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**AN ALIEN INVASIVE MANAGEMENT PLAN FOR THE
PROPOSED COMBINED CYCLE GAS TURBINE (CCGT) POWER
PLANT AND ASSOCIATED INFRASTRUCTURE, SALDANHA
BAY LOCAL MUNICIPALITY, WEST COAST DISTRICT
MUNICIPALITY, WESTERN CAPE PROVINCE**

Prepared for: **VORTUM ENERGY (PTY) LTD**

Prepared by: **Exigo**

AN ALIEN INVASIVE MANAGEMENT PLAN FOR THE PROPOSED COMBINED CYCLE GAS TURBINE (CCGT) POWER PLANT AND ASSOCIATED INFRASTRUCTURE, SALDANHA BAY LOCAL MUNICIPALITY, WEST COAST DISTRICT MUNICIPALITY, WESTERN CAPE PROVINCE

February 2016

Conducted on behalf of:
VORTUM ENERGY (PTY) LTD

Compiled by:
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Ms. E. Grobler (EAP.)

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Vortum Thermal Power Plant Invasive Alien Species Management Plan

Declaration

I, Barend Johannes Henning, declare that -

- I act as the independent specialist;
- I will perform the work relating to the project in an objective manner, even if this results in views and findings that are not favourable to the project proponent;
- I declare that there are no circumstances that may compromise my objectivity in performing such work;
- I have expertise in conducting the specialist report relevant to this project, including knowledge of the National Environmental Management Act, 1998 (Act No. 107 of 1998; the Act), regulations and any guidelines that have relevance to the proposed activity;
- I will comply with the Act, regulations and all other applicable legislation;
- I will take into account, to the extent possible, the matters listed in Regulation 8;
- I have no, and will not engage in, conflicting interests in the undertaking of the activity;
- I undertake to disclose to the project proponent and the competent authority all material information in my possession that reasonably has or may have the potential of influencing - any decision to be taken with respect to the project; and - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority or project proponent;
- All the particulars furnished by me in this document are true and correct; and
- I realise that a false declaration is an offence in terms of Regulation 71 and is punishable in terms of section 24F of the Act.



Signature of specialist

Company: Exigo Sustainability (Pty) Ltd.

Date: February 2016

Vortum Thermal Power Plant Invasive Alien Species Management Plan

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1 ASSIGNMENT

Exigo Sustainability was appointed by AGES Limpopo to compile an alien invasive management plan for the proposed establishment of an energy generation facility (thermal power plant) with associated infrastructure and structures on a portion (± 130 ha) of the Remainder of the Farm LANGEBOER 188, Malmesbury RD (861.6007 ha in extent), located within the Saldanha Bay Local Municipality, West Coast District Municipality, Western Cape Province. The development also includes the development of a new powerline corridor between the site and the Aurora Substation, as well as a natural gas or liquid fuel supply pipeline.

The assignment is interpreted as follows: Compile a management plan to control Invasive Alien Species (IAS) occurring on the proposed development site. The study will be done according to guidelines stipulated by the Department of Environmental Affairs and Tourism (DEAT), South Africa.

1.1 INFORMATION SOURCES

The following information sources were obtained:

1. IAS 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 the IAS of the site concerned;
3. Requirements regarding the management plan as requested by DEAT;
4. Information on the micro-habitat level was obtained through obtaining a first-hand perspective from the ecological study compiled by Henning (2015) was also utilized for this study.

1.2 REGULATIONS GOVERNING THIS REPORT

1.2.1 National Environmental Management Act, 1998 (Act No. 107 of 1998) - Regulation No. R982

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. 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

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- 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 proposed 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 proposed activity or portions thereof should be authorised and
 - ii. If the opinion is that the proposed activity or portions thereof should be authorised, any avoidance,

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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 during the course of 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.

1.3 TERMS OF REFERENCE

1.3.1 Objectives

1. Determine the IAS and other exotic weeds occurring in the study area;
2. Describe the management principles and specific methodology on the control of specific IAS occurring in the study area.

1.3.2 Limitations and assumptions

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

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2 INTRODUCTION

Invasive alien 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. Invasive alien species (IAS) have also been called weeds, pests, encroachers, aliens, invasives, exotics or non-indigenous. They are native to a particular area or region, but have been introduced elsewhere, either by accident or on purpose. Invasive alien species can be animals (e.g. rats), plants (e.g. lantana) and micro-organisms (e.g. cholera). IAS 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 in more than thousand years ago. These were plants mainly from central and northern African origin 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. They intensify the impact of fires and floods and increase soil erosion. Of the estimated 9 000 plants introduced to this country, 198 are currently classified as being invasive. 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 IAS in South Africa.

Vehicles often transport many seeds and some may be of 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 the 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.

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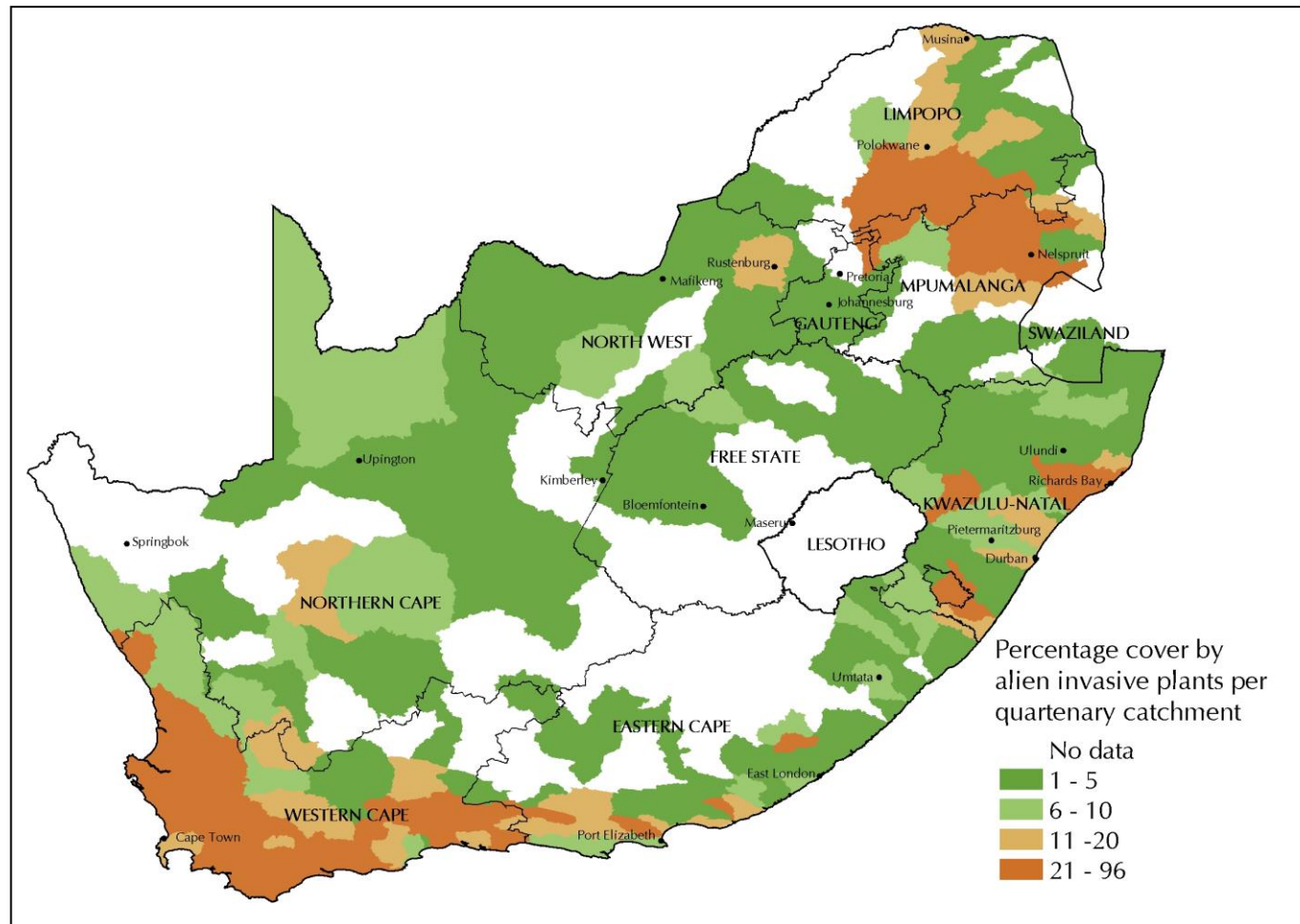


FIGURE 1. DISTRIBUTION AND PERCENTAGE COVER OF IAS IN SOUTH AFRICA

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3 STUDY AREA

3.1 LOCATION AND DESCRIPTION OF ACTIVITY

The project site consists of a portion (± 130 ha) of the Remainder of the Farm LANGEBERG 188, Malmesbury RD (861.6007 ha in extent), located within the Saldanha Bay Local Municipality, West Coast District Municipality, Western Cape Province. The project site is located 9 km North-East of the Port of Saldanha Bay, West of the regional road R27, in an area excluded from the provisions of the Subdivision of Agricultural Land Act (Act 70 of 1970) and already earmarked for Industrial Uses.

The Eskom Blouwater Distribution Substation is located 3.2 km South-West of the project site; the Saldanha Steel Works is 5km West-South-West from the project site; the Langebaanweg Military Airport is 7.5 km east of the project site.

Access to the project site would be either:

- From the regional road R27, which runs adjacent to the eastern boundary of the project site; or
- From a secondary road (R79) linking the regional road R27 with the regional road R399, which runs adjacent to the southern boundary of the project site.

The developed area (footprint) will be up to 80 hectares. The energy generation facility will be a thermal power plant with a maximum generation capacity up to 1200 MW_{el} (electrical rated power). The aerial image of the site is indicated in figure 2.

The name of the facility will be VORTUM THERMAL POWER PLANT. The characteristics, the technology and the extent of the initiative are defined more in detail below.

The proposed thermal power plant will be a Combined Cycle Gas Turbine (CCGT) power plant, to be fuelled with natural gas imported by means of one or more gas import facilities (e.g. LNG Import Terminal(s) and/or new gas pipeline(s)). Indeed the Department of Energy is investigating the feasibility of new gas pipelines and LNG Import Terminals, in order to import natural gas from new offshore gas fields and/or from other countries (e.g. Mozambique). The securing of new energy sources, like natural gas, has become high priority for the Government, considering that the current energy production is not able to meet the increased energy demand of the Country. This leads to frequent electricity shortage and fluctuations in supply ("load shedding"), detrimental to the economic development of South Africa.

Should natural gas not be available at the time of the commissioning of the Vortum Thermal Power Plant, the proposed facility may be fuelled with liquid fuel (diesel or other types of liquid fuels) until natural gas is available. Gas turbines can be fuelled either with natural gas or liquid fuel.

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Due to the current electricity shortage and the urgent need for new power generation units in the Country, the Vortum Thermal Power Plant may operate as an Open Cycle Gas Turbine (OCGT) power plant as a first phase and in the second phase, with the "closure" of the open cycle (by means of steam turbine units added to the gas turbine units), as a Combined Cycle Gas Turbine (CCGT) power plant. The construction timeframe of an OCGT plant is notably shorter than that of a CCGT plant.

In a CCGT power plant a Rankine cycle (steam cycle) is added to a Brayton cycle (gas cycle). The combination of the two thermodynamic cycles result in improved overall efficiency as less heat is wasted because heat is recovered - the "waste" heat from the gas cycle is utilised to produce steam to generate additional electricity via steam turbine units, enhancing the efficiency of overall electricity generation. The thermal efficiency of a CCGT power plant is up to 62%.

A Combined Cycle Gas Turbine (CCGT) power plant consists of gas turbine units coupled with steam turbine units: the "waste" heat from each gas turbine is sent to heat recovery steam generators (HRSG) to generate high pressure steam; the steam from the HRSG drives steam turbines coupled with generators, in order to generate electricity increasing the efficiency of the power plant.

Each gas turbine and steam turbine are coupled to the single generator in a tandem arrangement, on a single shaft (single-shaft configuration). The CCGT power plant will consist of the following components:

- Two or more gas turbine units with a capacity up to 400 MW_{el} (electrical rated power) each;
- Fuel storage facility (in case of liquid fuel);
- Heat recovery steam generators (HRSG) to generate steam;
- Two or more steam turbine units with a capacity up to 220 MW_{el} (electrical rated power) each;
- Electrical generators, which convert the mechanical energy of the gas and steam turbine units to electricity;
- Gas compressors and combustors, for the gas cycle;
- Water pumps and pressurisers, for the steam cycle;
- Cooling system, with condensers & cooling towers, in order to condensate the steam to water;
- A dam, to collect the water necessary for the generation of steam;

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- A control room with offices;
- Warehouses;
- A natural gas or liquid fuel supply pipeline;
- A water supply pipeline;
- On-site high voltage substation;
- High-voltage power lines, for the connection to the Eskom grid.

The number and size (capacity) of the gas and steam turbine units has not been finalised yet and will depend on the load (demand) curve required by the grid. This will be assessed during the scoping phase in consultation with Eskom.

The CCGT power plant may consist of - e.g.:

- 2 gas turbines units of 375 MW_{el} each + 2 steam turbines units of 200 MW_{el} each (overall installed capacity: 1150 MW_{el}); or (e.g.)
- Gas turbines units of 150 MW_{el} each + 5 steam turbines units of 80 MW_{el} each (overall installed capacity: 1150 MW_{el}); or;
- A combination of different sizes of gas and steam turbine units.

The overall installed capacity will nevertheless be up to 1200 MW_{el}. The Vortum Thermal Power Plant will deliver the energy to the Eskom AURORA main transmission substation via one or more 400 kV power lines approximately 27 km long. The number of new 400 kV power lines will be assessed during the scoping phase in consultation with Eskom. The proposed power line corridor runs parallel to existing Eskom high-voltage power lines and may cross through the following properties (please refer to Locality Map Figure 1)

- Portions 1 and 9 (Remaining Extent) of the Farm LANGEBERG 187;
- Portions 1 and Remainder of the Farm UYEKRAAL 189;
- Farm EVERTS HOPE 190;
- Farm WASCHKLIP 183;
- Farm ZOUTEKUYLEN 179;
- FARM 1162;
- Portions 3 and 8 of the Farm LANGVERWACHT 178;
- Farm ADJOINING SPRINGFONTEIN 174;
- Portions 3 and 4 of the Farm DRIEHOEKS FONTEIN 176

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A natural gas / fuel supply pipeline is also planned as part of the development.

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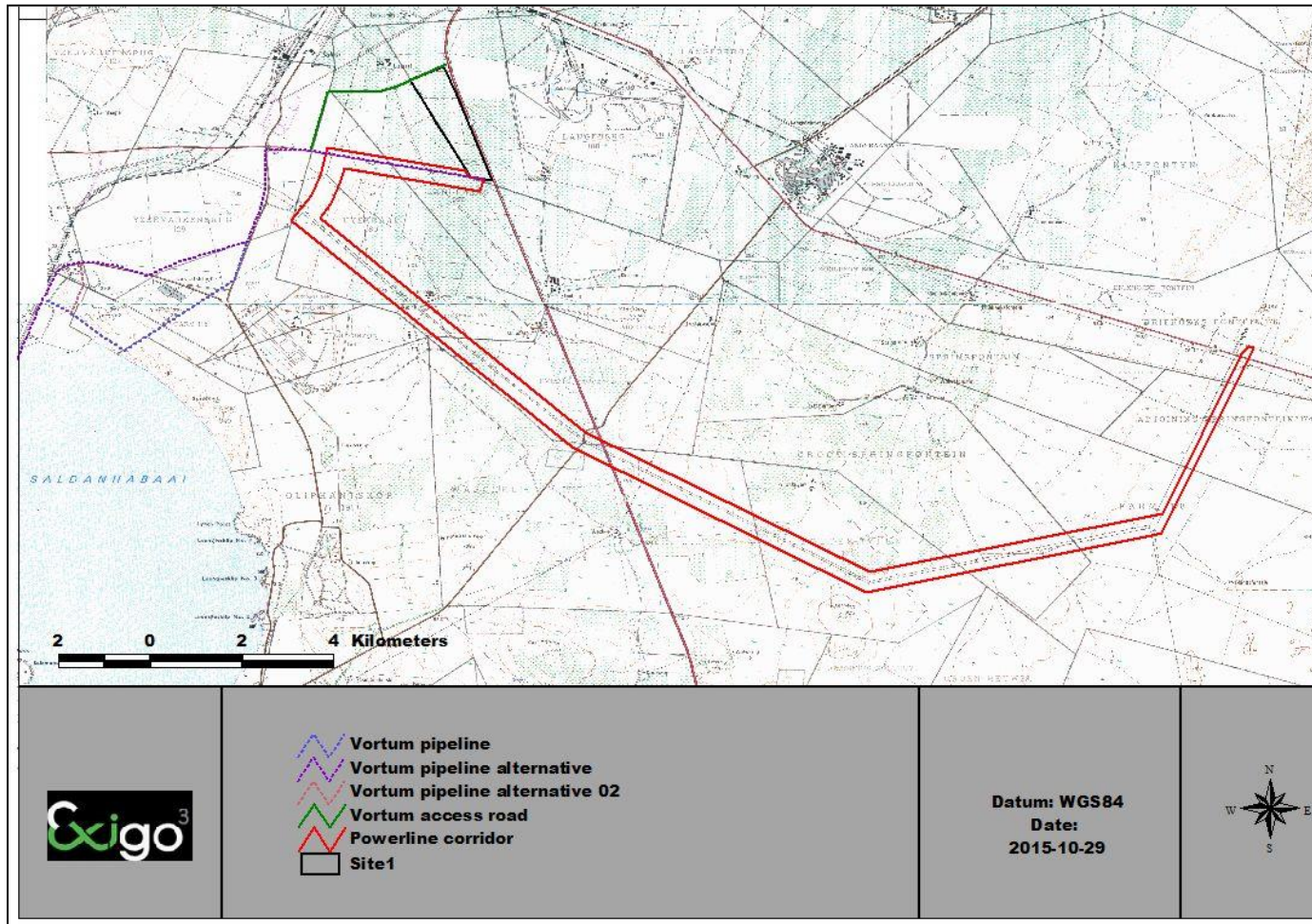


Figure 2. Regional Location Map

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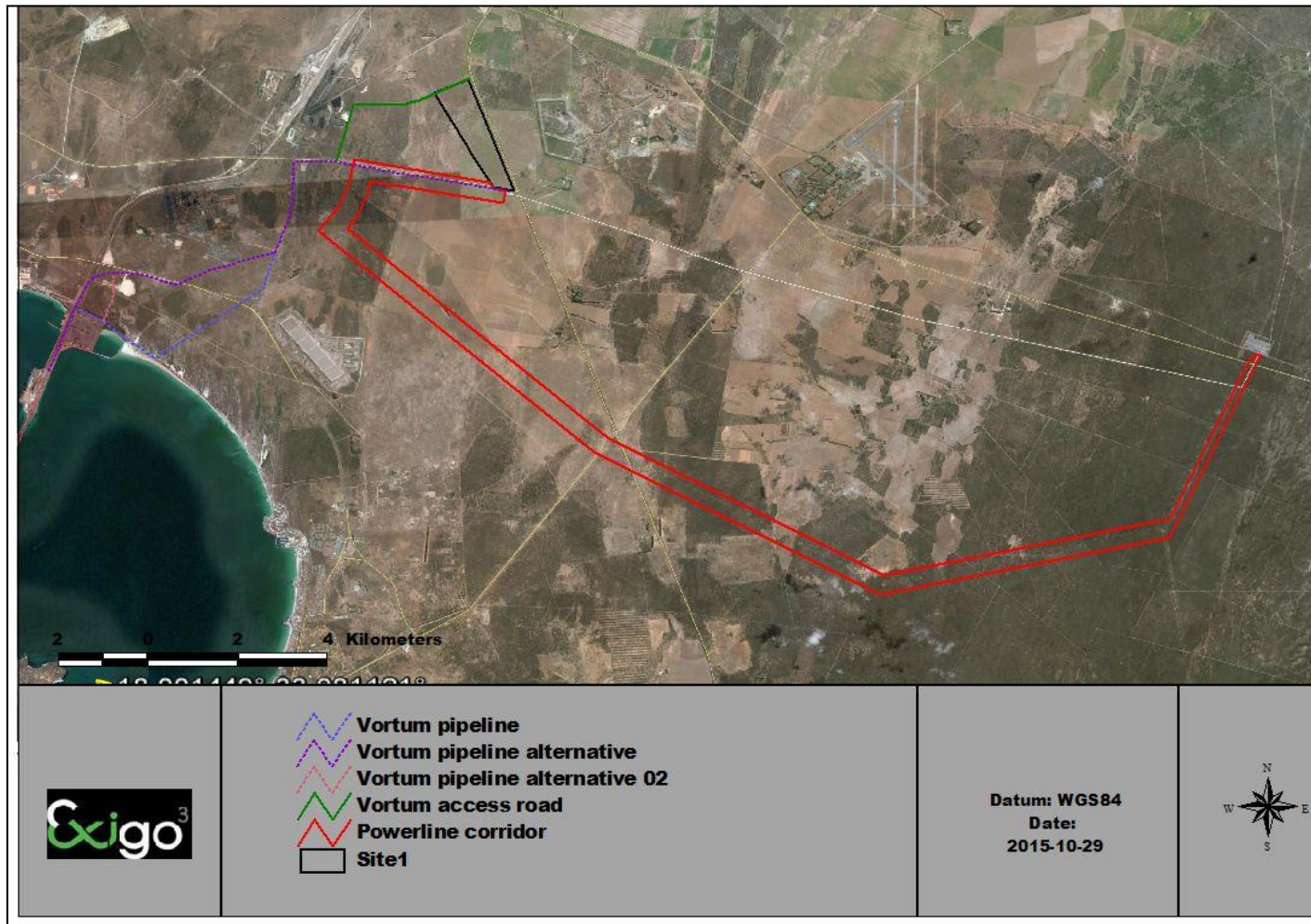


Figure 3. Satellite image showing the project area (Google Pro, 2010)

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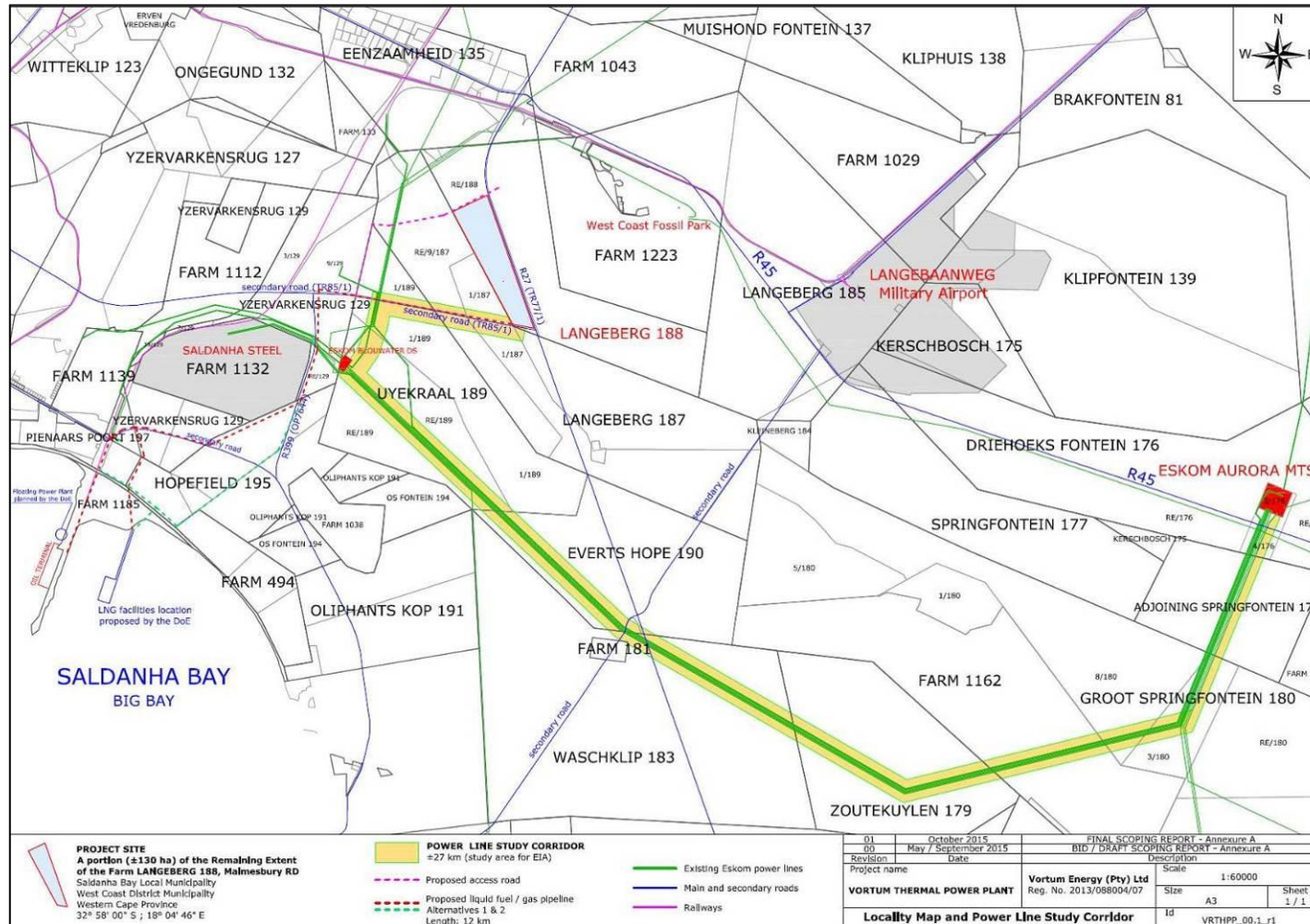


Figure 4. Layout Map of the proposed Vortum Thermal Power Plant and associated powerline and gas / fuel pipelines

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4 LEGISLATION PERTAINING TO THE CONTROL OF IAS

The Alien and Invasive Species Regulations (GNR 599 of 2014) are stipulated as part of the National Environmental Management: Biodiversity Act (10/2004). The regulation listed a total of 559 alien species as invasive and further 560 species are listed as prohibited and may not be introduced into South Africa. Below is a brief explanation of the four categories of Invasive Alien Plants 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.

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5 CONTROL OF INVASIVE ALIEN SPECIES

5.1 BACKGROUND

Vehicles often transport many seeds and some may be of invader species, which may become established along the roads inside the proposed development site where the area is disturbed. The construction phase of developments in the area will almost certainly carry the greatest risk of alien invasive species being imported to the site, and the 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. 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.

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.

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

- Prevention: Keeping an IAS from being introduced onto the site ecosystem. Ideally, this usually means keeping alien plants from entering the development site;
- Early detection: Locating IAS before they have a chance to establish and spread. This usually requires effective, site-based inventory and monitoring programmes;
- Eradication: Killing the entire population of IAS. Typically, this can only be accomplished when the organisms are detected early;
- Control: The process of long-term management of the IAS' population size and distribution when eradication is no longer feasible. This can be done by implementing the following strategies:
 - Institute strict control over materials brought onto site, which should be inspected for potential invasive invertebrate species 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

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contractor is responsible for the control of weeds and invader plants within the construction site for the duration of the construction phase;

- Control involves killing the plants present, killing the seedlings which emerge, 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 Invasive Alien 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.
 - Always start at the highest point and work downwards i.e. downhill or downstream;
 - Start from the edge of the infestation and work towards the centre;

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- Take care to prevent the spread of cuttings;
- Once plants have been removed, banks and slopes should be stabilised by erosion protection measures (such as geotextiles or 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 in conjunction with cutting or slashing of plants
 - 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 the appropriate herbicides to be used 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:

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- 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, because it does not kill all the target plants at once
- It allows the natural vegetation to recover gradually in the shelter of the dying weeds.
- Integrated control - combinations of the above three approaches. Often an integrated approach is required in order to prevent enormous impacts.


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

6 SPECIES SPECIFIC CONTROL

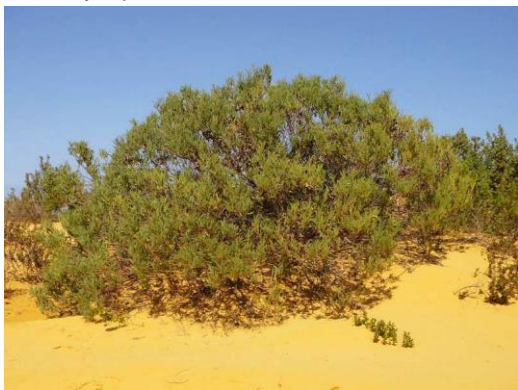
Table 1 indicate specific control methods for the different IAS that occurs on the proposed development site as identified by Henning (2015):

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Table 1. Invasive Alien Species with a distribution centred within the study area and also documented during the ecological surveys (Henning, 2014) also indicating control methods

Species	Common name	CARA status	Priority to control	Control Method
<p><i>Acacia mearnsii</i></p> 	Black wattle	1b	Medium	<p>Cultural control: Seedlings and saplings younger than three years old are sensitive to fire. However, Pieterse and Boucher (1997) investigated burning standing <i>A. mearnsii</i> trees as a viable management technique but found that a high proportion of mature trees survived to re-sprout, a large number of seeds in the seedbank were stimulated to grow and the overall size of the thicket increased significantly. In localized areas there are interactions with existing herbivores that limit the spread of this plant. An example cited in Kruger et al. (1986) occurs in the Umfolozi Game Reserve, South Africa where black rhinoceros removes <i>A. mearnsii</i> from river bank habitats. Attempts have also been made in South Africa to produce a sterile triploid variety by controlled crossing of the natural diploid form with an artificially created tetraploid form (Beck et al., 2003). However, this approach, while appealing, may yet create more problems in the future, as naturally occurring hexaploids in most plant species are thought to have originated from a natural doubling of chromosomes in triploids. Thus, plantations of sterile triploids could produce even more invasive hexaploids.</p> <p>Mechanical control: Since <i>A. mearnsii</i> re-sprouts from the roots, these should be removed (Weber, 2003), and girdling of the stem is also effective (PIER, 2007)</p> <p>Chemical control: Glyphosate may be used to spray seedlings and juvenile trees but for adult trees it is more appropriate to fell mechanically, and follow up with an application of herbicide to the cut stump (Weber, 2003). A variety of chemical treatment agents and techniques are described by PIER (2007), including dicamba, glyphosate and picloram used as cut surface treatments and triclopyr, 2,4-D, triclopyr ester in oil and triclopyr amine as basal bark treatments, where it</p>



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Species	Common name	CARA status	Priority to control	Control Method
				<p>is noted that <i>A. mearnsii</i> appears particularly sensitive to basal bark treatments, and application of diesel alone is also effective.</p> <p>Biological control: Henderson (2001) reports that both seed feeders and a mycoherbicide are used to control <i>A. mearnsii</i>. ARC (2000) names two agents that it supplies for the purpose of biological control in South Africa; the seed weevil <i>Melenterius maculatus</i> and a native South African fungus <i>Cylindrobasidium laeve</i> that attacks stumps and is applied after felling to prevent re-sprouting. More recently a cecidomyiid midge, <i>Dasineura rubiformis</i>, which forms galls in the flowers and prevents pod development was released (Impson et al., 2008).</p>
<p><i>Acacia cyclops</i></p> 	Red-eyed wattle or western coastal wattle	1b	High	<p><i>Acacia cyclops</i> may be controlled by cutting stems close to the ground. Combinations of clearing and burning stands are used to reduce the soil seed bank and the tree rarely re-sprouts after fire damage or felling. Working for Water (2003) state that seedlings and young plants may be pulled out by hand and that medium sized <i>A. cyclops</i> should be ring-barked or cut below the surface.</p> <p>Biological control of <i>A. cyclops</i> using three <i>Melantarius</i> species is currently under investigation (Working for Water, 2003), and Impson et al. (2000) reported that adult and larval seed-feeding weevils <i>Melanterius servulus</i> destroyed up to 95% of <i>A. cyclops</i> seeds at release sites in Western Cape Province. Continued research into the effectiveness of <i>M. servulus</i> as a biocontrol agent is focusing on weevil dispersal, interference by birds, a native alydid bug and rodents, and asynchrony in the phenologies of the weevils and <i>A. cyclops</i> (Impson et al., 2000).</p>



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Species	Common name	CARA status	Priority to control	Control Method
<i>Altenanthera pungens</i> 	Khakiweed	Not listed	Medium	This weed is controlled effectively by pre-emergence herbicides but becomes tolerant to post emergence herbicides as it matures. It should be mechanically removed when small
<i>Argemone ochroleuca</i> 	Mexican poppy	1b	High	<p>Chemical control: Plants of <i>A. ochroleuca</i> 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 <i>A. ochroleuca</i> include 2,4-D, 2,4-DB, dicamba, diuron, fluroxypyr, hexazinone, isoproturon, karbutilate, MCPA, metribuzin, oxadiazon, picloram and terbutryn.</p> <p>Biological control: A biological control programme of <i>A. ochroleuca</i> 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).</p>



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Species	Common name	CARA status	Priority to control	Control Method
<i>Bidens pilosa</i> 	black-jack, beggar-ticks, cobbler's pegs, and Spanish needle	Not listed	Low	<p><i>Bidens pilosa</i> can be controlled by persistent mowing, hoeing and hand pulling in order to prevent seed production. Thorough cultivation discourages growth. Chemical control regimes depend upon the cropping system in which one is working. Details for individual crops can be found in the CABI Invasive Species Compendium. When using any herbicide always read the label first and follow all instructions and safety requirements.</p>
<i>Chenopodium album</i> 	White goose foot	Not listed	High	<p><i>C. album</i> is easily controlled by cultivation and most of the pre- and post-emergence herbicides broadleaf weed herbicides.</p> <p><i>C. album</i> is sensitive to a range of foliage-applied herbicides, including 2,4-D, MCPA, paraquat, bentazone, dichlofop, isoproturon, metoxuron, methabenzthiazuron, sulfosulfuron, metsulfuron-methyl, chlorotoluron, bromoxynil and dicamba.</p>

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Species	Common name	CARA status	Priority to control	Control Method
<p><i>Opuntia ficus-indica</i> <i>Opuntia imbricata</i> <i>Opuntia stricta</i></p> 	Prickly pear	1b	High	<p>Mechanical: Complete eradication is difficult because each joint or fruit can produces a new plant.</p> <p>Biocontrol: sap-sucking cochineal and <i>Cactoblastis</i> moth effective on large patches. Remainder must be sprayed with government-subsidised MSMA® but must leave some plants to keep bio-agents alive</p>
<p><i>Tagetes minuta</i></p> 	Southern Cone Marigold / Kakiebos	Not listed	Medium	<p>Mechanical Control: Tillage and hand pulling is very effective in controlling <i>T. minuta</i> in agricultural fields and in cultivation processes. However, agricultural machines should be cleaned to prevent seed dispersal among fields.</p> <p>Chemical Control: In screening trials Lorenzi (1986) showed <i>T. minuta</i> to be susceptible to acifluorfen, ametryne, bentazon, bifenox, bromacil, cyanazine, dicamba, diphenamid, diquat, diuron, 2,4-D, glyphosate, imazaquin, linuron, metribuzin, molinate, oxadiazon, oxyfluorfen, paraquat and simazine. Current The effect of these herbicides can be reduced if the herbicide leaches below the germination zone, e.g. in sandy soil.</p>

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Species	Common name	CARA status	Priority to control	Control Method
<i>Taraxacum officinale</i> 	Common dandelion	Not listed	Medium	Young plants are easy to control with post-emergence, systemic, broadleaf herbicides, but once established become more difficult to control on account of their strong tap roots
<i>Xanthium strumarium</i> 	Large cocklebur	1b	Medium	<p>Mechanical: Remove plants with fruits as soon as possible and dump in front of an active growing rock dump. Dead plants should then be covered with rock as soon as possible.</p> <p>Chemical: Herbicide treatment can be done by using 20ml Access and 30ml 2,4 D Eser / 10l water on active growing plants. Care must be taken not to affect other broadleaf herbs and trees.</p>

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 rehabilitation activities. The nature of secondary succession in disturbed areas (previously mined and cultivated) should be evaluated in order to determine whether a favourable succession pathway is occurring towards indigenous vegetation cover.

Plant life will probably resettle, especially after a detailed rehabilitation program on the plant and surrounding areas. The impact life may, however, be of a long-term and permanent nature. The re-vegetation of the disturbed areas will become an integral part of activities during the closure phase. Monitoring and maintenance of alien invasive and grass cover should be done until a self-sustaining plant community is established. Re-establishment of plant cover on disturbed areas should take place as soon as activities have ceased, for example the areas where the buildings and plant area are situated will only be re vegetated once the buildings have been removed during the decommissioning phase. All roads not required for access shall be ripped and planted with endemic vegetation.

Monitoring of alien invasive plants and weeds should be conducted bi-annually on the site for the Vortum Thermal Power Plant as follows:

Phase 1: 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: Monitoring should be undertaken bi-annually for the first three years, thereafter every third year, to determine:

- 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.

8 REFERENCES

BROMILOW, C. 2001. Problem Plants of South Africa: A Guide to the Identification and Control of more than 300 Invasive Plants and other Weeds. Briza Publications.

Henning B. 2015. Specialist ecological study for the proposed Vortum Thermal Power Plant. Exigo Sustainability (Pty) Ltd.

The Nature Conservation Corporation 2008. Invasive Alien Vegetation Management Manual.

VAN WILGEN, B. Invasive alien species – an important aspect of global change

www.agis.agric.za

APPENDIX A

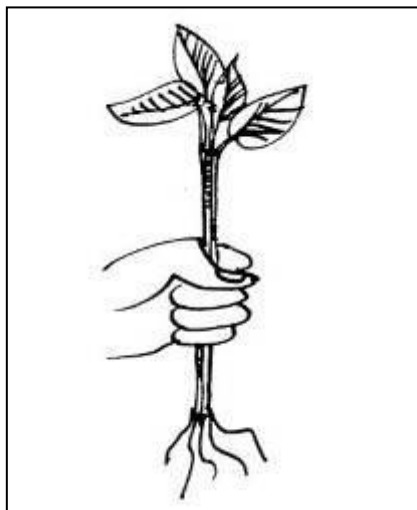
Control methods

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)



roots & all

- Pull hard and remove the plant,
- 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, bow-saws, 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 the use of herbicide.

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.

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- 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 the spray may come into contact with 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. Herbicides are applied in diesel or water as recommended for the herbicide.
- Applications in diesel should be to the whole stump and exposed roots and in

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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 therefore the risk of uncontrolled fire.
- Keep stacks well apart to prevent fires from crossing easily, not less than 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, power and telephone 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 plant's 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 have the ability of causing damage to the useful part of the plant, and instead using only seed-reducing agents. These reduce the reproductive potential of the plants, curb their dispersal and reduce the follow-up work needed after clearing, while still allowing for the continued utilisation of the plant. For instance, trees are normally grown for their wood, but the seeds are seldom utilised. If seeds are needed to replant a plantation, a seed orchard can be specially protected against the bio control agents in the same way as other crops are protected against insect pests. If, on the other hand, the pods are the most valuable part of the tree, as in the case of mesquite (*Prosopis* spp.), no bio control agents can be selected that will prevent pod production. The seed-feeding beetles that were introduced against mesquite prevent only the germination of seeds from the animal droppings, without significantly reducing the nutritional value of the pods. They do not prevent pod or seed production. Bio control agents are mostly introduced from the country of origin 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, in spite of the attack by a bio control agent, actually ensures that the agent does not die out as a result 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 it successfully before causing significant damage to its host plant.

Unfortunately, not all growth of invasive plant species can be curbed purely 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 the climatic regions in which the plant is a problem in South Africa, or that the habitat already contains predators or parasites 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.