AN ALIEN INVASIVE MANAGEMENT PLAN FOR THE PROPOSED DEVELOPMENT OF THE LICHTENBURG SOLAR PARK AND ASSOCIATED INFRASTRUCTUE ON PORTION 25 OF THE FARM HOUTHAALBOOMEN 31 IP AND PORTION 10 OF THE FARM LICHTENBURG TOWN AND TOWNLANDS 27 IP, NORTHWEST PROVINCE

April 2022

Prepared for: MATRIGENIX (PTY) LTD

Compiled by Dr BJ Henning

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Dr BJ Henning

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Reviewed by:

Ms. E Grobler

REPORT DISTRIBUTION LIST

Name	Institution
Ms. E. Grobler	AGES Limpopo (Pty) Ltd
Mr. E Burger	MATRIGENIX (PTY) LTD
	Department of Forestry, Fisheries and the Environment (DFFE)

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1 GENERAL INFORMATION AND BACKGROUND

AGES Limpopo (Pty) Ltd was appointed by MATRIGENIX (PTY) LTD to compile an alien invasive management plan for the proposed development of a solar plant named as follows:

- Lichtenburg Solar Park.

The project site includes the proposed development of the Lichtenburg Solar Park and power line on Portion 25 of the Farm Houthaalboomen 31 IP and Portion 10 of the Farm Lichtenburg Town and Townlands 27 IP, Ditsobotla Local Municipality, Ngaka Modiri Molema District Municipality, Northwest Province.

The assignment is interpreted as follows: Compile a management plan to control Alien Invasive Species (AIS) occurring on the proposed development site. The study will be done according to guidelines stipulated by the, then called, Department of Environmental Affairs and Tourism (DEAT) and forms part of the Environmental Management Programme (EMPr) for implementation.

1.1 Information Sources

The following information sources were obtained:

1. AIS distribution data according to databases to ascertain which species occur in the study area.
2. All relevant maps through Geographical Information Systems (GIS) mapping, and information (previous studies and environmental databases) on AIS of proposed site.
3. Requirements regarding the management plan as requested by DFFE.
4. Information on micro-habitat level was obtained through obtaining a first-hand perspective from the ecological study compiled by Henning (2021).

1.2 Regulations governing this report.

1.2.1 National Environmental Management Act, 1998 (Act No. 107 of 1998) (NEMA)

This report was prepared in terms of the National Environmental Management Act, 1998 (Act No. 107 of 1998) Gazette No. 38282 Government Notice R. 982 of 4 December 2014 (as amended). Appendix 6 – Specialist reports includes a list of requirements to be included in a specialist report:

1. A specialist report or a report prepared in terms of these regulations must contain:
    a. Details of
        i. The specialist who prepared the report; and
        ii. The expertise of that specialist to compile a specialist report, including a curriculum vitae.

b. A declaration that the specialist is independent in a form as may be specified by the competent authority.
c. An indication of the scope of, and purpose for which, the report was prepared.
d. The date and season of the site investigation and the relevance of the season to the outcome of the assessment.
e. A description of the methodology adopted in preparing the report or carrying out the specialized process.
f. The specific identified sensitivity of the site related to the activity and its associated structures and infrastructure.
g. An identification of any areas to be avoided, including buffers.
h. A map superimposing the activity including the associated structures and infrastructure on the environmental sensitivities of the site including areas to be avoided, including buffers.
i. A description of any assumptions made and any uncertainties or gaps in knowledge.
j. A description of the findings and potential implications of such findings on the impact of the activity, including identified alternatives, on the environment.
k. any mitigation measures for inclusion in the EMPr.
l. any conditions for inclusion in the environmental authorisation.
m. any monitoring requirements for inclusion in the EMPr or environmental authorisation
n. a reasoned opinion –
    i. As to whether the activity or portions thereof should be authorised and
    ii. If the opinion is that the activity or portions thereof should be authorised, any avoidance, management and mitigation measures that should be included in the EMPr and where applicable, the closure plan.
o. A description of any consultation process that was undertaken while preparing the specialist report.
p. A summary and copies of any comments received during any consultation process and where applicable all responses thereto; and
q. Any other information requested by the competent authority.

This Act also embraces all three fields of environmental concern namely: resource conservation and exploitation; pollution control and waste management; and land-use planning and development. The environmental management principles include the duty of care for wetlands / rivers and special attention is given to management and planning procedures.

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

The Alien and Invasive Species Regulations (GNR 599 of 2014) are stipulated as part of the National Environmental Management: Biodiversity Act, 2004 (Act No. 10 of 2004). In South Africa there is a total of 383 invasive plant species that must be controlled, and these species are listed in the NEMBA Alien and Invasive Species list of 2016.

Below is a brief explanation of four categories of Invasive Alien Plants (IAPs) as per the regulation.

1. Category 1a: Invasive species requiring compulsory control. Remove and destroy. Any specimens of Category 1a listed species need, by law, to be eradicated from the environment. No permits will be issued.
2. 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.
3. 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 Category 2 plants to exist in riparian zones.
4. 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 Category 3 plants to exist in riparian zones.

1.2.3 Conservation of Agricultural Resources Act, 1983 (Act No. 43 of 1983)

In terms of amendments to the regulations under this Act, landowners are legally responsible for the control of invasive alien plants on their properties. The schedules provide a list of declared weeds and invaders, which have been divided into three categories, as follows:

- Category 1 plants are prohibited and must be controlled.
- Category 2 plants (commercially used plants) may be grown in demarcated areas providing that there is a permit and that steps are taken to prevent their spread.
- Category 3 plants (ornamentally used plants) may no longer be planted; existing plants may remain, if all reasonable steps are taken to prevent the spreading there of, except within the floodline of watercourses and wetlands.

Alien species, regulated in terms of the Conservation of Agricultural Resources Act, 1983 (Act No. 43 of 1983) as weeds and invaders are exempted from NEMBA. This implies that the provisions of the CARA regarding listed weed and invader plants supersede those of NEMBA.

1.2.4 Fertilizer, Farm Feeds, Agricultural Remedies and Stock Remedies Act, 1947 (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, 1947 (Act No. 36 of 1947). This is regulated by the Department of Agriculture.

1.3 Terms of reference

1.3.1 Objectives

- Determine the AIS occurring in the study area.
- Describe the management principles and specific methodology on the control of specific IAS occurring in the study area.

1.3.2 Limitations and assumptions

- To obtain a comprehensive understanding of the dynamics of AIS, surveys and monitoring should ideally be replicated over several seasons and over several years. However, due to project time constraints such long-term studies are not feasible.
- The large study area did not allow for a finer level of assessment that can be obtained in smaller areas. Therefore, data collection in this study relied on data from representative sections, as well as general observations, generic data and a desktop analysis.

2 INTRODUCTION

Alien Invasive Species (plants, animals and micro-organisms) are species that occur outside of their natural habitat or country of origin and due to their ability to outperform and outgrow indigenous species; they establish themselves in these non-native habitats. Alien Invasive Species (AIS) have also been called weeds, pests, encroachers, aliens, invasives, exotics or non-indigenous. They are native to an area or region, but have been introduced elsewhere, either by accident or on purpose. Alien Invasive Species can be animals (*e.g.*, rats), plants (*e.g.*, lantana) and micro-organisms (*e.g.*, cholera). AIS can be found in households as decorative plants, pets or pests or on land as terrestrials and in water as aquatics. The most aggressive invaders can spread far from parent plants and cover large areas.

South Africa has a long history of problem plants. Alien plants were first introduced in South Africa more than a thousand years ago. These were plants mainly from central and northern Africa and were associated with human activities. Plants from other continents were introduced by colonists from 1652 onwards. Invasive alien plants (IAPs) pose a direct threat not only to South Africa's biological diversity, but also to water security, the ecological functioning of natural systems and the productive use of land. Invasive alien plants have negative impacts on the environment by decreasing both surface water runoff and groundwater recharge, causing direct habitat destruction, intensify flooding, and increasing the risk and intensity of wildfires (Görgens and Van Wilgen, 2004). With invasive plants having high evaporation rates, they often use more water than surrounding indigenous plants, which has a direct impact on stream flow and groundwater reserves. In South Africa, an estimate of 1.44 billion m^3 of water is lost to invasive plants annually. This amount of water loss is enough to provide 3.38 million households with four inhabitants with water for a year or to irrigate 120 000 hectares of cropland (WWF, 2016). It is estimated that these plants cover about 10% of the country and the problem is growing at an exponential rate. Figure 1 indicates the distribution and percentage cover of AIS in South Africa.

Vehicles often transport many seeds, and some may be invader species, which may become established along the roads inside the study area, especially where the area is disturbed. The construction phase of developments in the area will almost certainly carry the greatest risk of Invasive Alien Species being imported to the site, and high levels of habitat disturbance also provide the greatest opportunities for such species to establish themselves, since most indigenous species are less tolerant of disturbance. Continued movement of personnel and vehicles on and off the development sites, as well as occasional delivery of materials required for maintenance, will result in a risk of importation of alien species throughout the life of the project. The biggest risk is that invasive alien species such as the seeds of noxious plants may be carried onto the site along with materials that have been stockpiled elsewhere at already invaded sites.

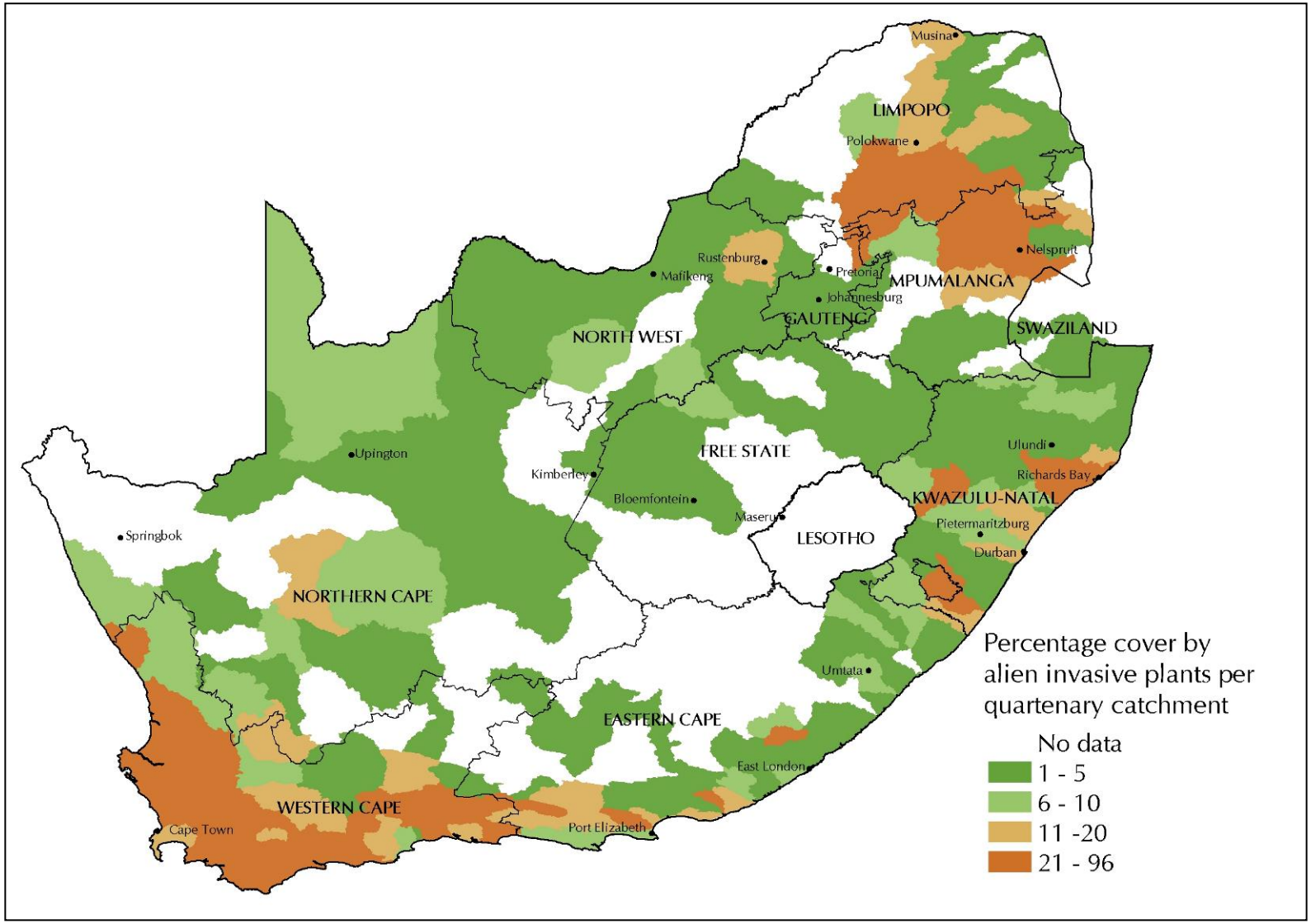

Figure 1. Distribution and percentage cover of AIS in South Africa

3 STUDY AREA

3.1 Location and description of activity

Matrigenix (Pty) Ltd is proposing the establishment of a renewable energy generation facility (Photovoltaic Power Plant) with associated infrastructure and structures, and power line on Portion 25 of the Farm Houthaalboomen 31 IP and Portion 10 of the Farm Lichtenburg Town and Townlands 27 IP, Ditsobotla Local Municipality, Ngaka Modiri Molema District Municipality, North-West province The proposed renewable energy generation facility will be Photovoltaic (PV) Power Plant with a maximum generation capacity up to 120 MW, at the point of connection (Export Capacity) with the Eskom connection infrastructure. The name of the facility will be LICHTENBURG SOLAR PARK.

The developed area (footprint) required for the proposed project will be up to 240 hectares. The Lichtenburg Solar Park will deliver the electrical energy to the Eskom's Watershed substation, located on the Remainder Portion of the farm Lichtenburg Town and Townlands 27 IP. The proposed development (the Photovoltaic (PV) Power Plants and connection infrastructure) consists of the installation of the following equipment:

- Photovoltaic modules (mono-crystalline, poly-crystalline, or bi-facial modules)
- Mounting systems for the PV arrays (single-axis horizontal trackers or fixed structures) and related foundations
- Internal cabling and string boxes
- DC/AC inverters
- Medium voltage stations, hosting LV/MV power transformers
- Medium voltage receiving station(s)
- Workshops & warehouses
- One on-site high-voltage substation with high-voltage power transformers, stepping up the voltage to 132kV and one high-voltage busbar with metering and protection devices
- One on-site switching station, with one high-voltage busbar with metering and protection devices
- One (1) 132 kV powerline, to the Eskom Watershed substation, located on the Remainder Portion of the farm Lichtenburg Town and Townlands 27 IP.
- Battery Energy Storage Systems (BESS), with a footprint up to 10 ha, next to the on-site high-voltage substation, within the PV plant footprint / fenced areas
- Electrical system and UPS (Uninterruptible Power Supply) devices

- Lighting system
- Grounding system
- Internal roads
- Fencing of the site and alarm and video-surveillance system
- Water access point, water supply pipelines, water treatment facilities
- Sewage system
- Interventions on the Eskom Watershed Substation.

During the construction phase, the site may be provided with additional activities which will be removed at the end of construction.

- Water access point, water supply pipelines, water treatment facilities
- Prefabricated buildings
- Workshops & warehouses

The connection may also entail interventions on the Eskom grid, according to Eskom's connection requirements/solution. The aerial map of the site is presented in Figure 5.

Figure 2. Regional location Map of the project area

Figure 3. Aerial Map of the project area

4 LEGAL OBLIGATIONS OF LANDOWNERS WITH REGARDS TO LISTED ALIEN INVASIVE SPECIES CONTROL

As per the definition clauses, an "Invasive species" means any species whose establishment and spread outside of its natural distribution range:

(a)Threaten ecosystems, habitats or other species or have demonstrated potential to threaten ecosystems, habitats or other species; and

(b) May result in economic or environmental harm or harm to human health.

The obligations contained in the Act do not however apply to all invasive species. A distinction is drawn between "invasive species" and "listed invasive species", which means –

Any invasive species listed in terms of section 70 (1)"

As far as listed invasive species are concerned, the situation is slightly different from that of alien species as the Act places some additional obligations on parties other than permit holders. A person wishing to conduct a restricted activity in relation to a listed invasive species will also require a permit and is subject to the same duty of care as is the case with alien species. However, in addition to those requirements, section 75 (4) mandates the Minister to coordinate and implement programmes for the prevention, control or eradication of listed invasive species. S 75 (4) reads as follows:

"75. Control and eradication of listed invasive species

(4) The Minister must ensure the coordination and implementation of programmes for the prevention, control or eradication of invasive species."

These programmes, referred to in the regulations as "Invasive Species Management Programmes" must be prepared by the governing bodies of all parastatal protected areas and all other organs of state. These programmes may also impact and be carried out on private land, but it is the Department who is responsible for its implementation, not the landowner.

However, in the context of certain "listed invasive species", specifically those categorised as 1a invasive species in terms of the regulations, the Act does place a limited obligation on the owner of land where listed invasive species occur.

In this regard, section 73 (2) of the Act reads as follows:

"73. Duty of care relating to listed invasive species.

(2) A person who is the owner of land on which a listed invasive species occurs must-

(a) Notify any relevant competent authority, in writing, of the listed invasive species occurring on the land.

(b) Take steps to control and eradicate the listed invasive species and to prevent it from spreading; and

(c) Take all the required steps to prevent or minimise harm to biodiversity.

(3) A competent authority may, in writing, direct any person who has failed to comply with subsection (1) or (2), or who has contravened section 71 (1), to take such steps-

(a) As may be necessary to remedy any harm to biodiversity caused by-

(i) The actions of that person; or

(ii) The occurrence of the listed invasive species on land of which that person is the owner; and

(b) As may be specified in the directive"

This provision certainly does place an obligation on a landowner to report the presence of any relevant listed invasive species (As per the regulations, category 1a species) to the competent authority and to rid the property of listed invasive species as well as prevent it from spreading.

4.1 Alien and Invasive Species Regulations

The categorisation of listed invasive species is significant as the regulations ascribe differing obligations vis-à-vis each category.

The categories and obligations are as follows:

Category 1a invasive species: Category 1 species are those that require compulsory eradication. It is these, and only these, to which section 73 (2) of the Act applies. This means that the property owner must notify the relevant authority of the presence of these species, actively combat and eradicate them as well as prevent their spread. As with category 1b, a property owner must permit an authorised official from the department to enter the property to monitor, assist with and implement the eradication of category 1a invasive species. A permit is also required for any restricted activities vis-à-vis this category of species. Where an Invasive Species Management Programme exists, the specimens must be eradicated in accordance with that plan.

Category 1b invasive species: Category 1b species must be controlled. In the context of the Act, 'controlled' means eradicated, or where not possible, the spread and propagation of this species must be prevented. This category applies to persons who are in control of a listed invasive species.

This section of the regulations does not expressly refer to section 73 (2) of the Act so presumably it does not apply to all landowners where the species occurs. By a 'person in control', the regulations could possibly refer to permit holders or people who are conducting restricted activities. To facilitate this control, a landowner must permit authorised personnel from the Department to enter the property to monitor, assist with or implement the control of the listed category 1b species. There does not however, seem to be any specific obligation on the landowner to eradicate the category 1b invasive species on his own accord, if he is not considered a 'person in control' of this category of listed species. Where an Invasive Species Management Programme exists, the control must be carried out according to the programme. Permits are required for restricted activities.

Category 2 invasive species: A category 2 species requires a permit to carry out any restricted activities. As with category 3 species, should any species listed under category 2 occur on a landowner's property, he or she is obliged to control its spread in accordance with any relevant Invasive Species Management Programme (if applicable). Over and above the provisions of any Invasive Species Management Programme, a landowner must ensure that no specimens of the species spread outside of his or her land.

Category 3 invasive species: These listed invasive species are referred to as 'exemptions' because species listed in this category may be exempted from permit requirements in relation to any restricted activities. A landowner is not obligated to eradicate the species nor control its spread except in accordance with any relevant Invasive Species Management Programme (if applicable). However, should any species listed under this category occur in a riparian area (on the banks of a river); it is deemed to be a category 1b listed invasive species.

The categories can be summarised as follows.

	Compulsory eradication by landowner	Compulsory control by landowner (prevent specie from spreading)	Permit required for restricted activities	Compliance with Invasive Species Management Plan
Category 1a	X	X	X	X
Category 1b			X	X
Category 2		X	X	X (if applicable)
Category 3				X (if applicable)

5 CONTROL OF ALIEN INVASIVE SPECIES

5.1 Background

According to the Biodiversity Act, 2004 (Act No.10 of 2004), it is stated that landowners are under legal obligation to control invasive alien plants occurring on their properties. Landowners must then identify all invasive alien plants on their property and make use of the correct methods to control or remove these plants. The control methods of alien invasive plants can be broadly classified into three categories: mechanical, chemical, or biological. Mechanical control methods involve the physical destruction or total removal of plants (e.g., felling, strip-barking; ringbarking, hand-pulling and mowing); chemical control of invasive alien plants include the foliar spraying of herbicides to kill targeted plants and biological control, or biocontrol methods involves the release of natural enemies that will reduce plant health and reduce population vigour to a level comparable to that of the natural vegetation. It is often necessary to use a combination of at least two of these methods to control or remove invasive alien plants (State of the World Plants, 2017). With repeated follow-up, mechanical and chemical control methods tend to be short-term activities suitable for smaller plant invasions that can result in the complete removal of the target species. After the implementation of your methods, it is important to evaluate the effectiveness of your methods and to monitor the cleared areas on a regular basis to identify emergent seedlings and to remove those immediately.

Goals for addressing the Alien Invasive Species (AIS) problem on site should include:

- Prevention: Keeping an AIS from being introduced onto the site ecosystem. Ideally, this means preventing alien plants from entering the development site.
- Early detection: Locating AIS before they get established and spread. This requires an effective, site-based inventory and monitoring program.
- Eradication: Killing the entire population of AIS. Typically, this can only be accomplished when the organisms are detected early.
- Control: Long-term management of the AIS population size and distribution when eradication is unfeasible, by implementing the following strategies:
    - Institute strict control over materials brought onto site, which should be inspected for potential invasive invertebrate species or plant material (seeds etc.) and steps taken to eradicate these before transport to the site. Routinely fumigate or spray all materials with appropriate low-residual insecticides prior to transport to or in a quarantine area on site. The contractor is responsible for the control of weeds and invader plants at the construction site during the construction phase.

- Control involves killing the plants present, killing emerging seedlings and establishing and managing an alternative plant cover to limit re-growth and re-invasion. Weeds and invader plants will be controlled in the manner prescribed for that category by the Conservation of Agricultural Resources Act or in terms of Working for Water guidelines.
- Rehabilitate disturbed areas as quickly as possible to reduce the area where invasive species would be at a strong advantage and most easily able to establish.
- Institute a monitoring programme to detect Alien Invasive Species early, before they become established and, in the case of weeds, before the release of seeds.
- Institute an eradication/control programme for early intervention if invasive species are detected, so that their spread to surrounding natural ecosystems can be prevented.

Any control programme for alien vegetation must include the following 3 phases:

- Initial control: drastic reduction of existing population.
- Follow-up control: control of seedlings, root suckers and coppice growth.
- Maintenance control: sustain low alien plant numbers with annual control.

Scientists and field workers use a range of methods to control invasive alien plants. These include:

- Mechanical methods - felling, removing, or burning invading alien plants.
  - Start at the highest point and work downwards (downhill/downstream).
  - Start from the edge of the infestation and work towards the centre.
  - Take care to prevent the spread of cuttings.
  - Once plants are removed, banks and slopes should be stabilised by erosion protection measures (geotextiles/other suitable materials).
  - When stacking materials, take note of fire protection measures and remember to always stack the material in rows.
- Chemical methods - using environmentally safe herbicides. The following general principles apply when using this method:
  - Chemical control of alien plants is not recommended in aquatic systems due to the risk of pollution but may be used on the floodplain / riparian zone in conjunction with cutting or slashing of plants.
  - Pesticides should always be used in a lawful manner, consistent with the product's label.

  - Chemicals should only be applied by qualified personnel.
  - Only approved chemicals should be applied.
  - Follow the manufacturer's instructions carefully.
  - Appropriate protective clothing must be worn.
  - Chemicals to be applied immediately after cutting.
  - Only designated spray bottles to be used for applying chemicals.
  - Decanting of chemicals and cleaning of equipment should be undertaken at a designated location using drip trays and ground sheets to prevent spillage and contamination of the soil.
  - See next section on herbicides to use for treatment of specific plants.
- Biological control - using species-specific insects and diseases from the alien plant's country of origin. To date 76 bio-control agents have been released in South Africa against 40 weed species. The following general principles apply when using this method:
  - This method is environmentally responsible as it does not cause pollution and affects only the target plant.
  - It is cost effective.
  - It does not disturb the soil or create large empty areas where other invaders could establish, as it does not kill all target plants at once.
  - It allows natural vegetation to recover gradually in the shelter of dying weeds.
- Integrated control - combinations of the above three approaches. Often an integrated approach is required to prevent enormous impacts.

Detailed descriptions of the control methods are included in Appendix A of this management plan.

6 ALIEN INVASIVE SPECIES MANAGEMENT

6.1 DISPOSAL METHODS

Disposal of cut IAP material needs to be carefully considered. Options may include burning on site (with serious risks that need to be managed); chipping and composting (not appropriate if plant material contains seeds); use of woody biomass for charcoal manufacturing; use of cut material to generate electricity (if feasible); transporting of material to a garden refuse or disposal landfill site. Selected disposal method must meet all legal requirements and must not create risk for residents and infrastructure. Burning of some IAPs stimulates seed release or rapid seed germination.

6.2 PRIORITY CONTROL AREAS

Under normal circumstances, proposed development sites are divided into different priority areas according to the density of alien invasive and weed species. The listed alien invasive species and other exotic weeds occur patchy throughout the site and therefore all areas identified was considered as low priority control areas on the proposed development site. No map was therefore needed to indicate priority control areas.

6.3 SPECIES SPECIFIC CONTROL STRATEGY

Based on the integrated approach of initial clearing, follow-up and maintenance the following methods are best suited:

- Clearing Phase: Mechanical clearing initially after which necessary chemical control methods (cut-stump treatments etc.) for woody species are applied. Weeds are removed by hand or directly sprayed if already in flower or seed.
- Follow-up and maintenance phases: Monitoring of cleared plants followed by chemical control methods applied if any regrowth appeared.

Table 1 indicate specific control methods for the different IAS that occurs on the proposed development site as identified by Henning (2021)

Table 1. Invasive Alien Species with a distribution centred within the study area and documented during the ecological surveys (Henning, 2022).

Species	Control Method
Opuntia ficus-indica  	**Mechanical control:** Seedlings -Mature plants (not cost effective if there are large numbers of individuals): • Can be hoed out if small or dug out if mature. It is recommended that stout gloves be warn whilst working with this species as the spines will cause injury. **Herbicide control** Saplings/Mature plants: • Inject into 4 – 12 premade holes per plant any one of the following: MSMA (720g/l) Il mixed with 1l water and injected at 2ml per dose. Mamba (Glyphosate 360g/l) 1l mixed with 2l water and injected at 2ml per dose. Touchdown (Glyphosate 480g/l) 330ml mixed with 10l water and injected at 2ml per dose. It is recommended that stout gloves be warn whilst working with this species as the spines will cause injury. **Biological control:** • This is a very cost-effective way of removing this species. Although the spiny variety of this cactus is invasive and regarded as a problem, the spineless variety of the same species – known as cactus pear – is cultivated as cattle feed and a valuable crop plant. The cochineal, *Dactylopius opuntiae* (indigenous to Mexico, Texas and Arizona), and the cactus moth, *Cactoblastis cactorum* (a native of South America) were introduced during the 1930s, when Parliament declared prickly pear a national disaster. These two bio control agents attack both prickly pear and cactus pear. They are keeping prickly pear under effective control, preventing outbreaks such as those during the 1930s. Although cactus pear growers regard them as a pest, it is only the continued presence of these bio control agents in South Africa that makes the cultivation of cactus pear possible, by removing the risk of invasion. Cultivated cactus pear can be protected against the bio control agents by applying chemicals that were registered for this purpose.)

Species	Control Method
Xanthium strumarium 	**Mechanical Control: Seedlings can be controlled by cultivation, but older plants often produce shoots from axillary buds if the root has not been severed. Adoption of zero or reduced tillage systems can potentially reduce Xanthium populations, because burs seldom germinate on the soil surface.** **Chemical Control:** X. strumarium is controlled by many soil-applied and foliar herbicides.
Verbena bonariensis 	Controlling the weed before it seeds will reduce future problems. Control is generally best applied to the least infested areas before dense infestations are tackled. Consistent follow-up work is required for sustainable management. Complete clearance of the mature plant before seeding and the use of uncontaminated planting material and farm implements can help to prevent its spread. Small infestations can be cleared by hand pulling and digging. Larger infestations can be treated with herbicide. When using any herbicide always read the label first and follow all instructions and safety requirements. If in doubt consult an expert.

Species	Control Method
Argemone ochroleuca 	Chemical control: Plants of *A. ochroleuca* should be destroyed or removed before they produce seeds. Seedlings are readily controlled by light tillage. Long cultivated fallow or vigorous perennial pastures will control large infestations (Parsons and Cuthbertson, 1992). Herbicides which control A. ochroleuca include 2,4-D, 2,4-DB, dicamba, diuron, fluroxypyr, hexazinone, isoproturon, karbutilate, MCPA, metribuzin, oxadiazon, picloram and terbutryn. Biological control: A biological control programme of A. ochroleuca has been initiated in Australia. This native of Mexico is naturalized in most warm countries of the world in sub-humid as well as semiarid regions. This project sought natural enemies in Mexico and identified several predatory insects including an extremely damaging species of root-breeding and leaf-feeding weevil (CSIRO, 1999; Julien, 2002).

7 RECOMMENDED MONITORING PLAN FOR AIS

The implementation of an AIS monitoring programme is strongly recommended and will be a direct indicator of habitat transformation. This is the only quantifiable means to evaluate the impact of current and possible future management practices on the vegetation of the study area. This includes evaluating the success of clearance of AIS. The nature of secondary succession in disturbed areas should be evaluated to determine whether a favourable succession pathway is occurring towards indigenous vegetation cover.

Monitoring and maintenance of alien invasive, indigenous trees and grass cover should be done until a self-sustaining plant community is established. Re-establishment of plant cover on cleared areas should take place as soon as clearance activities have ceased for specific priority areas.

Monitoring of alien invasive plants and weeds should be conducted bi-annually around the focus area as follows:

Phase 1 (Pre-Construction): As an initial stocktaking exercise, a reconnaissance-type survey should be undertaken to determine:

- The number, distribution and broad categorization of habitat of AIS.
- Whether any obvious signs of dense stands do occur and prioritize control of the specific AIS populations.

Phase 2 (Construction and Operational Phases): Monitoring should be undertaken bi-annually during the construction phase and annually during the operational phase of the solar plant. The monitoring should be conducted by a botanist or an Environmental Control Officer or suitably trained on site personnel with suitable knowledge of the plants, especially during the construction phase where vegetation is cleared. The following will be determined:

- The continued presence of AIS in all recorded localities.
- The population density and age of all located populations.
- Further control of the AIS populations on site.
- Success of planting indigenous trees and the rehabilitation of the cleared areas/ riverbanks.
- The next monitoring exercise should be conducted early 2023.
- The monitoring plan could be implemented on the Lichtenburg Solar Park by the Environmental Control Officer.

8 REFERENCES

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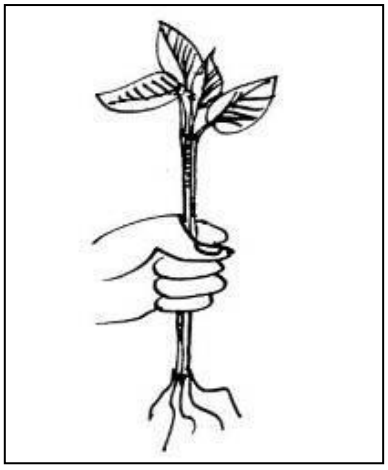
APPENDIX A. CONTROL METHODS

The different control methods are discussed in the following section of this management plan as stipulated by the Nature Conservation Corporation (2008):

1. **Mechanical Methods**

a. Hand pulling

- Hand pulling is most effective where plants are small (30cm), immature or shallow rooted.
- Use the following method:
    - Use a pair of gloves and grip the plant firmly around the stem just above the root (see figure below)



    - Pull hard and remove the plant, roots & all.
    - Kicking around the root area of the plant may assist in loosening root system, making it easier to pull out.
    - Shake the excess sandy material from the plant, this makes the plant easier to stockpile and lighter to transport.
    - Stack removed material into piles or spread out evenly if it is not going to be a fire hazard, or
    - Stack the seedlings on brush piles or rows along contour lines, to facilitate easy follow-up.

b. Chopping/ cutting/ slashing

- This method is most effective for plants in the immature stage, or for plants that have relatively woody stems/ trunks.
- This is an effective method for non-re-sprouters or in the case of re-sprouters (coppicing), if done in conjunction with chemical treatment of the cut stumps

- Use implements such as pangas (slashers), handsaws, bowsaws, chainsaws, brush cutters and axes. Remember to wear protective clothing.
- Use the following method:
    - Cut/slash the stem of the plant as near as possible to ground level.
    - Paint re-sprouting plants (i.e., black wattle, lantana and port jackson) with an appropriate herbicide immediately after they have been cut.
    - Stockpile removed material into piles of 2m high, 3m wide windrows/stacks.

c. Grubbing/ hoeing/ digging out/ tree poppers.

- Grubbing, hoeing, or digging involves the use of a hoe, stick, tree popper or spade.
- The entire plant and root must be removed.
- Use the following method:
    - Dig around the plant making sure the sand is loosened around the root system.
    - Dig down, under the roots, applying pressure, and wrench the entire plant out.
    - Kicking the plant may help to dislodge it, however, care should be taken if the plant is seeding, as dry seeds may be dislodged.
    - Stockpile removed material into piles of 2m high, 3m wide windrows/stacks.

d. Basal bark

- Application of suitable herbicide in diesel can be carried out to the bottom 250mm of the stem. Applications should be by means of a low pressure, coarse droplet spray from a narrow angle solid cone nozzle or by using a paintbrush. If multi stemmed, then each stem needs to be treated.

e. Ring barking

- Remove the bark and cambium around the trunk of the tree for a continuous band around the tree at least 25cm wide, starting as low as possible.
- Where clean de-barking is not possible due to crevices in the stem or where exposed roots are present, a combination of bark removal and basal stem treatments should be carried out.

- For better control of aggressively coppicing species pull off the bark below the cut to ground level (bark stripping), to avoid use of herbicides.

Note: that since this method means that the tree is left standing, it is only recommended for single trees, not for stands. Slashers or axes should be used for debarking.

f. Frill

- Using an axe or bush knife, make a series of overlapping cuts around the trunk of the tree, through the bark into the softwood (approximately 500mm from ground level). The thickness of the blade should force the bark open slightly, ensuring access to the cambium layer.
- Ensure to affect the cuts around the entire stem.
- Immediately apply the registered herbicide to the cuts by spraying into the frill '. The frill needs to be deep enough to retain the herbicide.

g. Bark stripping

- Where bark stripping is used, then all the bark shall be stripped from the trunk between the ground level and 1 meter above ground level.
- Application of suitable herbicide can also be used with this method.
- Applications should be by means of a low pressure, coarse droplet spray from a narrow angle solid cone nozzle or by using a paintbrush.

2. Chemical control

a. Injection

- Drill or punch downward slanting holes into the tree around the entire circumference of the stem
- Inject the chemical directly into the plant.

b. Foliar spray

- This method is not recommended but may be used under certain circumstances. Best results are obtained if the solution is sprayed on a large leaf area on an actively growing plant.
- Use a solid cone nozzle that ensures an even coverage on all leaves and stems to the point of run off.
- Do not spray just before rain (a rainfall-free period of 6 hours is recommended) or before dew falls.
- Avoid spraying in windy weather as spray may spread to non-target plants.
- Spraying dormant or drought stressed plants is not effective as they do not absorb enough of the herbicide.

c. Cut stump application.

- This is a highly effective and appropriate control method for larger woody vegetation that has already been cut off close to the ground.
- The appropriate herbicide should be applied to the stump using a paintbrush within 30 min of being cut.
- Stems should be cut as low as practical as stipulated on the label and herbicides are applied in diesel or water, as recommended.
- Applications in diesel should be to the whole stump and exposed roots and in water to the cut area as recommended on the label.

d. Stacking

- Stacking the cut material in heaps, or in windrows along mountain contours to reduce erosion, facilitates easy access for follow up.
- It also assists in containing the resulting fuel load and risk of an uncontrolled fire.
- Keep stacks well apart to prevent fires from crossing easily, not less that fire meters apart, this is naturally dependant on the size of the stack & the resulting fire intensity when they burn.
- Stockpile removed material into piles of 2m high, 3m wide windrows/stacks.
- Stack light branches separately from heavy timber (75mm and more). Preferably remove heavy branches to reduce long burning fuel loads that can result in soil damage from intensely hot fire.
- Do not make stacks under trees and power lines, within 30 meters of a fire belt or near watercourses, houses and other infrastructure.

e. Safety

- Always wear the appropriate safety clothing when working with herbicides.
- Mix all herbicides on a drip groundsheet when working in the veld. Keep away from watercourses.
- Do not rinse herbicide equipment in veld. ALWAYS READ THE HERBICIDE LABEL and observe instructions for safe use of herbicide.

3. Biological Control

a. What is biological control?

Biological control is an attempt to introduce the plant ‘s natural enemies to its new habitat, with the assumption that these natural enemies will remove the plants’ competitive advantage until its vigour is reduced to a level comparable to that of the natural vegetation. Natural enemies that are used for biological control are called bio control agents. In the control of invasive plants, the bio control agents used most frequently are insects, mites, and pathogens (disease-causing organisms such as fungi). Bio control agents target specific plant organs, such as the vegetative parts of the plant (its leaves, stems or roots) or the reproductive parts (flowers, fruits, or seeds).

The choice of bio control agents depends on the aim of the control project. If the aim is to get rid of the invasive plant species, scientists select the types of bio control agents causing the most damage that are available. In such projects, scientists may use agents that affect the vegetative parts of the plant as well as agents that reduce seed production. However, if the target plant is useful in certain situations but becomes a pest when uncontrolled, conflict of interests arises regarding biological control. This conflict is usually resolved by avoiding bio control agents that could cause damage to the useful part of the plant, and instead using only seed-reducing agents. These reduce the reproductive potential of the plants, curb seed dispersal and reduce follow-up work needed after clearing, while still allowing the continued utilisation of the plant.

b. How effective is biological control?

Probably without exception, bio control agents do not completely exterminate populations of their host plants. At best, they can be expected to reduce the weed density to an acceptable level or to reduce the vigour and/or reproductive potential of individual plants. The fact that a few host plants always survive, despite the attack by a bio control agent, ensures that the agent does not die out because of a lack of food. The small population of bio control agents that persists will disperse onto any regrowth or newly emerged seedlings of the weed. For this reason, bio control can be regarded as a sustainable control method. Biological control works relatively slowly. On average, at least five years should be allowed for a bio control agent to establish itself successfully before causing significant damage to its host plant.

Unfortunately, not all growth of invasive plant species can be curbed by biological control. It could be that effective bio control agents do exist but cannot be released in South Africa because they are not sufficiently host specific. Alternatively, the invasive plant might be a man-made hybrid between two or more species and is no longer an acceptable host to the natural enemies of either of the parent plants. It could also

happen that the natural enemies of some plants are not adapted to all climatic regions in which the plant is a problem in South Africa, or that the habitat already contains predators or parasitoids that attack the bio control agents. In such cases, biological control will have to be replaced or supplemented by chemical or other control measures.

c. Advantages of biological control

Bio control is:

- Environmentally friendly because it causes no pollution and affects only the target (invasive) plant.
- Self-perpetuating or self-sustaining and therefore permanent
- Cost-effective
- Does not disturb the soil or create large empty areas where other invaders could establish, because it does not kill all the target plants at once. Instead, it allows the natural vegetation of the area to recover gradually in the shelter of the dying weeds.