November 2022

DONAWAY
ENVIRONMENTAL

ALIEN INVASIVE MANAGEMENT PLAN

The Construction of the Beta Photovoltaic Solar Energy Facility near Hertzogville, Free State Province

PROJECT DETAILS

Project title:	**Alien Invasive Management Plan -** The Construction of the Beta Photovoltaic Solar Energy Facility near Hertzogville, Free State Province
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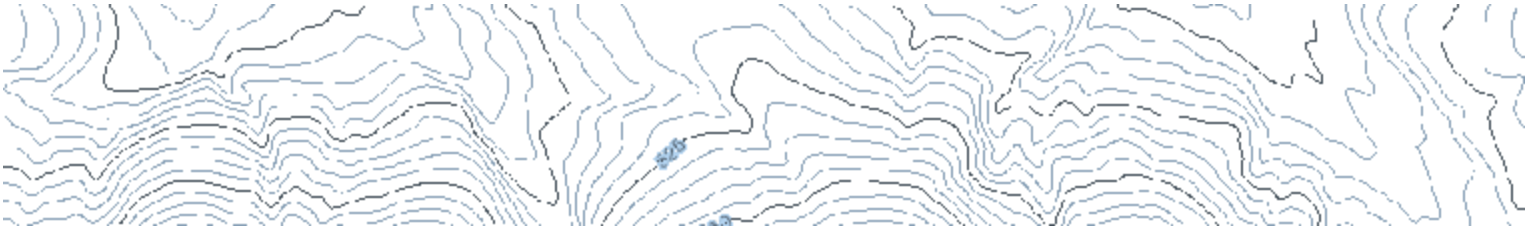

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EXECUTIVE SUMMARY

PROJECT BACKGROUND

Beta Solar Power Plant (RF) (Pty) Ltd is in the process of developing a photovoltaic solar facility and associated infrastructure on the farm Talana 1241, Registration Division Boshof, Free State Province, situated within the Tokologo Local Municipality area of jurisdiction. The site is located approximately 18km east-southeast of Hertzogville. The total footprint of the project will approximately be 115 hectares (including supporting infrastructure on site). The site was identified as being highly desirable due to its suitable climatic conditions, topography (i.e., in terms of slope), environmental conditions (i.e., agricultural potential, geology and archaeology), proximity to a grid connection point (i.e., for the purpose of electricity evacuation), as well as site access (i.e., to facilitate the movement of machinery, equipment, infrastructure and people during the construction phase).

The project will form part of the Department of Mineral Resources and Energy (DMRE) Renewable Energy Independent Power Producer Procurement (REIPPP) Programme. The REIPPP Programme aims to secure 14 725 Megawatts (MW) of new generation capacity from renewable energy sources, while simultaneously diversifying South Africa's electricity mix. According to the 2021 State of the Nation Address, Government will soon be initiating the procurement of an additional 11 800 MW of power from renewable energy, natural gas, battery storage and coal in line with the Integrated Resource Plan 2019 and fulfilling their commitments under the United Nations Framework Convention on Climate Change and its Paris Agreement which include the reduction of greenhouse gas emissions. Eskom, our largest greenhouse gas emitter, has committed in principle to net zero emission by 2050 and to increase its renewable capacity.

The Environmental Impact Assessment (EIA) process for the approved facility was undertaken by Environamics Environmental Consultants. In accordance with the Environmental Authorisation (EA), this Alien Invasive Management Plan will be included in the final EMPr.

APPROACH AND CONTENT

Section 2 provides a summary of the Acts that apply to management of alien plants on site. These are the Conservation of Agricultural Resources Act (Act No. 43 of 1983), the National Environmental Management: Biodiversity Act, 2004 (Act No.10 of 2004) and the Fertilizer, Farm Feeds, Agricultural Remedies and Stock Remedies Act (Act No. 36 of 1947).

Section 3 provides information on the responsibilities of certain entities of the project.

Section 4 provides a summary of the status of invasive alien plants on site. More detailed information is provided for 12 species that are considered to have a high probability of invading the site under the right conditions.

Section 5 provides control guidelines, including specific measures that should be taken during different phases of the project to ensure that alien plants do not become established on site.

Section 6 provides a brief guide to control methods, including mechanical, chemical and biological control, as well as the advantages and disadvantages of each.

Section 7 provides some guidelines for habitat management to ensure that invasive alien plants do not become established on site.

Section 8 provides an outline of safety standards and guidelines, specifically for the handling of herbicides as well as for the use of Personal Protective Equipment.

Section 9 gives an outline of monitoring requirements for early detection of invasive alien plants on site as well as to evaluate the success of clearing operations. The monitoring covers all phases of the project from construction to decommissioning.

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LIST OF ACRONYMS

DEA	Department of Environmental Affairs (National)
DEAT	Department of Environmental Affairs and Tourism
DFFE	Department Forestry, Fisheries and the Environment
DMRE	Department of Mineral Resources and Energy
DM	District Municipality
EA	Environmental Authorisation
ECA	Environment Conservation Act (No. 73 of 1989)
ECO	Environmental Control Officer
EHS	Environmental, Health and Safety
EIA	Environmental Impact Assessment
EMPr	Environmental Management Programme
ha	Hectares
IPP	Independent Power Producer
km	Kilometre
kV	Kilovolt
MW	Megawatt
NEMA	National Environmental Management Act (No. 107 of 1998)
OHS	Occupational Health and Safety
PV	Photovoltaic
RE	Renewable Energy
REDZ	Renewable Energy Development Zone
REIPPP	Renewable Energy Independent Power Producer Procurement Programme
SEF	Solar Energy Facility
SPP	Solar Power Plant
ToR	Terms of Reference

1. INTRODUCTION

1.1. Project Background

Beta Solar Power Plant (RF) (Pty) Ltd is in the process of developing a photovoltaic solar facility and associated infrastructure on the farm Talana 1241, Registration Division Boshof, Free State Province, situated within the Tokologo Local Municipality area of jurisdiction. The site is located approximately 18km east-southeast of Hertzogville. The total footprint of the project will approximately be 115 hectares (including supporting infrastructure on site). The site was identified as being highly desirable due to its suitable climatic conditions, topography (i.e., in terms of slope), environmental conditions (i.e., agricultural potential, geology and archaeology), proximity to a grid connection point (i.e., for the purpose of electricity evacuation), as well as site access (i.e., to facilitate the movement of machinery, equipment, infrastructure and people during the construction phase).

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1.2. Project Location

The proposed Beta SPP is located approximately 18km east-southeast from the town of Hertzogville, bordering the R708 Regional Road.

Please refer to **Figure 1.1** below, Locality Map.

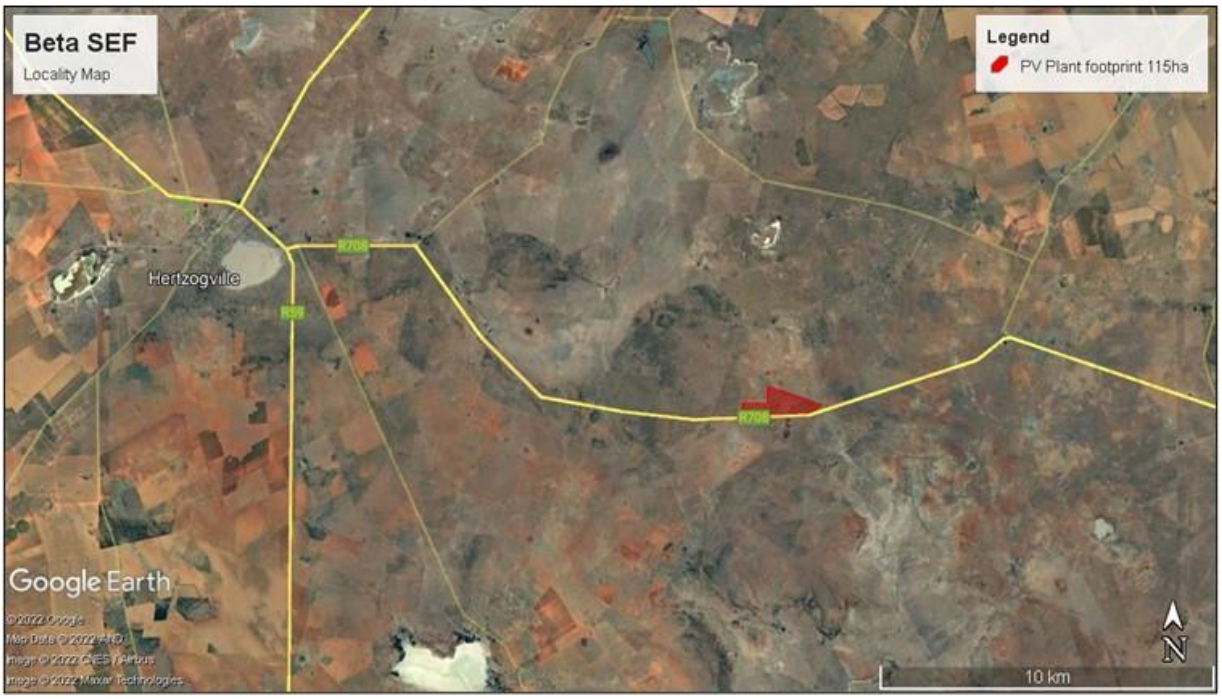

Figure 1: Locality Map.

1.3. Purpose of the Alien Invasive Management Plan

The purpose of the alien management plan is:

- to ensure that alien plants do not become established on site;
- to ensure that alien plant species do not become dominant in all or parts of the landscape; and
- to implement a monitoring programme to detect the presence of alien plant species as well as to monitor the success of the alien management plan.

1.4. Project Team and Experience

The project team will consist of Johan Botha.

Johan Botha graduated with an Honours degree in 2011 from the North West University in the field of Environmental Sciences specialising in Geography and Environmental Management and has since been involved in the environmental management of substations, powerlines and solar PV plants together with Visual Impact Assessments (VIA), Social Impact Assessments (SIA) and management plans mostly in the field of Renewable Energy. All the above-mentioned experience accumulated the necessary skills to conduct visual and social impact assessments.

2. LEGAL FRAMEWORK

2.1. Conservation of Agricultural Resources Act (Act No. 43 of 1983)

In terms of the regulations under the Conservation of Agricultural Resources Act (Act No. 43 of 1983), all declared aliens must be effectively controlled. Landowners are legally responsible for the control of invasive alien plants on their properties. In terms of this Act 198 alien species were listed as declared weeds and invaders and ascribed to one of the following categories:

- Category 1: Prohibited and must be controlled.
- Category 2 (commercially used plants): May be grown in demarcated areas provided that there is a permit and that steps are taken to prevent their spread.
- Category 3 (ornamentally used plants): May no longer be planted. Existing plants may be retained as long as all reasonable steps are taken to prevent the spreading thereof, except within the flood line of watercourses and wetlands.

2.2. National Environmental Management: Biodiversity Act, 2004 (Act No.10 of 2004)

The National Environmental Management: Biodiversity Act (NEMBA) regulates all invasive organisms in South Africa, including a wide range of fauna and flora. Regulations have been published in Government Notices R.506, R.507, R.508 and R.509 of 2013 under NEMBA. According to this Act and the regulations, any species designated under section 70 cannot be propagated, grown, bought or sold without a permit. Below is an explanation of the three categories:

- Category 1a: Invasive species requiring compulsory control. Any specimens of Category 1a listed species need, by law, to be eradicated from the environment. No permits will be issued.
- Category 1b: Invasive species requiring compulsory control as part of an invasive species control programme. Remove and destroy. These plants are deemed to have such a high invasive potential that infestations can qualify to be placed under a government sponsored invasive species management programme. No permits will be issued.
- Category 2: Invasive species regulated by area. A demarcation permit is required to import, possess, grow, breed, move, sell, buy or accept as a gift any plants listed as Category 2 plants. No permits will be issued for Cat 2 plants to exist in riparian zones.
- Category 3: Invasive species regulated by activity. An individual plant permit is required to undertake any of the following restricted activities (import, possess, grow, breed, move, sell, buy or accept as a gift) involving a Category 3 species. No permits will be issued for Cat 3 plants to exist in riparian zones.

It is important to note that alien species that are regulated in terms of the Conservation of Agricultural Resources Act (Act 43 of 1983) (CARA) as weeds and invader plants are exempted from NEMBA. This implies that the provisions of the CARA in respect of listed weed and invader plants supersede those of NEMBA.

2.3. Fertilizer, Farm Feeds, Agricultural Remedies and Stock Remedies Act (Act No. 36 of 1947)

According to Government Notice No. 13424 dated 26 July 1992, it is an offence to "acquire, dispose, sell or use an agricultural or stock remedy for a purpose or in a manner other than that specified on the label on a container thereof or on such a container".

Contractors using herbicides need to have a valid Pest Control Operators License (limited weeds controller) according to the Fertilizer, Farm Feeds, Agricultural Remedies and Stock Remedies Act (Act No. 36 of 1947). This is regulated by the Department of Agriculture, Forestry and Fisheries.

3. RESPONSIBLE PARTIES

Effective management of alien plant species during the construction and operational phases of the project will be dependent on a number of project personnel. These are listed below:

3.1. The Developer

This refers to the project proponent, Beta Solar Power Plant (RF) (Pty) Ltd. They will be responsible for the following:

- Ensure that the requirements set out in this management plan are adhered to and implemented;
- Allocate the responsibilities assigned to the Environmental Control Officer (ECO) to an independent suitably qualified individual prior to the start of construction activities on site; and
- Provide all principal contractors working on the project with a copy of this management plan as part of tender contract documentation to allow the contractors to cost for its requirements within their respective construction contracts.

3.2. The Engineer

The engineer of the proposed development will be responsible for the overall implementation of the management plan during the construction phase of the project. To effectively implement the alien management plan, the engineer must be aware of the findings, mitigation measures and conclusions of the Final EIA report, the requirements of the EA, and this management plan.

3.3. The Environmental Control Officer (ECO)

The ECO is responsible for monitoring and verifying the implementation of the management plan during the construction phase of the project. To effectively implement the management plan, the ECO must be aware of the findings, mitigation measures and conclusions of the Final EIA Report, the EA, and this management plan.

3.4. The Contractor

The contractor, being any directly appointed company or individual undertaking the implementation of works, will be responsible for complying with the management plan at all times during the construction phase.

4. CURRENT STATUS OF ALIEN SPECIES IN THE AREA

This section provides an outline of the existing status of the site and the surrounding area with respect to alien invasive plant species as well as problem species. The purpose is to provide an indication of the likelihood of such plants becoming established on site and the likely identity of such species.

4.1. Vulnerable ecosystems and habitats

Invasive alien plants threaten three main components of the landscape:

- agricultural potential of the land;
- biodiversity value of the land;
- water quality and quantity.

Some habitats are more vulnerable to invasion by alien and problem plant species than others and are therefore more likely to become problematic areas with respect to management of such plant species. In addition, some parts of the site will be subject to greater levels of disturbance than others, which will promote conditions suitable for invasion by alien and problem plant species. Although any part of the site could become invaded by alien plants, the areas on site that are most likely to be problematic from the point of view of invasion by alien plants are as follows:

- drainage lines and watercourses;
- areas with deeper soils, including primarily valley bottom areas;
- areas immediately adjacent to any disturbance due to construction activities;
- areas prone to increased runoff following construction, for example road margins;
- areas of prolonged disturbance, for example, construction camps and laydown areas.

4.2. Alien species observed in the general area

Based on a literature and database search, the following alien invasive plant species have been previously recorded in the general geographical area and could potentially become established on site. The species highlighted in bold have all been observed in the area or the study site and therefore have greater potential to invade the site under favourable conditions:

Botanical Name	Common Name	CARA Category
Agave americana	American agave	Proposed
Argemone ochroleuca	Mexican poppy	1
Datura ferox	Large thorn apple	1
Eucalyptus camaldulensis	Red river gum	2
Harrisia martini	Moon cactus	1
Melia azeradach	Syringa	3
Nicotiana glauca	Wild tobacco	1

Opuntia aurantiaca	Jointed cactus	1
Opuntia ficus-indica	Prickly Pear	1
Opuntia imbricata	Imbricate prickly pear	1
Opuntia stricta	Australian pest pear	1
Populus deltoides	Match poplar, cottonwood	Proposed
Populus nigra var. *italica*	Lombardy poplar	Proposed
Populus X canescens	Grey poplar	2
Prosopis glandulosa var. *torreyana*	Honey mesquite	2
Prosopis velutina	Velvet mesquite	2
Pyracantha angustifolia	Yellow firethorn	3
Salix babylonica	Weeping willow	2
Schinus molle	Pepper tree	Proposed
Xanthium spinosum	Spiny cocklebur	1
Xanthium strumarium	Large cocklebur	1

4.2.1. American Agave

Botanical Name: *Agave americana*

Category: 3 in the Western Cape but not listed elsewhere. Best practice to control.

Impact: Invades dry habitats, rocky outcrops, drainage lines. Agave Americana forms an impenetrable barrier because the leaves are tipped with a spine. The plant is still used as a barrier. Cultivated worldwide as an ornamental plant.

Control: Can be controlled with the direct injection of concentrated MSMA into the bole. When the plants have dried out, they can be cleared by burning. Physical removal is restricted to the use of bulldozers.

Figure 2: American Agave

4.2.2. Large Thorn Apple

Botanical Name: *Datura ferox*

Category: 1b

Impact: Invades wastelands, cultivated lands, roadsides, riverbanks, riverbeds. Declared as weeds not only because they are poisonous, but also because of their tall and aggressive growth habit. Difficult to control and contaminate crops such as maize. One seed per 10 kg can cause rejection of maize crop.

Control: Being deep germinators, these weeds are not adequately controlled by many pre-emergence herbicides. In annual crops, it is best to delay treatment as long as possible in order to catch late germinating individuals.

Figure 3: Large Thorn Apple.

4.2.3. Red River Gum

Botanical Name: *Eucalyptus camaldulensis*

Category: 2

Impact: It competes with and replaces indigenous riverine species. Extensive stands along watercourses are likely to cause a significant reduction in stream flow. It draws up a large amount of water from the ground, contributes to soil erosion and adversely affects nutrient cycling and soil properties.

Control: Juvenile trees up to one meter can be de-rooted by hand. Ring-barking is useful for killing large trees. A cane knife or axe is used to remove the tree's bark and cambium, in a horizontal band about 30cm wide (about 50cm from the ground). Herbicide, if used, should be applied immediately after ring-barking on the cut area. Large trees can also be cut down and a herbicide applied to the newly exposed stem. Livestock should not be exposed to fresh cut leaves as digesting it can be lethal.

Figure 4: Red River Gum.

4.2.4. Syringa

Botanical Name: *Melia azeradach*

Category: 1b and 3 in urban areas.

Impact: Can form dense stands restricting the regeneration of native species. Its leaf litter may alter soil chemistry increasing pH. Its flowers are a respiratory irritant and its leaves, bark flowers and sometimes fruit are poisonous.

Control: Juvenile trees up to one meter can be de-rooted by hand. Ring-barking is useful for killing large trees. A cane knife or axe is used to remove the tree's bark and cambium, in a horizontal band about 30cm wide (about 50cm from the ground). Herbicide, if used, should be applied immediately after ring-barking on the cut area. Large trees can also be cut down and an herbicide applied to the newly exposed stem.

Figure 5: Syringa.

4.2.5. Imbricate Prickly Pear

Botanical Name: *Opuntia imbricata*

Category: 1

Impact: Invades Karoo, dry savanna and grassland. Each piece that breaks off the main plant is capable of rooting and producing a new plant. If the plant is cut down, all pieces must be collected and destroyed. Ease of growth, rapid spread and unpleasant spines result in infested areas becoming inaccessible

Control: Chemical control is restricted to the spraying or injecting of MSMA or glyphosphate, but it is time-consuming and costly. The introduction of cactoblastis as a biocontrol agent has greatly reduced the problem.

Figure 6: Imbricate Prickly Pear.

4.2.6. Australian Pest Pear

Botanical Name: *Opuntia stricta*

Category: 1b

Impact: Invades savanna and dry grassland. Propagates easily from the leaf-pads or cladodes. Even a small piece lying on the ground can produce roots and flourish.

Control: Chemical control is possible with several herbicides, such as MSMA and glyphosphate. However, continues to be kept under control by the use of the Cactoblastis moth and a cochineal insect, *Dactylopius opuntiae*. Special control measures are rarely required. Cochineal insects are not very mobile so isolated plants must be inoculated manually by placing an infected cladode on top of the plant to be controlled.

Figure 7: Australian Pest Pear.

4.2.7. Weeping Willow

Botanical Name: *Salix babylonica*

Category: 2

Impact: Damaged ecosystem services Ecosystem change/ habitat alteration. Reduces native biodiversity. Extensive stands along watercourses are likely to cause a significant reduction in stream flow. It draws up a large amount of water from the ground.

Control: Juvenile trees up to one meter can be de-rooted by hand. Ring-barking is useful for killing large trees. A cane knife or axe is used to remove the tree's bark and cambium, in a horizontal band about 30cm wide (about 50cm from the ground). Herbicide, if used, should be applied immediately after ring-barking on the cut area. Large trees can also be cut down and an herbicide applied to the newly exposed stem.

Figure 8: Weeping Willow.

4.2.8. Velvet Mesquite

Botanical name: *Prosopis velutina*

Category: 1b

Impact: Invades riverbeds, riverbanks, drainage lines and sometimes open veld in semi-arid to arid areas. Seed pods are eaten by livestock and game and thereby spread. The plant is extremely tolerant of drought, high temperatures and overgrazing. It forms dense thickets, thereby excluding natural vegetation.

Control: Control is difficult because plants damaged by inadequate removal, resprout from dormant buds just below ground level, resulting in a dense multi-stemmed shrub. Cut-stump, foliar and soil-applied herbicide registrations exist, but with either chemical or physical control, follow-up treatments are always necessary.

Figure 9: Velvet Mesquite.

5. CONTROL GUIDELINES

This section provides an outline of the overall approach that should be adopted at the site in order to minimize the probability of invasive alien plants becoming established and ensuring that any outbreaks are managed quickly to ensure that they do not become a long-term problem on site. The establishment of any dense infestations will be expensive to eradicate and will require more complex control measures than would be necessary for low density invasions.

5.1. Prevention

A prevention strategy should be considered and established, including regular surveys and monitoring for invasive alien plants, effective rehabilitation of disturbed areas and prevention of unnecessary disturbance of natural areas. Prevention could also include measures such as washing the working parts and wheels of earth-moving equipment prior to it being brought onto site, visual walk-through surveys every three months and other measures, as listed in the section below ("Habitat management").

5.2. Early identification and eradication

Monitoring plans should be developed which are designed to catch Invasive Alien Plant Species shortly after they arrive in the project area. Keeping up to date on which weeds are an immediate threat to the site is important, but efforts should be planned to update this information on a regular basis. When new Invasive Alien Plant Species are spotted an immediate response of locating the site for future monitoring and either hand-pulling the weeds or an application of a suitable herbicide should be planned. It is, however, better to monitor regularly and act swiftly than to allow invasive alien plants to become established on site.

5.3. Containment and control

If any alien invasive plants are found to become established on site, action plans for their control should be developed, depending on the size of the infestations, budgets, manpower considerations and time. Separate plans of control actions should be developed for each location and/or each species. Appropriate registered chemicals and other possible control agents should be considered in the action plans for each site/species. The key is to ensure that no invasions get out of control. Effective containment and control will ensure that the least energy and resources are required to maintain this status over the long-term. This will also be an indicator that natural systems are impacted to the smallest degree possible.

5.4. Construction phase activities required

The following management actions are required to minimize soils and vegetation disturbance during the construction phase, as well as reducing the probability that invasive alien plants will become established on site:

Table 1: Construction phase activities required

Action	Frequency
The Environmental Control Officer (ECO) is to provide permission before any natural vegetation is to be cleared for development.	Daily / when required
Clearing of vegetation must be undertaken as the work front progresses if possible.	Weekly
Should revegetation not be possible immediately, the cleared areas must be protected with packed brush or appropriately battered with fascine work (fixing horizontal branches along the ground using vertical pegs to create resistance to down-slope flow of water/materials). Alternatively, jute (Soil Saver) may be pegged over the soil to stabilize it.	Weekly
Organic matter used to encourage regrowth of vegetation on cleared areas should not be brought onto site from foreign areas. Brush from cleared areas should be used as much as possible. The use of manure or other soil amendments should not be used as this would encourage invasion.	Weekly
Care must be taken to avoid the introduction of alien invasive plant species to the site. Particular attention must be paid to imported material such as building sand or dirty earth-moving equipment. Stockpiles should be checked regularly and any weeds emerging from material stockpiles should be removed.	Weekly
ECO to survey site once a month to detect aliens and have them removed.	Monthly
Alien vegetation regrowth must be controlled throughout the entire site during the construction period.	Monthly
The alien plant removal and control method guidelines should adhere to best practice for the species concerned. Such information can be obtained from the Working for Water website as well as herbicide guidelines.	Monthly
Clearing activities must be contained within the affected zones and may not spill over into adjacent no-go areas. No-go areas should be clearly demarcated prior to construction.	Daily

5.5. Operational phase activities required

The following management actions are aimed at maintaining non-invaded areas clear of invasive alien species as well as reducing the abundance of any aliens on site:

Table 2: Operational phase activities required

Action	Frequency
Surveys for alien species should be conducted regularly. All aliens identified should be cleared.	Every 3 months for 2 years and biannually thereafter.
Revegetation with indigenous, locally occurring species should take place in areas where natural vegetation is slow to recover or where repeated invasion has taken place.	Biannually, but revegetation should take place at the beginning of the rainy season.
Areas of natural vegetation that need to be maintained or managed to reduce plant height or biomass, should be controlled using methods that leave the soil protected.	When necessary
No alien species should be cultivated on site. If vegetation is required for aesthetic or other purposes, then non-invasive locally occurring species should be used.	When necessary

5.6. Decommissioning phase activities required

Although it is not anticipated that the site will be decommissioned, the following management actions are aimed at preventing invasion by invasive alien species of revegetated areas created during decommissioning activities:

Table 3: Decommissioning phase activities required

Action	Frequency
All damaged areas shall be revegetated upon completion of activities.	Once-off
Revegetation with indigenous, locally occurring species should take place in disturbed areas. Reseed with locally sourced seed of indigenous grass species that were recorded on site prior to construction.	Once off, with annual follow-up revegetation, if necessary
Maintain alien plant monitoring and removal programme for 2 years after rehabilitation with the potential for extension if revegetation is not to the satisfaction of the auditor.	Biannually for 2 years

6. CONTROL METHODS

This section provides an outline of existing control measures that have published for the various alien plant species that could potentially occur on site. The section is a summary of control measures – there are more detailed publications for control measures. Some of these publications are referenced.

There are various means of managing invasive alien plants:

6.1. Mechanical Control

This entails damaging or removing the plant by physical action. Different techniques could be used, e.g., uprooting, felling, slashing, mowing, ringbarking or bark stripping. This control option is only really feasible in sparse infestations or on small scale, and for controlling species that do not coppice after cutting. Species that tend to coppice need to have the cut stumps or coppice growth treated with herbicides following the mechanical treatment. Mechanical control is labour intensive and therefore expensive, and could cause severe soil disturbance and erosion. For the current project, hand-pulling or manual removal using hand tools will be the most appropriate methods since there are no existing dense stands of invasive alien plants.

Table 4: Mechanical control advantages and disadvantages

Advantages	Disadvantages
Effective method in areas with low infestation.	Not an effective method for dense infestations, as the cost of clearing is extremely high, with little or no impact.
High job creation and associated poverty alleviation potential.	Time consuming.
No contamination of water with herbicides.	If no herbicides are used then the manual control techniques must be very well executed to ensure success.

6.2. Chemical Control

Chemical control should only be used as a last resort, since it is hazardous for natural vegetation. It should not be necessary if regular monitoring is undertaken, which should be effective for controlling invasive alien plants.

Chemical control involves the use of registered herbicides to kill the target weed. Managers and herbicide operators must have a basic understanding of how herbicides function. The use of inappropriate herbicides and the incorrect use of the appropriate herbicides are wasteful, expensive practices and often do more harm than good, especially when working close to watercourses. Some herbicides can quickly contaminate fresh water and/or be transported downstream where they may remain active in the ecosystem.

Contractors using herbicides are required to have a permit according to Fertilizer, Farm Feeds, Agricultural Remedies and Stock Remedies Act (Act No. 36 of 1947). Herbicides are either classified as selective or non-selective. Selective herbicides are usually specific to a particular group of plants, e.g.,

those specified for use on broad leaf plants, but should not kill narrow-leaf plants such as grasses. Non-selective herbicides can kill any plant that they come into contact with and are therefore not suitable for use in areas where indigenous vegetation is present.

Chemical application techniques include foliar (leaf) application, stem applications (basal stem, total frill, stem injections) and stump applications (cut stump, total stump, scrape and paint):

Table 5: Chemical control advantages and disadvantages

Advantages	Disadvantages
Complements mechanical control methods, increasing the effectiveness of control activities.	May kill non-target plants or species. This is a very important consideration and poses risks for remaining natural areas on site.
Achieve results over short period (within 6 weeks of application).	Herbicides are expensive.
Large areas can be treated quickly.	The use of herbicides may contaminate sites used for drinking water, for washing and for fishing, and can therefore threaten human and animal health.
	Specialized training and certification is required for use of herbicides.

6.3. Biological Control

Biological weed control consists in the use of natural enemies to reduce the vigour or reproductive potential of an invasive alien plant. Biological control agents include insects, mites, and micro-organisms such as fungi or bacteria. They usually attack specific parts of the plant, either the reproductive organs directly (flower buds, flowers or fruit) or the seeds after they have dropped. The stress caused by the biological control agent may kill a plant outright or it might impact on the plant's reproductive capacity. In certain instances, the reproductive capacity is reduced to zero and the population is effectively sterilized. All of these outcomes will help to reduce the spread of the species.

To obtain biocontrol agents, provincial representatives of the Working for Water Programme or the Directorate: Land Use and Soil Management (LUSM), Department of Agriculture, Forestry and Fisheries (DAFF) can be contacted.

Table 6: Biological control advantages and disadvantages

Advantages	Disadvantages
Most environmentally friendly and most sustainable of all control methods.	Generally slow, especially initially.

Usually does not require high or long-term maintenance.	Low levels of infestation, with occasional outbreaks, will remain a feature of systems under biological control.
Relatively low-cost implication over the long term.	Any use of chemicals around biocontrol agent colonies may adversely affect the potency of this control method.
	Cannot be used where the biocontrol agent would threaten commercial populations of the target species that may exist nearby.
	Biocontrol agents are not available for all target species.

7. HABITAT MANAGEMENT

The best way to prevent invasion by alien invasive plant species is to manage the natural vegetation in such a way as to reduce the opportunity for these plants becoming established. The general principle is to not disturb any areas beyond the footprint of the proposed infrastructure and to also ensure that the natural processes that maintain vegetation patterns are not disrupted.

Post-removal follow-up and rehabilitation

Re-establishment of indigenous vegetation needs to be undertaken to reduce the probability of re-emergence of invasive alien plants and to reduce the risk of soil erosion where the soil surface is poorly vegetated. In most soils, the seeds and other propagules of the plants of the former natural habitat still survive, thus natural regeneration without the need for planting may be possible in many cases. However, if natural regeneration is not likely due to the length of time since disturbance or if the soil has been disturbed to such a degree that seeds and propagules no longer survive then planting or seeding may be required. Rehabilitation should follow these steps:

1. Monitor cleared areas on a regular basis (monthly during construction and three-monthly during operation) for emergent seedlings of invasive alien species and remove these (hand pulling or chemical control).
2. All areas of exposed soil should immediately be protected by placing packed brush on the slope, or creating erosion control barriers using branches, sticks or logs placed horizontally across the slope at 1m intervals (the steeper the slope the closer the barriers should be placed to one another). If topsoil has been lost, rehabilitation of indigenous vegetation will be a difficult and expensive process.
3. If the soil remains relatively undisturbed and the area has some indigenous vegetation left intact, the natural regeneration process of the indigenous vegetation on the site should be managed. This involves regular follow-up to remove emerging invasive alien plants and protecting the area from other forms of disturbance (heavy grazing, trampling, disturbance by vehicles, etc.) while the vegetation re-established naturally.
4. If required, indigenous vegetation can be planted on the cleared areas. This can be in the form of a seed mix or plants rescued from previous clearing.

8. SAFETY STANDARDS AND GUIDELINES

Safety is of the utmost importance when working with invasive alien plant control. Staff is likely to be working in remote areas with potentially dangerous equipment and chemicals. Proper safety training and equipment is therefore required.

8.1. Herbicide safety

Herbicides must be stored in a dedicated storeroom.

The Herbicide Storeroom needs to comply with national Occupational Health and Safety standards. Some important safety rules are as follows:

- An herbicide storeroom must have adequate ventilation. If the air is stagnant or there is a smell of herbicides when opening up the storeroom then it is a good indication that there is not enough ventilation.
- Clean water needs to be available in close proximity to the storeroom.
- The floor must be non-porous. This is important because when the floor is cleaned (which must be done regularly), no residue of herbicides must remain. Place herbicide containers on wooden pallets to increase ventilation and make mopping up after spillage easier.
- 'No Smoking' and 'No Fire' signs should be posted on the door of the storeroom as well as a sign stating that it is a chemical store and who the responsible person is for the store.
- Keep the storeroom locked to prevent herbicide getting into the wrong hands.
- A spill kit needs to be kept in the storeroom to mop up any spill. The spill kit must contain a bucket with sand and a spade. The sand is to be placed on the spill to absorb the liquid. Once the sand has absorbed the spill, it is to be collected and disposed of where it cannot contaminate the environment. It is preferable to keep contaminated sand in a container and dispose of it with empty containers at a certified chemical recycling plant.
- Obtain the Material Safety Data Sheet from the supplier of the herbicide and ensure that you are familiar with the product before using it. Keep the Material Safety Data Sheet in the storeroom in case of an emergency.
- Always store herbicides in the original labelled container to avoid confusion with other products. Do not store other products in the store, such as protective clothing, food, etc., as they can become contaminated.
- All empty herbicide containers, or herbicides that have reached their expiry date, need to be safely disposed of. This can be done at a registered chemical recycling company. It is important that all empty containers are spiked before disposal. This ensures that they cannot later be used for carrying drinking water, food, etc.
- The contact number for the nearest Poison Control Centre should be posted nearby.

8.2. Personal Protective Equipment (PPE)

The use of Personal Protective Equipment (PPE) by staff controlling invasive alien plants in the field is required by law. The PPE specifications differ for the different types of control. Mechanised control

includes the use of chainsaws and brush cutters and will therefore require slightly different PPE from someone using manual control (slasher, knapsack sprayer, etc.). PPE required for manual control is as follows:

Table 7: PPE items

Item	Specification
Overall	100% cotton, two-piece overalls are best for absorbing perspiration, they last longer and are cooler.
Rubber gloves	Standard, wrist-length rubber gloves are sufficient.
Leather gloves	Standard wrist-length leather gloves are appropriate.
Safety boots	Gumboots or standard safety boots, which support the ankles, are sufficient. Steel toecaps are recommended for workers that are working with heavy equipment or large trees.
Hat	If working with large trees, on steep gradients or if any other safety risk may be present, then wearing a hardhat is advisable. Otherwise, a wide-brim hat can be used to protect the worker from the sun.
Safety glasses	Large, clear safety glasses, which allow air to pass through, are acceptable.
Face mask	A face mask which covers the nose and mouth is essential when mixing herbicides and for foliar spraying.

9. MONITORING PROGRAMME

In order to monitor the impact of clearing activities, follow-ups and rehabilitation efforts, monitoring must be undertaken. This section provides a description of a possible monitoring programme that will provide and assessment of the magnitude of alien invasion on site as well as an assessment of the success of the management programme. Based on the detailed pre-construction walk-through survey in which declared alien invasive plant species were found on site, the baseline condition prior to construction is assumed to be one in which some alien plants are present.

In general, the following principles apply for monitoring:

- Photographic records must be kept of areas to be cleared prior to work starting and at regular intervals during initial clearing activities. Similarly, photographic records should be kept of the area from immediately before and after follow-up clearing activities. Rehabilitation processes must also be recorded.
- Simple records must be kept of daily operations, e.g., area/location cleared, labour units and, if ever used, the amount of herbicide used.
- It is important that, if monitoring results in detection of invasive alien plants, that this leads to immediate action.

9.1. Construction phase monitoring

The following monitoring is required during the construction phase of the project:

Table 8: Construction phase monitoring

Monitoring action	***Indicator***	***Timeframe***
Document alien species present on site	Alien species list	Pre-construction & monthly thereafter
Alien plant distribution	Distribution maps, GPS coordinates	Monthly
Document and record alien control measures implemented	Record of clearing activities	6-monthly
Review alien control success rate	Decline in abundance of alien plant species over time	Annually

9.2. Operational phase monitoring

The following monitoring is required during the construction phase of the project:

Table 9: Operational phase monitoring

Monitoring action	***Indicator***	***Timeframe***
Document alien species distribution and abundance on site	Alien species distribution maps	Annually
Document alien plant control measures implemented & success rate achieved	Records of control measures and their success rate.	Annually
Document rehabilitation measures implemented and success achieved in problem areas	Decline in vulnerable bare areas over time	Annually

9.3. Decommission phase monitoring

The following monitoring is required during the decommissioning phase of the project:

Table 10: Decommissioning phase monitoring

Monitoring action	***Indicator***	***Timeframe***
Monitor newly disturbed areas where infrastructure has been removed to detect and quantify any aliens that may become established for 2 years after decommissioning and rehabilitation.	Alien plant surveys and distribution map	Biannually until natural vegetation has recovered sufficiently to resist invasion
Monitor re-vegetated areas to detect and quantify any aliens that may become established for 2 years after decommissioning and rehabilitation.	Alien plant surveys and distribution map	Biannually for 2 years
Document alien plant control measures implemented & success rate achieved	Records of control measures and their success rate.	Annually for 2 years

10. CONCLUSION

It is important to take into consideration working according to national laws to ensure compliance and to avoid prosecution. Responsible entities should ensure compliance and developers or contractors should source qualified personnel to help with implementation and compliance.

Designated environmental personnel should be able to identify alien vegetation or vegetation related to bush encroachment. Proper monitoring and eradication should be implemented as set out in this document. Furthermore, companies are available all over the country that can help with the eradication of alien species as well as supplying the necessary advice, herbicides and services.

11. REFERENCES

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