

- Name of the plant:
 - Both the common name and scientific name should be added.
- Date of collection:
 - This is especially important for species that require strict timelines for harvesting and propagation.
- Accession number, which traces the locality where the plant was collected:
 - For rehabilitation purposes this will be vital to ensure that the species will be planted in the correct area of the diverted river, thereby ensuring that the reference state be replicated as far as possible.
- When it was pricked out and planted out:
 - Important for monitoring the success of rehabilitation.

TIP: Colour coded labels can be used to make it easier to track specific species e.g., protected plants, rare plants and pioneers can be given labels with specific colours.



Containers

For cuttings the use of plastic multi-trays is recommended since they do not become waterlogged and plant roots do not grow into the sides of the container (as is the case with polystyrene containers).

Seeding and potting mixes

The soil mix is a medium in which to germinate the seed. It is a free-draining mixture that must be able to hold some moisture to start the germination process. Successful propagation depends greatly on the correct soil mix.

- Ingredients used in soil mixes include coconut palm fibre, coarse river sand, loam or topsoil, milled pine bark, fertiliser or manure.
- For special plants and sensitive collections, hand mixing certain ingredients is recommended. Commercially available composts cater for the general market and are inappropriate for the more specific needs of some plants. It is recommended that some soil from the plant's natural habitat be used as the wild soil inoculates the nursery growing media with soil organisms, such as fungi, which may be useful to the plant you are trying to cultivate.
- Seedling mixes should be able to drain well. The best mixtures are those that use sharp, coarse, 2–4mm grain size river sand. Avoid the use of shale- and clay-based soils that tends to hold too much water.

Watering

Seedling soil should always be kept damp or moist, but not waterlogged. It is very important that the caretaker of the seedlings checks the plants at least twice a day and individually waters those trays that dry out faster. Automatic irrigation systems are not entirely reliable if there are many variables.

Temperature and light

- Morning sun and good ventilation are very important in the area used for germination.
- Raise the trays off the ground onto benches to allow air movement above and below the trays. Slugs and snails attracted to soft succulent vegetable matter and damp conditions, will not be able to reach the trays here.
- Note, however, that elevated trays tend to dry out faster and trays should be monitored at least twice a day to ensure the soil medium does not dry out.

Filling Trays

- Before filling the trays, make sure that all old soil has been removed from the trays, as fungi and other insect pests hide in it and reinvest newly planted seeds.
- Wash the trays, containers, and tools for planting seedlings in Jeyes Fluid, at least a week before planting, and place them in the sun to dry. Sunlight is a great fungicide and it is free.
- Once they are ready, fill the trays with seedling mix to a level about 20 mm from the top. This allows enough room during watering to keep water from spilling over the rim of the tray. Once the medium is level within the tray, tamp it down using a tamping tool.

Sowing seed

- Water the tray thoroughly before sowing the seed. Once sown, the water will help to hold the seed in position in the tray. Sow the seed evenly and sparingly over the surface of the mix in the tray.
- Depending on the kind of seed, you may either have to cover it with a thin layer of mix or push it into the soil to ensure that it is held firmly in place.
- Tamp the seed down and water again, but lightly this time, using a watering can with a fine rose. If the seed is fine, stand the tray in a container of water about half as deep as the mix in the tray. The surface of the seedling mix will change colour as the water seeps up. Once the soil in the tray is saturated, remove the tray and place it in its position in the germination area.



Methods for preparing cuttings

Soft-tip cuttings

Most plants with a soft, herbaceous growth habit are worth trying to propagate using soft tip cuttings. Many plant families provide visual clues as to whether they will root or not, for example, adventitious roots formed at the nodes.

- Cut a shoot that includes the first four nodes: two nodes for the shoot and two nodes for the roots.
- Trim off about half to two thirds of the leaves and use a sharp knife to cut the stem below the base of the lowest node at right angles to the stem.
- Dip the cutting into rooting hormone used for rooting softwood cuttings.
- Make a hole in the rooting medium with a dibber.
- Place the cutting in the hole and tamp the medium back firmly against the stem.
- Water the cutting to help settle it down and wait for it to root. Depending on the plant species, rooting time varies from about ten days to a few weeks.
- Keep damp at all times under a mist system or under waterproof sheeting.

Hard-wood cuttings

Most shrubs and trees can be propagated from cuttings.

- It is preferable to take evergreen plant cuttings at the beginning of the growing season, during spring or early summer. Deciduous plant cuttings should be taken before the end of winter, when the sap is rising, and the buds are about to swell. Deciduous cuttings should be rooted in a protected, but not too moist environment, such as a cold frame. Evergreen cuttings can also be rooted in cold frames, as long as the stems are not too soft.
- Cuttings should be taken from healthy shoots from the previous season's growth. Choose cuttings that are about as thick as a pencil, but not thicker than your finger. Set these according to the same principles as soft tip cuttings.
- A giant form of hardwood cutting is called a truncheon. This is a large branch with a diameter of more than 40 mm. This method works very well for succulent plants and certain tree families, including Anacardiaceae, some Fabaceae, Euphorbiaceae, Burseraceae, and Bombacaceae. In rural areas where piped water is a luxury, this is the best way to propagate figs. The best time to use this method is in late winter or early spring. Root establishment can take up to a full growing season. Bury one-third of the truncheon in soil, while leaving two thirds exposed to produce new growth.

Heel cuttings

Heel cuttings are often the most successful type of cutting for the propagation of shrubs and trees. It involves removing a short, actively growing, side shoot from the main stem. A side shoot is torn off the supporting (main) stem and a part of the main stem is left attached to the base of the cutting. This is called the heel. The roots will appear at the callus tissue that forms around the heel. Again, the process of setting these cuttings is similar to the process followed for hard and soft cuttings.

Leaf cuttings

Some families will produce roots from leaves. This is a slow method that requires patience.

- It is important to let the wound at the leaf-base dry before planting the cuttings in coarse, well-drained river sand.

Another method is to place the leaves on the surface and let the roots develop above ground. Do not keep the sandy medium too wet. The following genera are all capable of producing new plantlets from the leaf bases:

- *Streptocarpus*, African violet (*Saintpaulia*),
- *Sansevieria*,
- *Gasteria*,
- *Haworthia*,
- *Crassula*, and *Kalanchoe*.

Southern African Begonias tend to have tuberous rootstocks and they root better from normal cuttings. Mesems, including *Lithops* and *Conophytum* will all divide from leaves if they are carefully separated

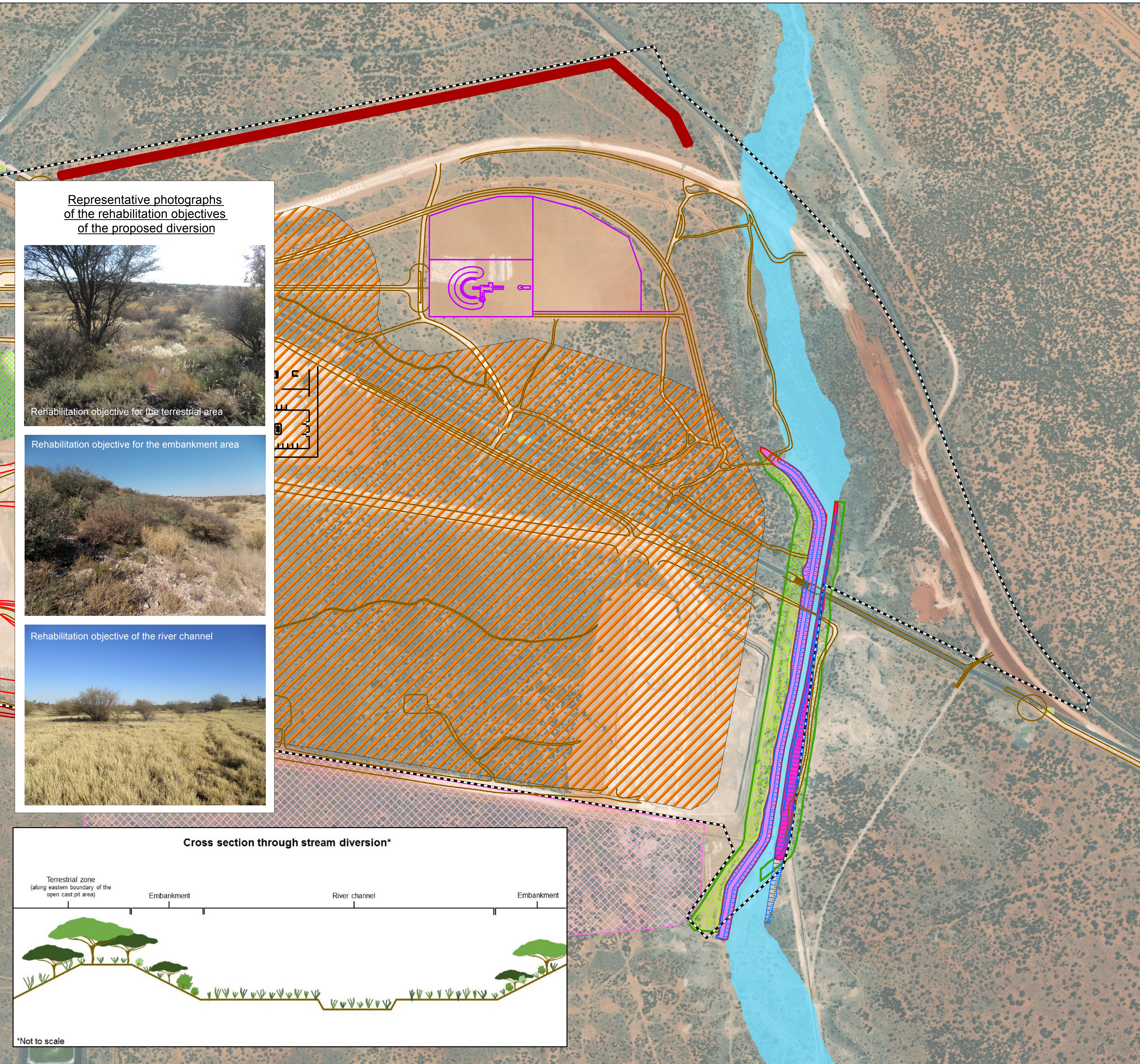


from the parent plant. *Euphorbia* will grow from stems that resemble leaves. Dry out the cut stem for at least a week before striking it in a cutting bed.

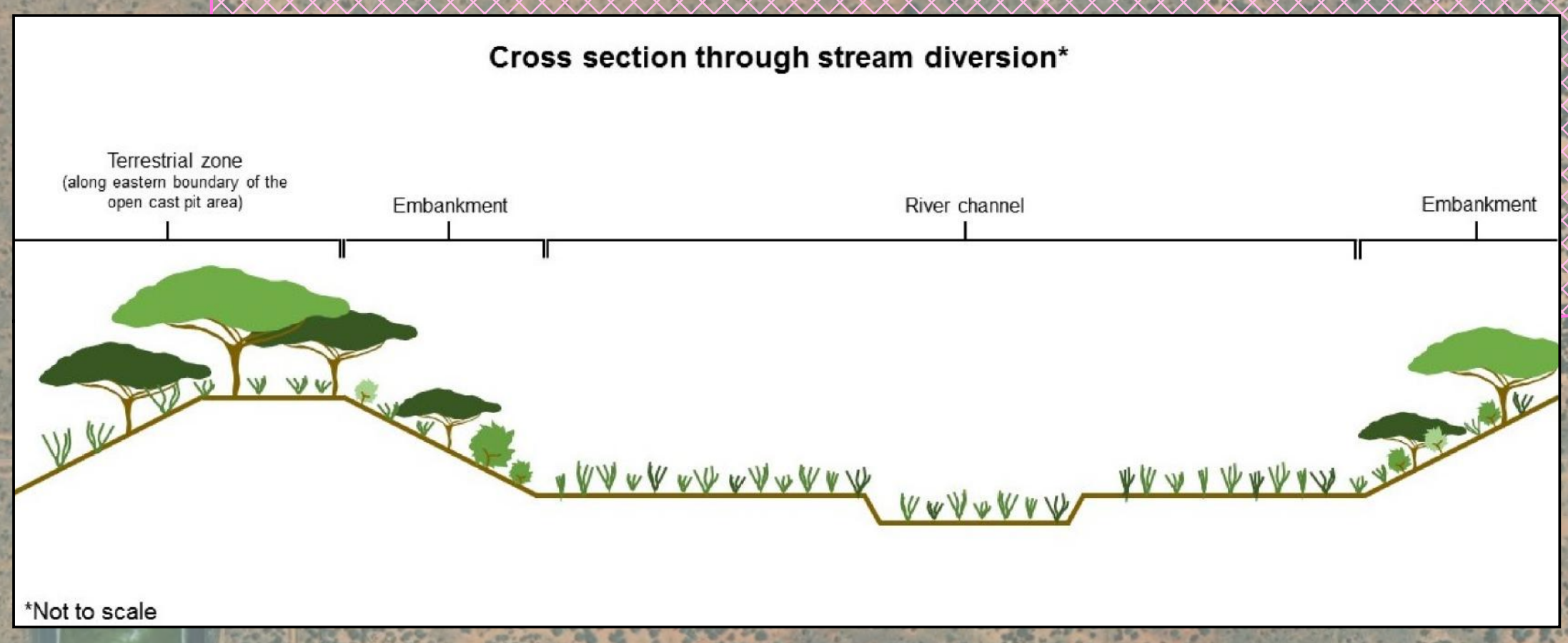
Transplanting seedlings

- A seedling's first leaves are the cotyledons. The next set of leaves are the real leaves. When there are two to four of these 'proper' leaves, the seedlings are ready to be transplanted.
- Water the roots of the seedling so they take on a wet, streamlined shape. Ease the roots into the hole in the soil. Tamp the soil back around the roots and finally fill the hole, leaving about 20–30 mm of freeboard on the surface for water to gather.
- After pricking them out, most plants tend to wilt, but pick up once their roots are settled. It is possible that some plants are lost in the transplanting process. The cause of plant loss is often linked to dried out roots and rough handling.





Representative photographs of the rehabilitation objectives of the proposed diversion



TERRESTRIAL AREAS

- Western Terrestrial Area**
 - Trees & Shrubs**
 - Grewia flava* (d)
 - Lycium spp* (d)
 - Rhigozum trichotomum*
 - Tarchonanthus camphoratus* (d)
 - Vachellia erioloba*
 - Vachellia hebeclada* subsp. *hebeclada*
 - Vachellia haematoxylon*
 - Ziziphus mucronata* (d)
 - Dwarf Shrubs**
 - Gnidia polycephala* (d)
 - Monechma genitifolium* subsp. *australe* (d)
 - Psilocaulon junceum*
 - Salsola rabieana* (d)
 - Forbs**
 - Amellus tridactylus* subsp. *arenarius*
 - Babiana hypogaea* (d)
 - Dicoma capensis*
 - Geigeria ornativa* subsp. *ornativa*
 - Hirpicium echinus*
 - Nerine laticoma* (d)
 - Pentzia calcarea* (d)
 - Sesamum triphyllum*
 - Grasses**
 - Aristida stipitata*
 - Cenchrus ciliaris* (d)
 - Cymbopogon pospischilii*
 - Eragrostis echinochloidea*
 - Schmidtia kalahariensis* (d)
 - Schmidtia pappophoroides* (d)
 - Stipagrostis uniplumis*
- Eastern Terrestrial Area**
 - Trees & Shrubs**
 - Grewia flava* (d)
 - Lycium cinereum*
 - Senegalia mellifera* (d)
 - Vachellia erioloba*
 - Ziziphus mucronata* (d)
 - Dwarf Shrubs**
 - Monechma genitifolium* subsp. *australe* (d)
 - Psilocaulon junceum*
 - Forbs**
 - Amellus tridactylus* subsp. *arenarius*
 - Arctotis leocarpa*
 - Pentzia calcarea* (d)
 - Nerine laticoma*

RIVER EMBANKMENTS

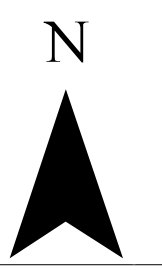
- Western Embankment**
 - Trees & Shrubs**
 - Grewia flava* (d)
 - Lycium spp* (d)
 - Tarchonanthus camphoratus* (d)
 - Vachellia erioloba*
 - Vachellia hebeclada* subsp. *hebeclada*
 - Ziziphus mucronata* (d)
 - Dwarf Shrubs**
 - Gnidia polycephala*
 - Monechma genitifolium* subsp. *australe* (d)
 - Psilocaulon junceum*
 - Salsola rabieana* (d)
 - Forbs**
 - Babiana hypogaea*
 - Nerine laticoma* (d)
 - Pentzia calcarea* (d)
 - Grasses**
 - Cenchrus ciliaris* (d)
 - Cymbopogon pospischilii*
 - Eragrostis echinochloidea*
 - Eragrostis lehmanniana*
 - Fingerhuthia Africana*
 - Schmidtia kalahariensis* (d)
 - Schmidtia pappophoroides* (d)
 - Stipagrostis uniplumis* (d)
- Eastern Embankment**
 - Trees & Shrubs**
 - Grewia flava*
 - Vachellia erioloba*
 - Ziziphus mucronata*
 - Dwarf Shrubs**
 - Monechma genitifolium* subsp. *australe* (d)
 - Forbs**
 - Amellus tridactylus* subsp. *arenarius*
 - Babiana hypogaea*
 - Pentzia calcarea*
 - Nerine laticoma*
- Dwarf Shrubs**
 - Monechma genitifolium* subsp. *australe* (d)
- Forbs**
 - Pentzia calcarea*
- Grasses**
 - Cenchrus ciliaris*
 - Cynodon dactylon* (d)
 - Schmidtia pappophoroides*

DIVERSION CHANNEL/ ACTIVE RIVER CHANNEL

- Dwarf Shrubs**
 - Monechma genitifolium* subsp. *australe* (d)
- Forbs**
 - Pentzia calcarea*
- Grasses**
 - Cenchrus ciliaris*
 - Cynodon dactylon* (d)
 - Schmidtia pappophoroides*

LEGEND

- Ga-Mogara River
- Project Area Layout Changes (Existing and Proposed)
- Approved Waste Rock Dump
- Contractors Area
- Proposed Product Stockpile Area Relocated
- Topsoil Stockpiles
- Roads
- River Diversion
- Relocated low grade stockpile
- Proposed Infrastructure Areas**
 - Barrier Pillar between Kalagadi and Mokala Mine
 - Proposed Open Pit Expansion Area
 - Terrestrial Areas
 - River Embankments



Scientific Aquatic Services
29 Arterial Road West
Oriel, Johannesburg, 2007
Tel 011 616 7893
Fax 086 724 3132
www.sasenvironmental.co.za
admin@sasenvgroup.co.za

NOTES:
Landscape Plan to be read in conjunction with the rehabilitation measures outlined in the Freshwater Assessment and Rehabilitation Plan

REVISION: 00		
NO	DESCRIPTION	DATE

PROJECT: SASTS MOKALA MANGANESE MINE

DESCRIPTION: Landscape Plan

DRAWING NUMBER:
SASTS_MOKALA_LP_01_R0

DATE: 14 JULY 2018
SCALE: 1:10000 (A1)
PURPOSE: Information/Approval

MOKALA MANGANESE MINE Landscape Plan