ENVIRONMENTAL MANAGEMENT PROGRAMME

for

RESIDENTIAL DEVELOPMENT

on

Remainder of Erf 2833, Great Brak River, Mossel Bay

In terms of the

National Environmental Management Act (Act No. 107 of 1998, as amended) & 2014 Environmental Impact Regulations (as amended)

Prepared for Applicant:
New Care Innovations (Pty) Ltd

Date: 22 May 2024

Appointed EAP: Ms Louise-Mari van Zyl
Assisted by Candidate EAP: Ms Mariska Byleveld
Email: louise@cape-eaprac.co.za | mariska@cape-eaprac.co.za

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Case Officer: Dorien Werth

Cape EAPrac
Cape Environmental Assessment Practitioners

Tel: +27 44 874 0365 PO Box 2070, George 6530
Fax: +27 44 874 0432 17 Progress Street, George

www.cape-eaprac.co.za

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APPOINTED ENVIRONMENTAL ASSESSMENT PRACTITIONER:

***Cape EAPrac* Environmental Assessment Practitioners**

PO Box 2070

George

6530

Tel: 044-874 0365

Appointed EAP: Director **Louise-Mari van Zyl** (MA Geography & Environmental Science [US]); Registered Environmental Assessment Practitioner with the Environmental Assessment Practitioners of South Africa, EAPSA, **Registration Number 2019/1444**. Ms van Zyl has over twenty years' experience as an environmental practitioner.

Assisted by:

Candidate EAP: Mariska Byleveld (MSc Geology at the University of the Free State). Registered Candidate Environmental Assessment Practitioner with the Environmental Assessment Practitioners of South Africa, EAPASA, **Registration Number 2023/6593**.

PURPOSE OF THIS REPORT:

Environmental Management Programme

APPLICANT:

New Care Innovations (Pty) Ltd

CAPE EAPRAC REFERENCE NO:

MOS788/09

SUBMISSION DATE

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Submitted for:

Stakeholder Review & Comment

Report Issued by:

Cape Environmental Assessment Practitioners

Tel: 044 874 0365

Web: www.cape-eaprac.co.za

PO Box 2070

17 Progress Street

George 6530

ORDER OF REPORT

Environmental Management Plan

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Appendix 4 of Regulation 982 of the 2014 EIA Regulations contains the required contents of an Environmental Management Programme (EMPr). The checklist below serves as a summary of how these requirements were incorporated into this EMPr.

Table 1: Checklist in terms of Appendix 4 of Regulation 982 of 2014 EIA Regulations

Requirement	Description
Details and expertise of the EAP who prepared the EMPr; including curriculum vitae.	Ms Louise-Mari van Zyl for Cape Environmental Assessment Practitioners. See Appendix 4.
A detailed description of the aspects of the activity that are covered by the EMPr as identified by the project description.	Section 1
A map at an appropriate scale which superimposes the proposed activity, its associated structures, and infrastructure on the environmental sensitivities of the preferred site, indicating any areas that must be avoided, including buffers	Appendix 1
A description of the impact management objectives, including management statements, identifying the impacts and risks that need to be avoided, managed and mitigated as identified through the environmental impact assessment process for all the phases of the development including – (i) Planning and design; (ii) Pre-construction activities; (iii) Construction activities; (iv) Rehabilitation of the environment after construction and where applicable post closure; and (v) Where relevant, operation activities.	Section 4 – Environmental Impacts & Mitigations Section 5 - Responsibilities Section 6 – Pre-Construction Design Section 7 – Construction Phase Section 8 – Operation Phase
A description and identification of impact management outcomes required for the aspects contemplated above.	Section 4
A description of the proposed impact management actions, identifying the manner in which the impact management objectives and outcomes contemplated above will be achieved and must, where applicable include actions to – (i) Avoid, modify, remedy control or stop any action, activity or process which causes pollution or environmental degradation; (ii) Comply with any prescribed environmental management standards or practises; (iii) Comply with any applicable provisions of the Act regarding closure, where applicable; and (iv) Comply with any provisions of the Act regarding financial provisions for rehabilitation, where applicable.	Section 4 Section 6 Section 7 Section 8
The method of monitoring the implementation of the impact management actions contemplated above.	Section 9 Section 11
The frequency of monitoring the implementation of the impact management actions contemplated above.	Section 9

Requirement	Description
An indication of the persons who will be responsible for the implementation of the impact management actions.	Section 5
The time periods within which the impact management actions must be implemented.	Not Applicable
The mechanism for monitoring compliance with the impact management actions.	Section 9
A program for reporting on compliance, taking into account the requirements as prescribed in the Regulations.	Section 9
An environmental awareness plan describing the manner in which – (i) The applicant intends to inform his or her employees of any environmental risk which may result from their work; and (ii) Risks must be dealt with in order to avoid pollution or the degradation of the environment.	Section 5 Section 6 Section 7 Section 8 Section 9
Any specific information that may be required by the competent authority.	Not Applicable.

ABBREVIATIONS AND ACRONYMS

BSP Biodiversity Sector Plan - to inform land use planning, environmental assessments, land and water use authorisations, as well as natural resource management, undertaken by a range of sectors whose policies and decisions impact on biodiversity.

CARA Conservation of Agricultural Resources Act (Act 43 of 1983) - provides for control over the utilization of the natural agricultural resources of the Republic in order to promote the conservation of the soil, the water sources and the vegetation and the combating of weeds and invader plants; and for matters connected therewith.

CBA Critical Biodiversity Area - areas required to meet biodiversity targets for ecosystems, species and ecological processes, as identified in a systematic biodiversity plan.

DFFE National Department of Forestry, Fisheries & the Environment – the national authority responsible for the sustainable environmental management and integrated planning.

DEA&DP Department of Environmental Affairs and Development Planning – the provincial authority for sustainable environmental management and integrated development planning. The competent authority is this case.

DWS Department of Water & Sanitation Affairs – National authority mandated to enforce the National Water Act (NWA).

EA Environmental Authorisation – Authorisation obtained on completion of an Environmental Impact Assessment in terms of the National Environmental Management Act (NEMA).

ECA Environment Conservation Act, 1989 - To provide for the effective protection and controlled utilization of the environment and for matters incidental thereto.

ECO Ecological Control Officer – independent site agent appointed to observe and enforce the implementation of environmental policies and principles on a development site.

EIA Environmental Impact Assessment - a process of evaluating the likely environmental impacts of a proposed project or development, taking into account inter-related socio-economic, cultural and human-health impacts, both beneficial and adverse.

EMPr Environmental Management Programme – an environmental management tool used to ensure that undue or reasonably avoidable adverse impacts of the construction, operation and decommissioning of a project are prevented and that positive benefits of the projects are enhanced.

GIS Geographic Information System - system designed to capture, store, manipulate, analyse, manage, and present all types of geographical data.

GPS Global Positioning System - a radio navigation system that allows land, sea, and airborne users to determine their exact location, velocity, and time 24 hours a day, in all weather conditions, anywhere in the world.

NEMA National Environmental Management Act (Act 107 of 1998, as amended) – national legislation that provides principles for decision-making on matters that affect the environment.

NEM:BA National Environmental Management: Biodiversity Act (Act No.10 of 2004) – provides for the management and conservation of South African biodiversity within the framework of NEMA.

NFA National Forestry Act (Act No.84 of 1998) - provides for the protection of forests, as well as specific tree species within South Africa.

NSBA National Spatial Biodiversity Assessment – aims to assess the state of South Africa's biodiversity based on best available science, with a view to understanding trends over time and informing policy and decision-making across a range of sectors.

NWA National Water Act (Act No.36 of 1998) - ensures that South Africa's water resources are protected, used and managed.

1. INTRODUCTION

Cape Environmental Assessment Practitioners (*Cape EAPrac*) was appointed by the Applicant, New Care Innovations (Pty) Ltd to develop an Environmental Management Programme (EMPr) which will be used to promote and ensure environmental monitoring and control during all relevant phases (construction, operational and possible decommissioning) associated with the proposed residential development on Remainder of Erf 2833, Great Brak River (Mossel Bay, Western Cape Province) (**Figure 1**).

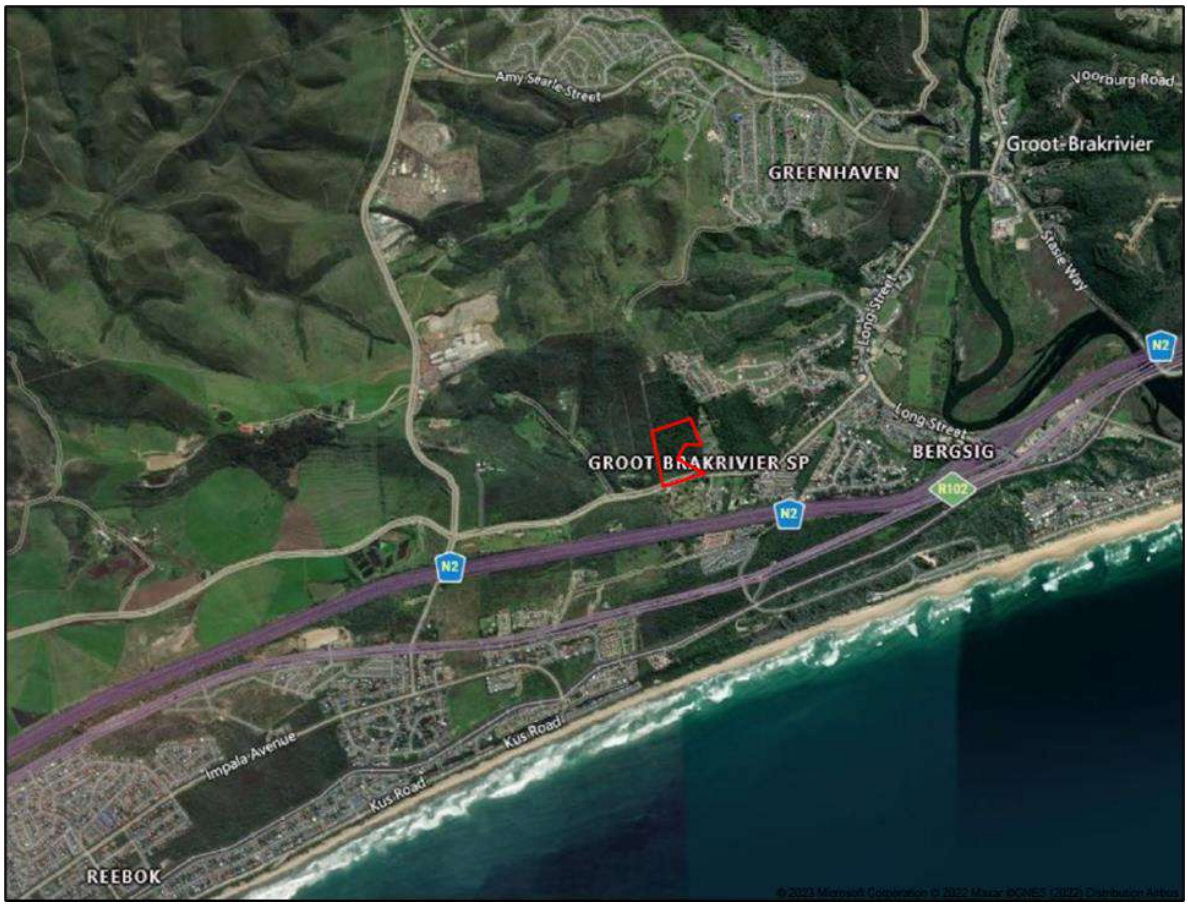


Figure 1: Locality Map of RE/2833 Great Brak River (CapeFarmMapper, 2023).

New Care Innovations (Pty) Ltd , hereinafter referred to as the Applicant, proposes to develop a residential estate on Remainder of Erf 2833 (RE/2833), Great Brak River (Mossel Bay Municipal District, Western Cape Province) (Figure 1).

RE/2833 is ±6ha in size and currently zoned Agriculture I. The site is located in Sandhoogte Road and is accessible via a narrow servitude on the property's western boundary. The property is located inside the urban edge of Great Brak River and is bounded by residential dwellings to the east and across Sandhoogte road to the south.

The Applicant proposes to rezone and subdivide the property to accommodate for the following (Figure 2):

- 41 x General Residential Zone II erven on ±1.1ha,
- 4 x Open Space II erven on ±3.56ha,
- 1 x Transport Zone III erf on ±0.99ha, and
- 1 x Transport Zone II erf on ±0.35ha.
- 1 x Utility Zone erf on ±0.03ha.

Figure 2: Preferred Site Development Plan (source: Jan Vrolik Town Planning).

TABEL 1: GRONDGEBRUIKE

Gedeelte No	Sonering verwysing	Sonering	Oppervlakte (ha)	% van totaal
1 tot 3, 6 tot 12 en 14 tot 44		Algemene Residensiële Sone I	1.11	19.00
5		Nutsone	0.03	0.05
4, 13, 45 en 46		Oopruimtesone III	3.56	58.77
47		Vervoersone III (Privaat straat)	0.99	16.39
48		Vervoersone II (Publieke straat)	0.35	5.79
TOTAAL			6.04	100

Figure 3: Enlarged figure of the proposed land uses as illustrated in Figure 2.

This activity requires an Environmental Authorisation in terms of the National Environmental Management Act (NEMA, Act 107 of 1998) before commencing. This document provides part of a series of documents that is being circulated for public and stakeholder input as part of the Environmental Impact Assessment (EIA) process, before being provided to the provincial competent authority, the provincial Department of Environmental Affairs & Development Planning (DEA&DP), for decision-making.

This EMPr contains **management requirements** and **recommendations** made by *Cape EAPrac*, the appointed specialist as well as in terms of the regulations contained in the **National Environmental Management Act** (NEMA, Act 107 of 1998), and best practice principles. The EMPr should be updated to include any conditions of the **Environmental Authorisation** (EA) as issued.

1.1 PURPOSE OF THE EMPR

The purpose of this EMPr is to ensure that the environmental impacts and management of the various phases, of the proposed activity, on the receiving environment are managed, mitigated and kept to a minimum (ie. the **outcome** of implementing the EMPr). The EMPr must provide easily understood and clearly defined **actions** that must be implemented during each phase of the proposed activity. The EMPr is a dynamic document that is flexible and responsive to new and changing circumstances.

The document is binding on the Applicant, all contractors and sub-contractors to the site. It must be included as part of any documents / agreements, as well as contractual documents between the Applicant and any contractors. Copies of this EMPr must be kept on site and all **senior personnel** are expected to familiarise themselves with the content of this EMPr.

Any changes or deviations to this EMPr must be authorised by the competent authority.

1.2 STATUS OF THE EMPR

It is of utmost importance that this EMPr be read in conjunction with any legally obtained authorisations such as an Environmental Authorisation (EA). This EMPr is viewed as a dynamic document that must be reviewed and updated on a continual basis.

The EMPr is valid for the duration of the project with each applicable phase corresponding to the identified requirements.

2 EMPR PHASING

2.1 PRE-CONSTRUCTION PHASE

The pre-construction phase refers to the design phase of the project. This will ensure that any requirements and best practise mechanisms are built into the planning / design phase to be developed in the construction and operational phase. In terms of this application, the pre-construction can be considered as the site selection and engineering designs and mitigations.

2.2 CONSTRUCTION PHASE

The construction phase refers to the actual construction of the development on the property, and includes all earthworks and installation of bulk services (water, sewerage, roads, stormwater, electricity etc.). In terms of this application, this phase relates to the construction of the civil engineering services and individual houses/top structures.

2.3 OPERATIONAL PHASE

The operational phase of this project relates to the ongoing construction of individual houses/trop structures, inclusive of the ongoing management required to ensure sustainable development within designated urban areas i.e. management of open spaces. Construction of houses undertaken during the operational phases must still apply the principles provided in terms of the Construction Phase of this EMPr.

The EMP must be adhered to by individual (house) contractors should private landowners be permitted to erect their own homes, alternatively the Holder's contractor must adhere to the EMP.

In the event the Holder of the EA hands over the development to a managing agent or homeowners association, the latter will continue to be responsible for long-term operational activities such as ongoing alien clearing, maintenance of the property fence, internal roads/services, access ect.

The Applicant must ensure that the Operational Phase maintains the underpinning principles 'Duty-of-Care-to-the-Environment' and ideals of sustainable development.

2.4 CLOSURE AND DECOMMISSIONING PHASE

Decommissioning refers to the process of removing the operating assets of any development after completion of the operating life cycle.

The development is for a residential village which by its nature has a long lifespan, as such it is not possible to provide a specific decommissioning timeframe. However, if this does take place, the legislation applicable at that time must be applied. As a minimum the following should be considered:

- Correct demolition and removal of building structures.

3 LEGISLATIVE REQUIREMENTS

The project Applicant is required to comply with all necessary legislation and policies applicable to development and management of the development. These include but are not limited to:

3.1 NATIONAL ENVIRONMENTAL MANAGEMENT ACT (NEMA, ACT 107 OF 1998)

The National Environmental Management Act (**NEMA**, Act 107 of 1998, as amended), makes provision for the identification and assessment of **activities** that are potentially detrimental to the environment and which require authorisation from the competent authority (in this case, the provincial Department of Environmental Affairs & Development Planning (DEA&DP)) based on the findings of an Environmental Impact Assessment (EIA).

NEMA embraces the notion of sustainable development as contained in the Constitution of South Africa (Act 106 of 1996) in that everyone has the right:

- to an environment that is not harmful to their health or wellbeing; and
- to have the environment protected for the benefit of present and future generations through reasonable legislative and other measures.

NEMA aims to provide for cooperative environmental governance by establishing principles for decision-making on all matters relating to the environment and by means of Environmental Implementation Plans (EIP) and Environmental Management Plans/Programmes (EMPr), of which this EMPr is one.

Principles contained in Section 2 of the NEMA, amongst other things, prescribe that environmental management must:

- In order of priority aim to: avoid, minimise or remedy disturbance of ecosystems and loss of biodiversity;
- Avoid degradation of the environment and avoid jeopardising ecosystem integrity;
- Pursue the best practicable environmental option by means of integrated environmental management;
- Protect the environment as the people's common heritage;
- Control and minimise environmental damage; and
- Pay specific attention to management and planning procedures pertaining to sensitive, vulnerable, highly dynamic or stressed ecosystems.

It is incumbent upon the landowner, to ensure that the above-mentioned principles, entrenched in this EMPr are upheld and complied with.

3.2 ENVIRONMENT CONSERVATION ACT, 1989 (ECA)

The EIA regulations contained in the Environmental Conservation Act (ECA) have been replaced by NEMA. However, property owners must comply with the draft regulations pertaining to noise as published in the province of Western Cape Provincial Extraordinary Gazette as provision made in section 25 of the ECA, as well as Section 24 of the ECA regarding waste management and Section 20 of the ECA dealing with waste management under Part IV, Control of Environmental Pollution.

3.3 NATIONAL ENVIRONMENTAL MANAGEMENT: BIODIVERSITY ACT (NEM:BA) (ACT 10 OF 2004)

This Act controls the management and conservation of South African biodiversity within the framework of NEMA. Amongst others, it deals with the protection of species and ecosystems that warrant national protection, as well as the sustainable use of indigenous biological resources. Sections 52 & 53 of this Act specifically make provision for the protection of critically endangered, endangered, vulnerable and protected ecosystems that have undergone, or have a risk of undergoing, significant degradation of ecological structure, function or composition as a result of human intervention through threatening processes.

The National List of Threatened Ecosystems (Notice 1477 of 2009, Government Gazette No. 32689, 6 November 2009) was gazetted in 2014. The list of threatened terrestrial ecosystems supersedes the information regarding terrestrial ecosystem status in the National Spatial Biodiversity Assessment (NSBA) 2004 & 2011.

In addition to the management of ecosystems, this Act makes provision for the management and control of alien invasive vegetation. This includes the listing of invasive species that are a threat to natural ecosystems. These species must be strictly controlled and / or eradicated.

The Mitigated Site Development Plan is designed to avoid highly sensitive biodiversity areas (Valley Thicket). Development will be within areas consisting of secondary fynbos, senescent Erica Peltata dominated fynbos, black wattle dominated thicket, grass dominated field and black wattle stand. The proposal is within a CBA which cannot be avoided. Therefore, the mitigation hierarchy has been applied through the appointment of specialists to inform the layout through site sensitivity verification. The layout was mitigated to avoid the impacts on the loss of highly sensitive thicket.

3.4 NATIONAL WASTE MANAGEMENT STRATEGY

The National Waste Management Strategy presents the South African government's strategy for integrated waste management for South Africa.

It deals among others with: Integrated Waste Management Planning, Waste Information Systems, Waste Minimisation, Recycling, Waste Collection and Transportation, Waste Treatment, Waste Disposal and Implementing Instruments.

It is advisable that an integrated waste management system be adopted, which includes waste minimisation, waste recycling and the proper storage and disposal of waste, which does not impact of the health of the environment and human health.

Operational phase: Erf 5 (Utility erf) will be the collection point for all household waste. The municipal refuse truck will access Erf 5 via the internal private road (Kwikstertjiestraat) on RE/2833.

3.5 NATIONAL WATER ACT (NWA, ACT 36 OF 1998)

The National Water Act (NWA) gives effect to the constitutional right of access to water. The Act's overall purpose is to ensure that South Africa's water resources are protected, used and managed in ways which take into account a number of factors, including inter-generational equity, equitable access, redressing the results of past racial and gender discrimination, promoting sustainable and beneficial use, facilitating social and economic development, and providing for water quality and environmental protection.

The NWA makes persons who own, control, occupy or use land responsible for taking measures to prevent pollution of water resources, and empowers Government authorities to take measures to enforce this obligation.

Since no water resources are being affected by this development, this Act is not applicable.

3.6 NATIONAL FOREST ACT (ACT 84 OF 1998)

The NFA provides for the **protection of forests**, as well as **specific tree species**, quoting directly from the Act: "no person may cut, disturb, damage or destroy any protected tree or possess, collect, remove, transport, export, purchase, sell, donate or in any other manner acquire or dispose of any protected tree or any forest product derived from a protected tree, except under a licence or exemption granted by the Minister to an applicant and subject to such period and conditions as may be stipulated". The Department of Agriculture, Forestry & Fisheries (DAFF) is responsible for the implementation and enforcement of the NFA, which includes **prohibition of damage to indigenous trees in any natural forest without a licence** (Section 7 of the NFA), as well as the prohibition of the cutting, disturbing, damaging destroying or removing **protected trees** without a licence (Section 15 of the NFA).

The highly sensitive valley thicket contains Cheesewood trees and there is also a high probability that it also contains Milkwood trees. No development will take place within the highly sensitive thicket. These trees are protected under the National Forest Act. It is a requirement that a permit be obtained if any protected tree species be trimmed/removed. According to the Botanist, the vegetation on site is not representative of Coastal Thicket.

3.7 NATIONAL VELD AND FOREST FIRE ACT (ACT 101 OF 1998)

The purpose of the National Veld and Forest Fire Act is to **prevent and combat veld, forest and mountain fires** throughout the RSA and to provide institutions, methods and practices for achieving this purpose. Institutions include the formations of such bodies as **Fire Protection Associations** (FPA's) and **Working on Fire**. The Act provides the guidelines and constitution for the implementation of these institutions as well as their functions and requirements.

3.8 NATIONAL HERITAGE RESOURCES ACT (ACT 25 OF 1999)

The purpose of the National Heritage Resources Act is to:

- Introduce an integrated and interactive system for the management of the national heritage resources;
- Promote good government at all levels,
- Empower civil society to nurture and conserve their heritage resources so that they may be bequeathed to future generations;

- To lay down general principles for governing heritage resources management throughout South Africa;
- To introduce an integrated system for the identification, assessment and management of the heritage resources of South Africa;
- To establish the South African Heritage Resources Agency together with its Council to co-ordinate and promote the management of heritage resources at national level;
- To set norms and maintain essential national standards for the management of heritage resources in South Africa and to protect heritage resources of national significance;
- To control the export of nationally significant heritage objects and the import into South Africa of cultural property illegally exported from foreign countries;
- To enable the provinces to establish heritage authorities which must adopt powers to protect and manage certain categories of heritage resources;
- To provide for the protection and management of conservation-worthy places and areas by local authorities; and
- To provide for matters connected therewith.

No buildings and/or ruins were noted during fieldwork and from early imagery much of the property surface area had been previously transformed through cultivation/agriculture. Therefore, the proposed development would not impact on heritage resources of cultural significance for both design alternatives.

3.9 OCCUPATIONAL HEALTH AND SAFETY ACT (ACT 85 OF 1993)

The Act provides for the health and safety of persons at work and for the health and safety of persons in connection with the use of plant and machinery; the protection of persons other than persons at work against hazards to health and safety arising out of or in connection with the activities of persons at work.

In terms of this Act, a Health and Safety Officer and Protocol must be implemented on any sites. The appointment of a Health and Safety Officer is the responsibility of the proponent and contractor and is included in this report to ensure due diligence on construction sites. It is the responsibility of the appointed to HSO to conduct any required audits and as such only the appointment of an HSO will be auditable in terms of this document.

3.10 SANS 10400 APPLICATION OF THE NATIONAL BUILDING REGULATIONS

The application of the National Building Regulations contains performance parameters relating to fire safety, sanitation systems, moisture penetration, structural safety, serviceability and durability. It also takes into account how the above can be established to reflect social expectations in a manner which supports sustainable development objectives

3.11 NATIONAL BUILDING REGULATIONS

The National Building Regulations and Building Standards Act as amended must be complied with. This act addresses, inter alia:

- Specifications for draftsmen, plans, documents and diagrams;
- Approval by local authorities;
- Appeal procedures;

- Prohibition or conditions with regard to erection of buildings in certain conditions;
- Demolition of buildings;
- Access to building control officers;
- Regulations and directives; and
- Liability.

4 ENVIRONMENTAL IMPACTS & MITIGATIONS

The following specialist impact assessments / studies were undertaken for the proposal:

- Faunal Impact Assessment (Willem Matthee)
- Botanical & Biodiversity Impact Assessment (Bianke Fouche)
- Agricultural Compliance Statement (Johann Lanz)
- Integrated Heritage Impact Assessment (Perception Planning)
- Aquatic Compliance Statement

The following positive & negative environmental impacts of the proposed activity were identified and considered during the EIA process, based on which the associated mitigation measures were recommended for implementation (to reduce negative impacts & enhance positive ones):

Positive	Negative
The property currently has no land use other than being vacant. It does not contribute to any socio-economic aspects. The proposed development on the preferred property will therefore optimize vacant land in an urban context.	Temporary noise, dust and safety impacts associated with the movement of heavy vehicles. These impacts can be mitigated by implementing the mitigation measures as described in the Environmental Management Programme.
The location of the preferred alternative does not have potential impacts on view corridors, ridgelines and landscape assets.	Development on the preferred property will result in the loss of approximately ±2.5ha of indigenous vegetation including senescent Erica peltata dominated fynbos, secondary fynbos and black wattle dominated thicket.
Development will result in temporary employment opportunities during construction (to semi-skilled and unskilled workers mostly).	Temporary risk of increase crime during construction.
Development will result in permanent and temporary employment opportunities during the operational phase (to skilled and semi-skilled workers mostly).	Temporary increase in construction vehicular traffic.
The development will make use of existing Municipal services - additional income to the local Municipality through municipal rates and taxes.	Additional pressure on non-renewable services.
The remaining natural vegetation on site will be actively monitored and maintained. The homeowner's association will implement ongoing alien clearing on the property.	Continued maintenance cost (alien clearing, access control, clearing of dumped materials).
No / Negligible Impact: • No impact on Heritage Resources. • No impact on highly sensitive areas (Thicket). • No impact on butterfly-friendly fynbos vegetation.	

4.1 MITIGATIONS

Table 2: List of Mitigation Measures & Associated Management Requirements

Mitigation	Condition of Approval	Included in EMPr	Construction Phase	Operational Phase	Decomissioning Phase
Mitigations / Recommendations					
An ECO should be appointed prior to construction for the duration of both construction and operational phases.	✓	✓	✓	✓	
Fossil Chance Find Protocol: Should fossil bones and teeth be encountered in the deposits, work must cease at the site and the works foreman and the ECO for the project must be informed immediately. Scattered, unearthed parts/fragments of the find must be retrieved and returned to the main find site which must be protected from further disturbance. Heritage Western Cape must be informed and supplied with contextual information: • A description of the nature of the find. • Detailed images of the finds (with scale included). • Position of the find (GPS) and depth. • Digital images of the context. i.e. the excavation (with scales). If fossils are found by the environmental officer, or other responsible person once excavations for amenities, infrastructure and foundations have commenced then they should be rescued, and a palaeontologist called to assess and collect a representative sample.		✓	✓	✓	
If during ground clearance or construction, any archaeological material or human graves are uncovered, work in that area should be stopped immediately and the ECO should report this to Heritage Western Cape (Tel: 021 483 9689). The heritage resource may require inspection by the heritage authorities, and it may require further mitigation in the form of excavation and curation in an approved institution.		✓	✓		
Plant search and rescues must be conducted whenever a new dwelling or structure is being constructed on any of the new sub-divided erven within Erf 2833. • The construction area of influence must be clearly defined, and a nursery spot for rescued plants must be identified and used for each proposed development. • Any additional SCC plants that are observed at any point during the construction of any of the proposed dwellings must be reported to the ECO. • Naturally occurring plants that are rescued from the development footprints must be re-planted after construction within the disturbance envelope.		✓	✓	✓	
Protection and re-use of topsoil • The topsoil on the site contains valuable seeds and characteristics that will be vital for the success of rehabilitation of the site following construction processes. Topsoil in new excavation areas must be stripped to a depth of ca. 30cm and		✓	✓	✓	

Mitigation	Condition of Approval	Included in EMPr	Construction Phase	Operational Phase	Decomissioning Phase
kept in designated piles on site within the footprint of the proposed development(s). • Topsoil may not be removed from the site at all, to avoid contamination with any other material. Equipment used to handle and excavate the soil must be clean of any foreign material. • The topsoil piles must be clearly labelled so that it does not mix with subsoils excavated or any other construction material for the site. • Topsoil piles must be covered with plastic sheeting for the duration of the construction phase.					
Staff must be informed about the sensitivity of the remaining natural area on the site (ECO Environmental Inductions).		✓	✓	✓	
Ongoing monitoring and clearing of invasive alien plants during the construction phase & operational phase.		✓	✓	✓	
No kikuyu grass will be allowed anywhere, especially within riparian areas, as this is a listed invasive species.		✓	✓	✓	
Development and sub-divided erven to be developed must be outside of the sensitive valley vegetation with thicket on Erf 2833.		✓	✓	✓	
All new staff must be briefed about the layout of the construction site/s, and no-go natural areas must be clearly communicated.		✓	✓	✓	
Materials used during the construction phase must be sourced responsibly. • No waste (including cleared invasive slash) dumping or burning may occur on the site, and especially not in the valley. • Regular cleaning of the construction site must take place (at the end of every day). Bins must be available on the construction site. Refuse must be disposed of at the appropriate waste disposal facility. • Danger tape that is broken or that is starting to crumble must be disposed of and replaced. This applies to any construction material that has broken or become weathered. • Stockpiles and soil must all be placed within areas that will remain permanently/temporarily transformed and must be covered by a geotextile or plastic covering, which must also be bunded (e.g., sandbags) when the piles are not in use on the site. This will prevent the material from washing away and contaminating the substrate of the site which likely still contains useful seeds and soil organisms.		✓	✓		
Construction vehicles should be checked daily at the start of the day for leaks and other faults.		✓	✓	✓	

Mitigation	Condition of Approval	Included in EMPr	Construction Phase	Operational Phase	Decomissioning Phase
• Sandbags or sawdust should be available on the site to ensure that any accidental oil or toxic material spills can be contained and stopped quickly / Spill Kit • Any contaminated soil on the site must be removed by a registered hazardous waste service provider (Spill Tech, Interwaste, EnviroServ etc.). • Vehicles with leaks must not be allowed to operate on the site until they have been repaired.					
Adequate ablution facilities must be provided for every construction project. • Toilets must be placed on a level platform before construction starts. • Ablution facilities must be regularly maintained and cleaned. • At least one toilet per ten to fifteen construction staff should be available.		✓	✓	✓	
Additional gardening should be avoided and limited to a maximum of 100m^2 per dwelling. This area includes gardens and lawns. Landscaped gardens are to be planted with naturally occurring species from the area.		✓	✓	✓	
Only the rehabilitation of natural fynbos and thicket vegetation rescued from the site around the proposed developments in the disturbance envelope is allowed.		✓	✓	✓	
Landowners are responsible to maintain their gardens, so that plants do not overgrow. No garden waste may be dumped in any remaining natural area and must be disposed of in a responsible manner.		✓	✓	✓	
Fertilisers and pesticides must be avoided, and only where absolutely necessary can they be used with due caution to avoid killing indigenous species and natural pollinators in the surrounding landscape.		✓	✓	✓	
Gardens can be designed to be water wise (avoid erosion).		✓	✓	✓	
Conservation of some intact fynbos vegetation with larval food plants. • Planting suitable larval host plants and butterfly feeding plants in resident's gardens and promoting planting of indigenous flowering plants in resident's gardens. • Reducing the use of pesticides in gardens would also benefit the two butterfly species of conservation concern that could occur at the site. Ensuring that some fynbos vegetation with suitable larval food plants will also potentially benefit these (and other) species.		✓	✓	✓	
Using a fence that allows movement of Sensitive Species 8. • It is also recommended that mammal-funnels are placed in the fence line, at places where there is a high likelihood of species such as Sensitive Species 8 moving through the		✓	✓	✓	

Mitigation	Condition of Approval	Included in EMPr	Construction Phase	Operational Phase	Decomissioning Phase
landscape. These mammal-funnels should be monitored (with camera traps, or the ECO visiting each funnel).					
No free-roaming domestic cats are allowed within the valley thicket as they might disturbed the Knysna Warbler during its breeding season. • Additionally, putting up signage to inform homeowners of the impact their pets could have on the Knysna Warbler, could increase awareness and environmental consciousness of those living on the property. Dogs that are not housebound should be enclosed in a fenced area, to prevent access to more sensitive areas on the property.		✓	✓	✓	
If trails on the estate are planned, care should be taken when crossing through the thicket vegetation. Exotic plants in this vegetation are removed, and the trail follow the section that previously had the highest density of AIPs.		✓	✓	✓	
Rainwater harvesting tanks must be installed.		✓	✓	✓	
Use of swales to attenuate stormwater runoff, encourage infiltration and reduce the speed, energy and volumes at which stormwater is discharged from the site.		✓	✓	✓	
Use of permeable paving to encourage infiltration into the soil.		✓	✓	✓	
Clearly demarcate the construction area and ensure that heavy machinery does not compact soil or disturb vegetation outside of these demarcated areas.		✓	✓	✓	
Reduce transport of sediment using structures such as silt fences and biodegradable coir logs placed along a contour below the development footprint.		✓	✓	✓	
Ensure that vegetation clearing is conducted in parallel with the construction process to minimise erosion and runoff.		✓	✓	✓	
Revegetate exposed areas once construction has been completed.		✓	✓	✓	
Ensure that stormwater and runoff generated by hardened surfaces is discharged in retention areas, to avoid concentrated runoff and associated erosion.		✓	✓	✓	
A development set-back line of 3m from the crest of the slope or, alternatively provision should be made to support/retain this embankment with suitable methods. A Geotechnical Engineer must be appointed should the potential landowner decide to retain the steep embankment. Alternatively, development may only occur 3m from the crest of the slope.		✓	✓	✓	

Mitigation	Condition of Approval	Included in EMPr	Construction Phase	Operational Phase	Decomissioning Phase
Bulk earthworks and excavations should consider safe slope angles.		✓	✓	✓	
No landscaping is allowed around the path proposed in the open space are on the site.		✓	✓	✓	
Best Practise					
Construction work must take place during normal work hours.		✓	✓		
Traffic management must be in place during construction.		✓	✓		

5 ALIEN MANAGEMENT PLAN

Alien clearing is the responsibility of the Holder of the EA.

The following IAPs (Introduced and Invasive Alien Plants) were observed on site:

Species	Common name	Family	NEMBA	CARA
Physalis peruviana	Cape gooseberry	Solanaceae	NA	NA
Acacia cyclops	Rooikrans	Fabaceae	1b	2
Acacia mearnsii	black wattle	Fabaceae	2	2
Cenchrus clandestinus	Kikuyu Grass	Poaceae	1b	1
Cirsium vulgare	Bull Thistle	Asteraceae	1b	1
Hakea sericea	Bushy needlebush	Proteaceae	1b	1
Phytolacca octandra	Inkweed	Phytolaccaceae	1b	NA

A description of the relevant NEMBA category requirements is described below:

Category 1b

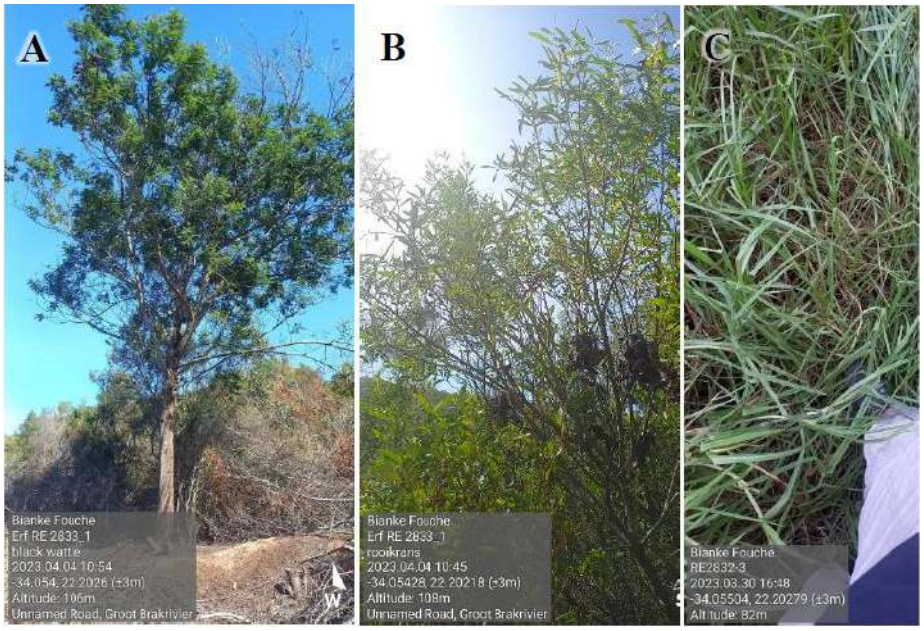
- Species which must be controlled.
- Property owners and organs of state must control the listed invasive species within their properties.
- If an Invasive Species Management Programme has been developed, a person must control the listed invasive species in accordance with such programme.
- Authorised officials must be permitted to enter properties to monitor, assist with or implement the control of listed species.
- Any Category 2 listed species (where permits are applicable) which fall outside of containment and control, revert to Category 1b and must be controlled.
- Any Category 3 listed species which occur within a Protected Area or Riparian (wetland) revert to Category 1b and must be controlled.
- The Minister may require any person to develop a Category 1b Control Plan for one or more Category 1b species occurring on a property.

Category 2

Any species listed under Category 2 requires a permit issued by the Department of Forestry, Fisheries and the Environment (DFFE) to carry out a restricted activity (See Permit Applications.)

- A permit is required to carry out any restricted activity.
- No person may carry out a restricted activity in respect of a Category 2 listed invasive species without a permit.
- A person in control of a Category 2 listed species must take all necessary measures to ensure that specimens of the species do not spread outside of the land or area, such as an aviary) specified in the permit.

Photos of the highlighted IAPs of the above table. The photos show A) Black Wattle, B) Rooikrans with viable seed pods, and C) Kikuyu grass:



The following Management Actions **must** be implemented:

Prior to Construction

1. In consultation with the appointed ECO, the Holder of the EA must determine costs and priority areas and produce a plan of operations detailing initial control (drastic reduction of the existing alien population), follow-up control (control of seedlings and re-growth) and maintenance (on-going, low-level control) and include targets and timeframes.

During Construction

1. Alien clearing must occur within phases. Follow-up clearing must be prioritized three (3) to six (6) months after initial clearing of a particular phase. During the **construction phase**, the appointed ECO must survey the Open Space II erven once a month to detect aliens and have them removed.

2. When teams responsible for invasive alien vegetation clearing enter the valley thicket area, they must ensure that they disturb as little possible indigenous vegetation to cut down and remove the invasive alien biomass (no vehicles may enter the valley thicket area for this purpose).

3. The ECO must induct the invasive alien vegetation clearing team to ensure that they know what protected tree species occur in the valley thicket to avoid unintended damage to protected trees.

4. It is important that invasive alien vegetation clearing commence at the same time as bulk earthworks/services installation to ensure that the open space area is actively cleared of invasive species from early on during the project implementation. Furthermore because the ECO/Botanist must inform the footpath/trail in the open space area (focused on areas where invasive alien vegetation grows) it is important for the invasive species to be cleared as early as possible.

5. Photographic records of clearing operations must be included in the Environmental Control Report during initial clearing, follow-up clearing and ongoing maintenance.

6. Suitable control methods in the attached *Best Practice Guideline: Alien Vegetation Management* must be followed.

7. The cleared areas must either be used for the proposed trail or must be protected/rehabilitated to avoid potential erosion. Brush from cleared areas should be used as much as possible.

8. Care must be taken to avoid the introduction of invasive plant species on site. Particular attention should be given to imported material such as building sand or dirty earth-moving equipment.

9. Stockpiles should be checked regularly for any weeds emerging.

Operational Phase

1. An ECO must remain appointed for the operational phase of this proposed development to ensure that the Managing Agent/Homeowners Association/Holder complies with the

requirement for the Open Space areas to not be transformed over time. These monitoring inspections must continue till the EA validity period lapses.

2. **During construction of individual houses**: The appointed ECO must survey the Open Space II erven once every six (6) months to detect aliens and have them removed. **Once the development is fully occupied:** The appointed ECO must survey the Open Space II erven annually till the EA validity period lapses.

3. Photographic records of clearing operations must be included in the Environmental Control Report during initial clearing, follow-up clearing and ongoing maintenance.

6 NO-GO AREAS & DEMARCATION

Construction (earthworks and services)

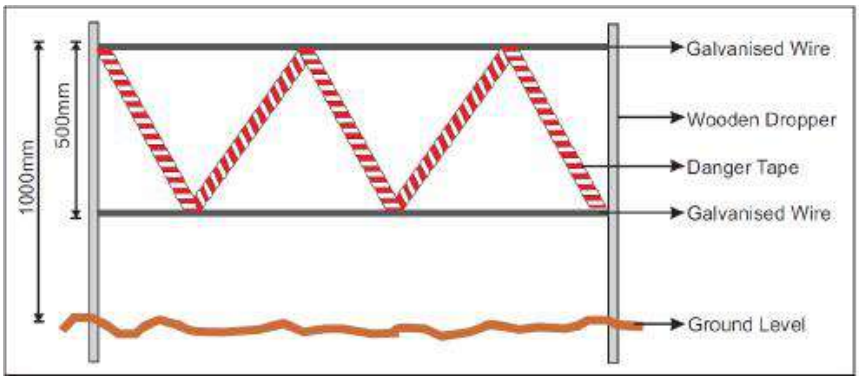
- The exact footprint of the construction areas to be surveyed and pegged prior to clearing of any vegetation/earthworks.
- The contractor, in conjunction with the ECO, must walk and inspect the areas determined and demarcate the full extent of the area to be disturbed (allowing sufficient space for the construction activity – prior to clearing of any vegetation).
- No earthworks or installation of bulk services are allowed outside the demarcated area.
- All areas outside the demarcated areas are "NO-GO" areas for any staff or vehicle/machine.
- The highly sensitive valley-thicket is identified as a no-go area during construction. No staff/workers are allowed within this area.
- If earthworks or installation of services takes place near the highly sensitive thicket, the thicket area must be surveyed and clearly demarcated. Demarcation can only be removed once all earthworks and/or installation of bulk services near the thicket have been completed (with approval from the ECO).
- Areas disturbed in the proposed Open Space II for the development of the road and installation of bulk services (per Method Statement approved by the ECO) must be rehabilitated immediately once completed. If earthworks and bulk services are phased, the first phase must be rehabilitated before proceeding with the second phase.
- Non-compliance with demarcation may be penalized.

Construction of Individual houses

- The exact footprint of each erf must be pegged out by a surveyor and clearly demarcated prior to clearing of any vegetation for construction of an individual house.
- All areas outside the demarcated areas are "NO-GO" areas for any staff and vehicle/machine.
- During the development of erven directly adjacent to the highly sensitive thicket, the thicket area must be surveyed and clearly demarcated to prevent anyone from going in there. Upon completion of an erf and upon approval from the ECO, the demarcation can be taken down.
- If the Developer/Owner intends to use another erf for stockpiling or storage of materials, the owner of that erf must give permission, that particular erf must be demarcated as well and groundcover restored once the erf is longer used for stockpiling.
- Non-compliance with demarcation may be penalised with financial implications for the Contractor.

Demarcation example

Plant wooden droppers all around the identified work area (as approved by the ECO) and connect it with either galvanised wire with danger tape or hessian/similar material so that no vehicle or staff can go through it.



All areas outside the demarcated area are considered as “no-go” areas for any construction activity including movement of staff (i.e. private open space).

- Construction staff must be briefed as part of the environmental induction on the requirements regarding the no-go areas.
- Signage must be put up on the demarcation indicating that it is a No-Go area.

Operational phase

- The landowners will be allowed to walk along a one circular trail within the highly sensitive valley-thicket.
- The trail within the valley thicket should only follow disturbed areas that have been cleared of alien vegetation.
- The landowners are restricted to the trail. All areas not within the trail are a no-go area to all landowners.
- These trails will provide access should alien vegetation be removed. The contractor removing all aliens, the ECO and the HOA will be allowed to enter the highly- sensitive thicket area beyond the trail to monitor and manage aliens.

7 STORMWATER MANAGEMENT PLAN

Prior Construction Phase

- Apply the principles of Low Impact Development (LID) in the design of the drainage systems.
- Stormwater must be managed according to the Sustainable Drainage System (SUDS) approach (Figure 4): Source Controls (rainwater tanks, permeable driveways and soakaways) & Local Controls (incorporate swales in the detailed design of the internal roads).
- Final design of the stormwater system must take place prior to construction to ensure timeous implementation.

Method of monitoring implementation	Frequency of Monitoring	Responsible Party for implementing management action	Time period	Mechanism for monitoring Compliance	Programme for reporting on Compliance

Site Plans	Once off	Architect / Engineer	Prior to construction	Audit	Once off

According to Mossel Bay Municipality, surface hardening should be restricted to 60% of the entire erf footprint.

Urban Engineering determined a high-level estimate of the expected stormwater run-off for minor (1:5 Year) and major (1:50 Year) storms for the expected catchment area. Based on Urban Engineering's calculations, the introduction of lawns, soft landscaped beds, rainwater harvesting tanks and roads that cut across the general fall of the site, will lead to an increase in time of concentration and subsequent reduction in Peak Flow Volumes (Rational Method). This must be considered in the final design of the stormwater system.

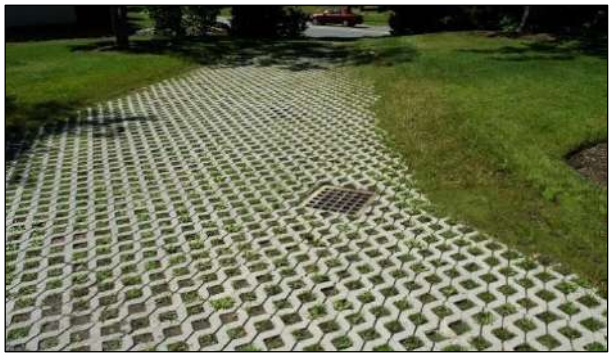


Figure 4: Example of permeable driveways & soakaways.

Construction Phase

- Minimise the quantity of stormwater entering cleared areas.
- Reduce transport of sediment using structures such as silt fences / biodegradable logs / strawbale check dams.
- Ensure that vegetation clearing is conducted in parallel with the construction process.
- Ensure that stormwater and runoff generated by hardened surfaces is discharged into retention areas to avoid concentration runoff and associated erosion.
- Any areas that are identified by the ECO as being prone to erosion must be suitably protected. During construction, the Contractor shall protect all areas susceptible to erosion by installing necessary temporary and permanent drainage works as soon as possible and by taking any other measures necessary to prevent stormwater from concentrating in streams and scouring slopes, banks, etc.
- Any erosion channels developed during construction on steep slopes must be backfilled, compacted and restored to an acceptable condition.
- Stabilisation of cleared areas to prevent and control erosion and/or sedimentation shall be actively managed. Consideration and provision shall be made for the following methods (or combination thereof): brush cut packing, mulch or chip cover, straw stabilising, watering, planting/sodding, soil binders and anti-erosion compounds, mechanical cover or packing structures (including the use of geofabric, log/pole fencing, etc.). Traffic and movement over stabilised areas shall be restricted and controlled, and damage to stabilised areas shall be repaired and maintained.
- In areas where construction activities have been completed and where no further disturbance would take place, rehabilitation and re-vegetation should commence as soon

as possible. A suitable rehabilitation method statement must be submitted to the ECO for approval.

Method of monitoring implementation	Frequency of Monitoring	Responsible Party for implementing management action	Time period	Mechanism for monitoring Compliance	Programme for reporting on Compliance
Method Statement	During construction phase	Developer / contractor	Pre implementation	Audit	Once off

Figure 5: Examples of silt fences (left) and coir logs (right) used to trap sediment mobilised from steep slopes.

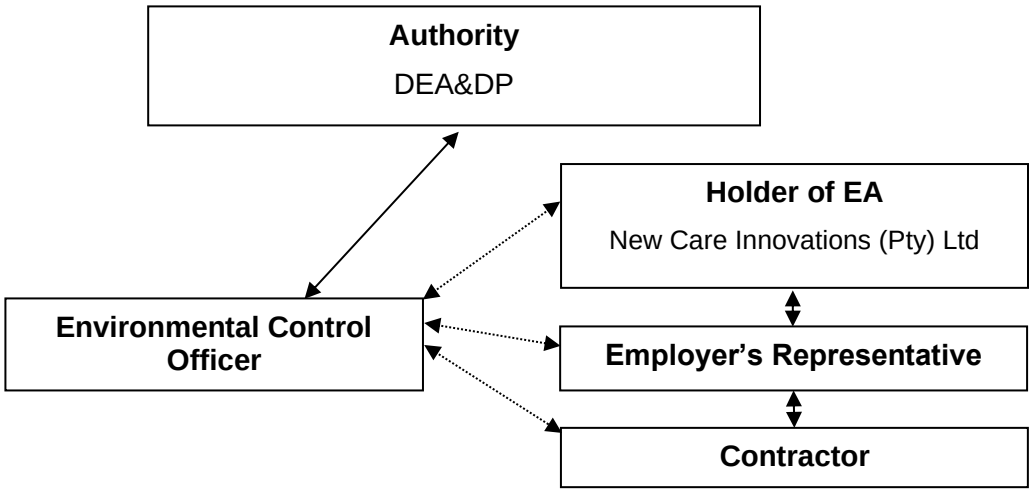
Operational Phase

- No stormwater runoff should be allowed to concentrate onto open spaces and roadways downstream of the property.
- Concentration of stormwater runoff will be minimised through the application of landscaping techniques, i.e. by creating grass lined swales, undulations and depressions.
- Ensure rainwater harvesting takes place.

Method of monitoring implementation	Frequency of Monitoring	Responsible Party for implementing management action	Time period	Mechanism for monitoring Compliance	Programme for reporting on Compliance
Ensure soft landscaping	Ongoing	Developer / HOA	As required	Audit	Audit

8 RESPONSIBILITIES

This section deals with the responsibilities of various parties during the Construction Phase of any development (see below chart).



8.1 HOLDER OF THE EA

The holder of the EA / property owner is the overseeing entity responsible for ensuring that all activities undertaken on the property comply with the Environmental Authorisation (EA) and associated Environmental Management Programme (EMPr) (& any other approval / licence / permit), as well as the management and maintenance of the open space areas.

The responsibilities of the holder of the EA / property owner include, but are not limited to the following:

- Ensure that **all tender documentation** include reference to, and the need for compliance with, the EA and EMPr as well as any other legally binding documentation, which include and are not limited to:
  - the Municipal Approval/s.
- Be conversant with, and ensure that all Contractors, Sub-contractors, Engineers (and future senior site managers / personnel) are made aware of, and understand the conditions and recommendations, contained in the abovementioned documentation;
- Ensure that all Contractors, Sub-contractors and Engineers (during construction activities) are made aware of their 'Duty of Care to the Environment' and that any damage or degradation of the natural environmental within the bounds of the property will not be tolerated and must be dealt with / remedied at the cost of the perpetrator.
- Take remedial and/or disciplinary action in circumstances where persons are found to be in contravention of the abovementioned legally binding documentation.

8.2 ENGINEERS, CONTRACTORS & SERVICE PROVIDERS

The Engineers, Contractors and Service Providers are often the parties responsible for physically carrying out the activities for which majority of the recommendations in this EMPr are intended. Service providers and Contractors include services, building contractors, 'handy-men' and engineers overseeing the installation and maintenance of services etc. The responsibilities indicated here are also relevant to Sub-Contractors.

The responsibilities of these parties include but are not limited to the following:

- Be conversant and compliant with the EA, the EMPr, and any relevant License, Permit or any legally binding documentation relevant to their operations;
- Have a responsibility to adhering to any conditions and recommendations laid out in above mentioned documentation;
- Prevent actions that may cause harm to the environment;
- Be responsible for any remedial activities in response to an environmental incident within their scope of influence;
- Liaise with the holder of the EA in complying with the EMPr, and in the event that any industry regulated standards are in contradiction with the EMPr or any other authorisations.
- Review and amend to any construction activities to align with the EMPr and Best Practice Principles;
- Ensure compliance of all site personnel and / or visitors to the EMPr and any other authorisations.

Contractors are responsible to ensure that all sub-contractors are compliant with the EA, the EMPr, and any relevant licence, permit or any legally binding documentation relevant to their operations. It is recommended that contractors and sub-contractors use colour codes for easy identification by the Environmental Control Officer (i.e., colour coded hard hats or vests).

8.3 ECOLOGICAL CONTROL OFFICER (ECO)

It is recommended that a suitably qualified Environmental Control Officer (ECO) be appointed to oversee all activities for the duration of the construction phase (i.e. construction activities, services, road works). The ECO must have a minimum of a tertiary level qualification in the natural sciences field. The ECO must have at least 3 years' experience and proven competency as an ECO.

The responsibilities of the ECO include but are not limited to the following:

- Provide environmental induction training to Contractors on site prior to construction activities commencing;
- Provide maintenance, update and review of the EMPr if necessary;
- Liaison between the Project Holder of the EA, Contractors, Authorities and other lead stakeholders on all environmental concerns, including the implementation of the EMPr;
- Compilation of Environmental Control Reports (ECR) to ensure compliance with the EA, EMPr and duty of care requirements, where necessary;
- Compilation of the Environmental Audit Report or Environmental Completion Statement, after completion of construction (or as otherwise defined in the Environmental Authorisation), where necessary;
- Ensuring / guiding and monitoring compliance with the EA and EMPr and any legally binding documentation;
- Facilitating consultation with relevant environmental authorities (e.g. DEA&DP, DFFE, CapeNature or Municipality);
- Facilitating the application for any required environmental authorisation, permit or licence;
- Provide guidance and interpretation of the EA and EMPr where necessary;
- Issuing site instructions to the contractor for corrective actions required;
- The ECO is required to conduct regular site visits for the duration of the construction period, in order to ensure the Contractor receives the necessary induction and that all procedures are in place. Additional visits may be undertaken in the event of any unforeseen environmental accidents;

- The duration and frequency of these visits may be increased or decreased at the discretion of the ECO;
- Attendance of site meetings if required;
- Maintain a record of environmental incidents (e.g. spills, impacts, legal transgressions etc.) as well as corrective and preventative measures taken. This information must also be included in the ECR;
- Maintain a public complaints register in which all complaints and action taken must be recorded. This information must also be included in the ECR.

8.4 ECO SITE VISIT FREQUENCY

The following site frequency for ECO site visits has been determined:

- **weekly** during specific site clearing and demarcation activities for bulk earth works and installation of civil services (water, roads, electricity, sewage),
- **weekly** during bulk earth works and installation of civil services for the greater development,
- **bi-weekly** (every two weeks) during earthworks and construction of individual homes/top structures,
- **3 months post construction** completion (of civil services) and site handover to inform the first Completion Statement.
- **3 months post construction** completion (of the individual homes/top structures) to inform the second Completion Statement.
- **Annual** site inspection of the open space areas to ensure that the Managing Agent/Homeowners Association/Holder complies with the requirement for these areas to not be transformed over time (also monitor rehabilitation, alien clearing and fire management). These monitoring inspections must continue till the EA validity period lapses.

Ad hoc site visits may be undertaken in the event of any incidents or specific requests from the project holder of the EA or project team.

8.5 ENVIRONMENTAL INDUCTION & TRAINING

The holder of the EA in consultation with the Contractor shall ensure that adequate environmental awareness training of senior site personnel takes place and that all construction workers receive an induction presentation on the importance and implications of the EA and EMPr. The presentation shall be conducted, as far as is possible, in the employees' language of choice. The Contractor must provide a translator from their staff for the purpose of translating, if this is deemed necessary.

As a minimum, training must include:

- Explanation of the importance of complying with the EA and EMPr and the employees accountability;
- Discussion of the potential environmental impacts of construction activities;
- The benefits of improved personal performance;
- Employees' roles and responsibilities, including emergency preparedness;
- Explanation of the mitigation measures that must be implemented when carrying out their activities;
- Explanation of the specifics of this EMPr and its specification (no-go areas, etc.);
- Explanation of the management structure of individuals responsible for matters pertaining to the EMPr.

Where staff turnover is high and with additional appointment of sub-contractors, it may be necessary to undertake additional induction training sessions. The Contractor must keep records of all environmental training sessions, including names, dates and the information presented.

9 PRE-CONSTRUCTION DESIGN CONSIDERATIONS

It is recommended that sustainable design considerations are implemented during the planning phase to ensure that the impacts associated with the development are avoided, minimised or managed before construction commences.

9.1 WATER RESOURCE PROTECTION

Management Statement	Impacts & Risks Avoided
To minimise the use of scarce water resources by improving consumption methods	Unsustainable or wasteful use of water for construction and operation purposes

Management Actions

a. Rainwater harvesting must be incorporated into the designs. All rainwater tanks must be shown on building plans.

Method of monitoring implementation	Frequency of Monitoring	Responsible Party for implementing management action	Time period	Mechanism for monitoring Compliance	Programme for reporting on Compliance
Site Plans	Once off	Architect / Engineer	Prior to construction	Audit	Once off

b. Water efficiency must be incorporated into the design of the units.

Method of monitoring implementation	Frequency of Monitoring	Responsible Party for implementing management action	Time period	Mechanism for monitoring Compliance	Programme for reporting on Compliance
Site Plans	Once off	Architect / Engineer	Prior to construction	Audit	Once off

Dual Flush Toilets

Conservative estimates have shown that a saving of more than 22 000 liters per household can be achieved annually with the installation of dual flush toilets (Aquanotion, 2008). All households and ablution facilities should be fitted with dual flush systems.

Low flow shower heads

The installation of low flow shower heads can not only reduce water consumption by up to 50%, but also the energy required for water heating by up to 50% (Eartheasy, 2008).

It has been estimated that a saving of up to 57 000 liters of water per annum per household can be achieved through the installation of low flow shower heads. Low flow shower heads make use of either aerators or pulse systems to reduce the flow without compromising the quality of the shower. The choice of shower head is up to the individual owner, but must have a flow of less than seven liters per minute.

Low flow Taps

Low flow tap use aerators to reduce the flow of the water. These are either built into the faucet or added as an aftermarket product. The faucets in bathrooms should have a peak flow of less than 10 liters per minute.

It is not necessary to install aerators in kitchen sinks as they are seldom run without a plug. All bathroom basins must be fitted with low flow faucets.

Washing machines

It is recommended that all washing machines that are to be installed in houses and shared facilities should be front loading washing machines as opposed to top loading washing machines. Apart from much lower energy and water requirements, front loader washing machines have a number of advantages that make them a better environmental choice:

- **Less wear and tear on washed materials** – Washed materials therefore last longer and result in a net resource saving;
- **Faster drying times** - Because of the horizontal axis and faster spin speeds, more water is removed and the materials dry faster which results in energy saving if a clothes dryer is used.;
- **Quieter operation** – Therefore less noise pollution; and
- **Less detergent** - Far less is required compared to top loaders. Fewer chemicals therefore reach treatment plants and ultimately waterways.

Geyser and pipe insulation

Apart from the savings in terms of energy as detailed below, insulating geysers and pipes save water, as shorter periods of running the tap to get hot water are required.

All structures should have insulation on geysers and all hot water pipes.

Waterwise Landscaping

Waterwise landscaping principles must be incorporated into the detailed landscaping plans. The following principles apply to waterwise gardening:

- Grow water-wise plants – generally the best suited plants are those indigenous to the area, as they seldom need additional watering;
- Group plants according to their water needs – this avoids wasting water on plants that don't need it;
- Consider the quality and type of the lawn. Lawns use unacceptable amounts of water, so consider reducing lawn areas to a minimum. Use tougher, low-water lawn types such as Buffalo (coastal areas) or Kweek (inland) rather than Kikuyu.
- Maintain the garden – remove unwanted plants, plant more perennials than summer annuals, as they have deeper root systems and so need less watering.
- Improve the soil and mulch. Soil water-holding capacity is improved by higher organic matter content. Mulching (covering the soil with a thick layer of bark, compost, straw etc.) keeps the soil much more moist.
- Plant in the right season – For winter rainfall areas this is in autumn and early winter so the plants have a chance to develop their root systems before the dry season. In summer rainfall areas it is spring and early summer for the same reason.
- Water correctly – avoid watering during the heat of the day or in windy conditions.
- The best irrigation system is drip irrigation – it uses 25% of water used by normal irrigation systems with the same effect, and can even be placed under lawns.

Grey Water

Grey water is the water that comes from the bath, shower, basins, laundry and the kitchen sink. It is not to be confused with Black water, which is sewage that comes from the toilet. Black water is toxic and requires very specific methods of treatment in order to be safe for re-use. Grey water, however, can easily be recycled and re-used for a variety of uses. These include:

- Irrigation of gardens;
- Water for flushing toilets;
- Any outdoor use;
- Dampening dusty areas or roads.

Grey water systems require precise methods to clean the water. There are various companies and organizations that can assist with implementing a grey water system.

9.2 ENERGY RESOURCE PROTECTION

Management Statement	Impacts & Risks Avoided
To minimise the use of energy resources by improving consumption methods	Excessive and unnecessary energy consumption

Management Actions

a. Incorporate energy efficiency into the design of the facility

Method of monitoring implementation	Frequency of Monitoring	Responsible Party for implementing management action	Time period	Mechanism for monitoring Compliance	Programme for reporting on Compliance
Energy saving checklist	Once off	Owner / Architect	Ad hoc	Audit	Once off

Solar heating water systems

Solar heated water systems are an innovative way of producing hot water without putting additional pressure on gas or municipal power supply. There are many different types available on the market, and homeowners should consider all their requirements (number of people using facility, location of house, angles of roof) before making a choice.

Energy Efficient Lighting

In terms of Best Practice, it is required that energy saving lighting fixtures be used throughout the entire development. It is therefore specified that Light Emitting Diode (LED) or Compact Fluorescent (CF) lighting be used as opposed to incandescent lighting. This is required for all internal and external lighting, including street lighting. Proximity switches should be used in areas where lighting for pedestrians is required.

NO external High-Pressure Sodium (HPS) or Metal Halide (MH) spot or floodlights should be installed.

CF lighting uses quantities of mercury in the bulbs and tubes which pose serious environmental hazards. The mercury from one CF bulb can pollute many thousand litres of water if not treated correctly (Eden District Municipality, 2011). CF lighting (energy saving bulbs and tubes) must be correctly disposed of at registered Hazardous waste sites. Companies like Pick n Pay and Woolworths offer facilities to collect CF bulbs for recycling and disposal. The following should be considered when handling CF bulbs (eHow Home, 2011):

Energy Efficient Appliances

Energy efficient appliances are becoming widely available. Follow the Energy Guide labels on appliances to help selection of correct models. Any appliance that has to heat up water or air will use more energy, as will an appliance that boasts additional extras such as ice making, dispensing and auto defrosting on fridges or heat drying on dishwashers.

Solar Cooling Systems

Where required by homeowners, the home owner should consider the use of solar cooling systems such as absorption or adsorption chillers as opposed to conventional air conditioning units.

Evaporative Cooling Systems

Consideration should be given to evaporative cooling systems as these cut down considerably on energy usage for appliances such as air conditioners. Furthermore, the system ensures that fresh air circulates within housing units, which improves on environmental health risks.

Fresh air is drawn from outside the house (the hotter the better) and passes through moistened pads which cools it down and filters it before flowing through outlets in the house.

There are certain parameters required for evaporative cooling systems, which should be thoroughly investigated prior to installation.

Geyser and pipe insulation

Apart from the savings in terms of energy as detailed below, insulating geysers and pipes save water, as shorter periods of running the tap to get hot water are required.

All structures should have insulation on geysers and all hot water pipes.

9.3 DEMARCATION OF WORK AND NO-GO AREAS

Management Statement	Impacts & Risks Avoided
To clearly define the work area and avoid impacting on non-works areas.	Negative construction impacts on natural and rehabilitated areas

Management Actions

a. Clearly identify and demarcate the development area, area of works and spoiling areas.

Method of monitoring implementation	Frequency of Monitoring	Responsible Party for implementing management action	Time period	Mechanism for monitoring Compliance	Programme for reporting on Compliance
Method Statement	Once off	Developer / contractor	Pre implementation	Audit	Once off

b. Fuel and chemicals may only be stored in a designated work area.

Method of monitoring implementation	Frequency of Monitoring	Responsible Party for implementing management action	Time period	Mechanism for monitoring Compliance	Programme for reporting on Compliance
Method Statement	Once off	Developer / contractor	Pre implementation	Audit	Once off

c. Provide on-site sanitation and rest areas for personnel.					
Method of monitoring implementation	Frequency of Monitoring	Responsible Party for implementing management action	Time period	Mechanism for monitoring Compliance	Programme for reporting on Compliance
Method Statement	Once off	Developer / contractor	Pre implementation	Audit	Once off

10 CONSTRUCTION CONSIDERATIONS

These Construction Phase requirements are aimed at using Best Practise Principles and / or specialist recommendations to manage the impacts on the environment during the construction of the development.

10.1 SITE CLEARANCE PLAN

Site clearance should be undertaken in a systematic manner within the demarcated areas to minimise the impacts of construction on the site. The following table provides a methodology to implementing site clearance according to this EMPr and the EA.

Table 3: Site Clearance Methodology.

No	Action	Scheduling
1	**Survey** approved layout on site.	Prior to construction
2	**Establish site camp** and **material stockpile sites** (incl. waste disposal area, portable toilets etc. The construction camp and necessary ablution facilities meant for construction workers must not be in any of the delineated watercourses or wetland areas (including 20m buffer).	Prior to construction.
3	**Demarcate work areas** using correct demarcation methods.	Prior to construction.
4	Demarcate **protected areas as no-go areas**.	Prior to construction.
5	**Erosion control measures** must be put in place prior to any construction activities that would result in soil being exposed.	Prior to construction.
6	Weather forecasts from the South African Weather Bureau of up to three days in advance must be monitored on a daily basis to avoid exposing soil, works or materials during a storm event. This must be considered in conjunction with tide tables for beach construction work.	Construction
7	Commence with mechanical vegetation clearing within the demarcated work areas only.	Construction

8	Vegetation clearing should occur **in parallel with the construction progress** to minimise erosion and/or run-off. Large tracts of bare soil will either cause dust pollution or quickly erode and then cause sedimentation in the lower portions of the catchment.	Construction
9	Any biomass from the clearing activities must be stockpiled within the development footprint at an area / areas approved by the ECO. It is recommended that the biomass must be **chipped in situ** and stockpiled within designated areas within the footprint. Alternatively, it must be removed and taken to an approved disposal site for biomass. NO DUMPING IS ALLOWED.	Construction
10	Any cleared areas that will not be immediately constructed or planted, must be covered with the wood chips or other mulch to prevent wind erosion.	Construction

10.2 DUST CONTROL

Management Statement	Impacts & Risks Avoided
To ensure there is no health risk or loss of amenity due to emission of dust to the environment.	Ensure land coverage with biomass chips / vegetation / damping to minimise dust

Management Actions

a. Implement a dust prevention strategy, developed at the project planning stage

Method of monitoring implementation	Frequency of Monitoring	Responsible Party for implementing management action	Time period	Mechanism for monitoring Compliance	Programme for reporting on Compliance
Method Statement	Once off	Developer / contractor	Pre implementation	Audit	Once off

The strategy should include the following amongst others:

- Speed control to minimise dust on site.
- During dry, dusty periods haul roads should be kept dampened to prevent excess dust. No potable water or seawater may be used for damping haul roads.
- Exposed stockpile materials must be adequately **protected** against wind (covered), and should be sited taking into consideration the prevailing wind conditions.
- Trucks bringing in materials must be covered to prevent dust and small particles escaping and potentially causing damage to people and property.

10.3 NOISE & VIBRATION

Management Statement	Impacts & Risks Avoided
To ensure nuisance from noise and vibration does not occur.	Nuisance impacts to neighbours and visitors.

Management Actions

a. Fit and maintain appropriate mufflers on earth-moving and other vehicles on the site.

Method of monitoring implementation	Frequency of Monitoring	Responsible Party for implementing management action	Time period	Mechanism for monitoring Compliance	Programme for reporting on Compliance
As required	Initially when vehicle or machinery is introduced to the site and thereafter monthly. As required if complaints registered.	Contractor	During construction and operation	Audit	As required

b. Enclose noisy equipment such as generators and pumps.

Method of monitoring implementation	Frequency of Monitoring	Responsible Party for implementing management action	Time period	Mechanism for monitoring Compliance	Programme for reporting on Compliance
As required	Initially when vehicle or machinery is introduced to the site and thereafter monthly. As required if complaints registered.	Contractor	During construction	Audit	As required

c. Provide noise attenuation screens, where appropriate.

Method of monitoring implementation	Frequency of Monitoring	Responsible Party for implementing management action	Time period	Mechanism for monitoring Compliance	Programme for reporting on Compliance
As required	Initially when vehicle or machinery is introduced to the site and	Contractor	During construction	Audit	As required

	thereafter monthly. As required if complaints registered.				

d. Where an activity is likely to cause a noise nuisance to nearby residents, restrict operating hours to between 7 am and 6 pm weekdays and 7 am to 1 pm Saturday, except where, for practical reasons, the activity is unavoidable.

Method of monitoring implementation	Frequency of Monitoring	Responsible Party for implementing management action	Time period	Mechanism for monitoring Compliance	Programme for reporting on Compliance
As required	As required if complaints registered.	Contractor	During construction	Audit	As required

10.4 TRAFFIC CONTROL

Management Statement	Impacts & Risks Avoided
To manage and minimise the nuisance effect created by construction traffic.	The development entrance access will be via Grens Street and construction traffic is likely to temporarily affect users.

Management Actions

a. Implement a traffic management strategy during construction.

Method of monitoring implementation	Frequency of Monitoring	Responsible Party for implementing management action	Time period	Mechanism for monitoring Compliance	Programme for reporting on Compliance
Method Statement	Daily	Contractor	During construction	Audit	As required

- Construction-related activities should be timed where possible to avoid peak periods.
- No construction workers, apart from security personnel, should be allowed to stay on site overnight.
- Contractors appointed by the developer must ensure that workers are transported to and from the site daily.
- Construction-related activities should comply with all relevant building regulations. In this regard activities on site should be restricted to between 07h00 and 18h00 during weekdays and 08h00 and 13h00 on Saturdays. No work should be permitted after 13h00 on Saturdays and on Sundays.

10.5 WASTE MANAGEMENT

Management Statement	Impacts & Risks Avoided

To minimise the waste load discharged to the environment.	Improve waste disposal methods during construction Reduce waste volumes to landfill sites

Management Actions

a. Reduce waste by selecting, in order of preference, avoidance, reduction, reuse and recycling.

Method of monitoring implementation	Frequency of Monitoring	Responsible Party for implementing management action	Time period	Mechanism for monitoring Compliance	Programme for reporting on Compliance
Record of volumes of material removed	As required	Contractor	As required	Audit	Records

b. Maintain a high quality of housekeeping and ensure that materials are not left where they can be washed or blown away to become litter.

Method of monitoring implementation	Frequency of Monitoring	Responsible Party for implementing management action	Time period	Mechanism for monitoring Compliance	Programme for reporting on Compliance
Photographic	Weekly	Contractor	As required	Audit	Records

c. Provide bins for construction workers and staff at locations where they consume food.

Method of monitoring implementation	Frequency of Monitoring	Responsible Party for implementing management action	Time period	Mechanism for monitoring Compliance	Programme for reporting on Compliance
Photographic	Weekly	Contractor	As required	Audit	Records

d. Conduct ongoing awareness with staff of the need to avoid littering.

Method of monitoring implementation	Frequency of Monitoring	Responsible Party for implementing management action	Time period	Mechanism for monitoring Compliance	Programme for reporting on Compliance
Induction	Once off	Contractor	As required	Audit	Attendance register

10.6 STOCKPILE MANAGEMENT

Management Statement	Impacts & Risks Avoided

To manage soil stockpiles so that dust and sediment in run-off are minimised.	Pollution due to dust and sediment run off

Management Actions

a. Minimise the number of stockpiles, and the area and the time stockpiles are exposed. Stockpiles must be placed within areas that will remain permanently / temporarily disturbed.

Method of monitoring implementation	Frequency of Monitoring	Responsible Party for implementing management action	Time period	Mechanism for monitoring Compliance	Programme for reporting on Compliance
Photographic	As required	Contractor	As required	Audit	Records

b. Keep topsoil and underburden stockpiles separate (clearly label topsoil).

Topsoil in new excavation areas must be stripped to a depth of 30cm.

Topsoil may not be removed from site to avoid contamination.

If possible, cover topsoil with plastic sheeting for the duration of the construction phase.

Method of monitoring implementation	Frequency of Monitoring	Responsible Party for implementing management action	Time period	Mechanism for monitoring Compliance	Programme for reporting on Compliance
Visual inspection of stockpiles	Daily when stripping topsoil	Contractor	Continuously during construction	Audit	Records

c. Ensure that stockpiles and batters are designed with slopes no greater than 2:1 (horizontal/vertical).

Method of monitoring implementation	Frequency of Monitoring	Responsible Party for implementing management action	Time period	Mechanism for monitoring Compliance	Programme for reporting on Compliance
Visual inspection of stockpiles	As required	Contractor	Continuously during construction	Audit	Monthly

d. Stabilise stockpiles and batters that will remain bare for more than 28 days by covering with mulch or anchored fabrics or seeding with sterile grass.					
Method of monitoring implementation	Frequency of Monitoring	Responsible Party for implementing management action	Time period	Mechanism for monitoring Compliance	Programme for reporting on Compliance
Visual inspection of stockpiles	As required	Contractor	Continuously during construction	Audit	Monthly
e. Establish sediment controls around unstabilised stockpiles and batters.					
Method of monitoring implementation	Frequency of Monitoring	Responsible Party for implementing management action	Time period	Mechanism for monitoring Compliance	Programme for reporting on Compliance
Visual inspection of stockpiles	As required	Contractor	Continuously during construction	Audit	Monthly
f. Suppress dust on stockpiles and batters, as circumstances demand.					
Method of monitoring implementation	Frequency of Monitoring	Responsible Party for implementing management action	Time period	Mechanism for monitoring Compliance	Programme for reporting on Compliance
Visual inspection of stockpiles	As required	Contractor	Continuously during construction	Audit	Monthly

10.7 STORING FUELS & CHEMICALS

Management Statement	Impacts & Risks Avoided
To ensure that fuel and chemical storage is safe, and that any materials that escape do not cause environmental damage.	Avoid hydrocarbon pollution to soil and watercourses / coastal environments
Management Actions	

a. Minimise fuels and chemicals stored onsite.					
Method of monitoring implementation	Frequency of Monitoring	Responsible Party for implementing management action	Time period	Mechanism for monitoring Compliance	Programme for reporting on Compliance
Method statement	As required	Contractor	As required	Audit	Method statement records
b. Install bunds and take other precautions to reduce the risk of spills.					
Method of monitoring implementation	Frequency of Monitoring	Responsible Party for implementing management action	Time period	Mechanism for monitoring Compliance	Programme for reporting on Compliance
Method statement	As required	Contractor	As required	Audit	Method statement records
c. Implement a contingency plan to handle spills, so that environmental damage is avoided.					
Method of monitoring implementation	Frequency of Monitoring	Responsible Party for implementing management action	Time period	Mechanism for monitoring Compliance	Programme for reporting on Compliance
Method statement	As required	Contractor	As required	Audit	Method statement records

10.8 MINIMISING EROSION

Management Statement	Impacts & Risks Avoided
To minimise the quantity of soil lost during construction due to land-clearing.	• Avoid overland flow by capture and store water from roof • Avoid siltation by installing silt traps
Management Actions	

a. Schedule measures to avoid and reduce erosion by phasing the work program to minimise land disturbance in the planning and design stage.					
Method of monitoring implementation	Frequency of Monitoring	Responsible Party for implementing management action	Time period	Mechanism for monitoring Compliance	Programme for reporting on Compliance
Method statement	As required	Contractor	As required	Audit	Method statement records
b. Keep the areas of land cleared to a minimum, and the period areas remain cleared to a minimum					
Method of monitoring implementation	Frequency of Monitoring	Responsible Party for implementing management action	Time period	Mechanism for monitoring Compliance	Programme for reporting on Compliance
Method statement	As required	Contractor	As required	Audit	Method statement records
c. Base control measures to manage erosion on the vulnerability of cleared land to soil loss, paying particular attention to protecting slopes.					
Method of monitoring implementation	Frequency of Monitoring	Responsible Party for implementing management action	Time period	Mechanism for monitoring Compliance	Programme for reporting on Compliance
Method statement	As required	Contractor	As required	Audit	Method statement records
d. Mulch, roughen and seed cleared slopes and stockpiles where no works are planned for more than 28 days, with sterile grasses.					
Method of monitoring implementation	Frequency of Monitoring	Responsible Party for implementing management action	Time period	Mechanism for monitoring Compliance	Programme for reporting on Compliance
Method statement	As required	Contractor	As required	Audit	Method statement records

e. Keep vehicles to well-defined haul roads.					
Method of monitoring implementation	Frequency of Monitoring	Responsible Party for implementing management action	Time period	Mechanism for monitoring Compliance	Programme for reporting on Compliance
Site plan	As required	Contractor	As required	Audit	Final site plan
f. Rehabilitate cleared areas promptly.					
Method of monitoring implementation	Frequency of Monitoring	Responsible Party for implementing management action	Time period	Mechanism for monitoring Compliance	Programme for reporting on Compliance
Visual / photographic	As required	Contractor	Continuously during construction	Audit	Final Rehabilitation statement

10.9 REHABILITATION & BOTANICAL MANAGEMENT

Management Statement	Impacts & Risks Avoided
To ensure that degradation to existing botanical components are minimised and that any rehabilitation is undertaken with conservation orientated approach.	To minimise the disturbance to existing flora To minimise the introduction and/or spread of weed species

Management Actions					
a. Demarcate sensitive areas to avoid damage during construction.					
b. Plant search and rescue must be conducted whenever a new dwelling is constructed.					
c. Anny SCC plants that are observed must be reported to the ECO.					
d. No kikuyu grass will be allowed.					
Method of monitoring implementation	Frequency of Monitoring	Responsible Party for implementing management action	Time period	Mechanism for monitoring Compliance	Programme for reporting on Compliance

Method statement	As required	Contractor / Owner	Continuously	Audit	Visual / photographic
e. Rehabilitation and landscaping may only make use of indigenous vegetation. Naturally occurring plants that are rescued from the development footprints must be re-planted after construction within the disturbance envelope.					
Method of monitoring implementation	Frequency of Monitoring	Responsible Party for implementing management action	Time period	Mechanism for monitoring Compliance	Programme for reporting on Compliance
Visual / photographic	As required	Contractor / Owner	Continuously	Audit	Visual / photographic

10.10 FAUNA MANAGEMENT

Management Statement	Impacts & Risks Avoided
To ensure that impacts to native faunal species is minimised and / or avoided.	To minimise the impact to fauna
Management Actions	
a. Prevent unnecessary mortalities of indigenous fauna	
b. Place mammal-funnels in the fence line to allow Sensitive Species 8 to move through the landscape. ECO to monitor the funnels for any signs of Sensitive Species 8.	
c. If trails on the estate are planned, care should be taken when crossing through the thicket vegetation. The trails should follow the section that previously had the highest density of AIPs.	

Method of monitoring implementation	Frequency of Monitoring	Responsible Party for implementing management action	Time period	Mechanism for monitoring Compliance	Programme for reporting on Compliance
Ad hoc	As required	Contractor	Continuously	Audit	Visual / photographic

10.11 SOCIAL REQUIREMENTS

Management Statement	Impacts & Risks Avoided

To ensure equitable, fair and safe social interaction on construction sites	Loss of employment opportunities to the region

Management Actions

a. It is strongly recommended that the Contractor make use of local labour as far as possible for the construction phase of the project.

Method of monitoring implementation	Frequency of Monitoring	Responsible Party for implementing management action	Time period	Mechanism for monitoring Compliance	Program for reporting on Compliance
Employment records	Ad hoc	Contractor	Ad hoc	Audit	Once off

b. Theft and other crime associated with construction sites is not only a concern for surrounding residents, but also the Developer and the Contractor.

Method of monitoring implementation	Frequency of Monitoring	Responsible Party for implementing management action	Time period	Mechanism for monitoring Compliance	Programme for reporting on Compliance
Site records	Ad hoc	Contractor	Ad hoc	Audit	Once off

Targets

- The contractor should endeavour to source local suppliers that are BEE compliant.
- The contractor must ensure that suitable procurement policies are in place that supports local economic growth.
- Locally manufactured products must be used as far as possible.

Site Security

Theft and other crime associated with construction sites is not only a concern for surrounding residents, but also the developer and the contractor.

Considering this, contractors need to be proactive in order to curtail theft and crime on and resulting from the construction site. It is recommended that the contractor develop a jobsite security plan prior to commencement of construction. This jobsite security plan should take into account protection of the construction site from both internal and external crime elements as well as the protection of surrounding communities from internal crime elements. All incidents of theft or other crime should be reported to the South African Police Service, no matter how seemingly insignificant.

10.12 METHOD STATEMENTS

Management Statement	Impacts & Risks Avoided

To ensure efficient communication mechanisms in the implementation of environmental performance requirements	Prevention of potential impacts are avoided during construction by means of correct communication

Management Actions

a. Method statements are written submissions by the Contractor to the ECO in response to the requirements of this EMPr or to a request by the ECO. The Contractor shall be required to prepare method statements for several specific construction activities and/or environmental management aspects.

Method of monitoring implementation	Frequency of Monitoring	Responsible Party for implementing management action	Time period	Mechanism for monitoring Compliance	Programme for reporting on Compliance
Method statement	Ad hoc	Contractor	As required	Audit	Once off

Based on the specifications in this EMPr, the following method statements are required as a minimum (more method statements may be requested as required at any time under the direction of the ECO):

- Demarcation of No-Go areas
- Site clearing
- Hazardous substances and their storage.
- Materials requirements & Sourcing.
- Solid waste control system.
- Fire control and emergency procedures.
- Petroleum, chemical, harmful and hazardous materials storage, if any.
- Stormwater Management and Erosion Control.

10.13 CEMENT BATCHING

Management Statement	Impacts & Risks Avoided
Cement powder has a high alkaline pH that may contaminate and adversely affect both soil pH and water pH negatively. A rapid change in pH can have consequences on the functioning of soil and water organisms as well as on the botanical component.	Minimises negative impacts to vegetation and soils on areas that will not be hard surfaced.

Management Actions

a. All concrete batching must take place on an area that is to be hard surfaced as part of the development.					
Method of monitoring implementation	Frequency of Monitoring	Responsible Party for implementing management action	Time period	Mechanism for monitoring Compliance	Programme for reporting on Compliance
Method statement	As required	Contractor	As required	Audit	Method statement records
b. Concrete mixing areas must have bund walls or a settling pond in order to prevent cement run off. Once the settling ponds dry out, the concrete must be removed and dispatched to a suitable disposal site.					
Method of monitoring implementation	Frequency of Monitoring	Responsible Party for implementing management action	Time period	Mechanism for monitoring Compliance	Programme for reporting on Compliance
Method statement	As required	Contractor	As required	Audit	Method statement records
c. When using Readymix concrete, care must be taken to prevent spills from the trucks while offloading. This form of batching is preferable for large constructions as no on-site batching is required and there is a lesser likelihood of accidental spills and run off. Trucks may not be washed out on site.					
Method of monitoring implementation	Frequency of Monitoring	Responsible Party for implementing management action	Time period	Mechanism for monitoring Compliance	Programme for reporting on Compliance
Method statement	As required	Contractor	As required	Audit	Method statement records

10.14 HERITAGE REQUIREMENTS

Management Statement	Impacts & Risks Avoided
To minimise the impacts of development, operation and maintenance of the Project on the heritage values in the Project area.	Ensure heritage impacts are minimised, and impacts outside of the approved disturbance area are avoided.
Management Actions	

a. No disturbance of heritage values outside of the approved disturbance area.					
Method of monitoring implementation	Frequency of Monitoring	Responsible Party for implementing management action	Time period	Mechanism for monitoring Compliance	Programme for reporting on Compliance
Site records	Ad hoc	Contractor	Ad hoc	Audit	Once off

- Should any heritage remains of potential cultural value be exposed during excavations, these must be immediately reported to the ECO and the Provincial Heritage Resource Authority of the Western Cape, namely Heritage Western Cape in terms of the national Heritage Resources Act (Act No. 25 of 1999). Heritage remains uncovered or disturbed during earthworks may not be disturbed further until the necessary approval has been obtained from Heritage Western Cape.
- Should any archaeological remains including (but not limited to) fossil bones, fossil shells, coins, indigenous ceramics, colonial ceramics, marine shell heaps, stone artefacts, bone remains, rock art, rock engravings and any antiquity be discovered during construction, they must be immediately reported to the ECO and Heritage Western Cape and not disturbed further until the necessary approval has been obtained.
- Should any human remains be uncovered, they must immediately be reported to the ECO and the HWC archaeologist, who can be contacted on **(021) 483 9685**. Construction in the area must cease immediately and the site may not be disturbed further until the necessary approval has been obtained.

11 OPERATIONAL PHASE ENVIRONMENTAL MANAGEMENT REQUIREMENTS

The Operational Phase of this EMPr refers to the day to day management activities that are required to ensure sustainability and the achievement of the principles and objectives of the development. The requirements are applicable to the proponent, any HOA that is put in place, all employees and all visitors to the property.

11.1 BOTANICAL / LANDSCAPING

Management Statement	Impacts & Risks Avoided
To ensure that indigenous vegetation is encouraged within urban areas.	• Ongoing spread of alien invasive species. • Ensure protected species are taken into consideration.

Management Actions

a. Homeowners must practice ongoing alien invasive management.

b. Additional gardening should be avoided and limited to a maximum of 100m^2 per dwelling.

c. Only the rehabilitation of natural fynbos and thicket vegetation rescued from the site around the development footprint in the disturbance envelope is allowed.

d. Landowners are responsible to maintain their gardens, so that plants do not overgrow. No garden waste may be dumped in any remaining natural area and must be disposed of in a responsible manner.

e. Fertilizers and pesticides must be avoided, and only where absolutely necessary can they be used, with due caution, to avoid killing indigenous species and natural pollinators in the surrounding landscape.

f. Gardens must be designed to be water wise to avoid erosion.

g. Retain and manage protected and indigenous vegetation.

h. Alien vegetation must be removed from the valley thicket & landscaped gardens. Alien removal must be ongoing.

Method of monitoring implementation	Frequency of Monitoring	Responsible Party for implementing management action	Time period	Mechanism for monitoring Compliance	Programme for reporting on Compliance

Visual / photographic	Ongoing	HOA / Developer	As required	Audit	Audit

- Rehabilitate with appropriate indigenous vegetation to promote soft landscaping.
- Replace vegetation if it dies off.
- Obtain permits for any pruning or removal of protected species, notably *Sideroxylon inerme* (Milkwoods) & Cheesewoods.

12 MONITORING

Monitoring is an important tool in determining the effectiveness of management actions by measuring changes in the environment. These could be in the form of fixed-point photography where an area is photographed on a regular / seasonal basis to ascertain changes, monitoring of a particular aspect such as landscape integrity parameters, recordings of animal movement from fixed point etc. The most important aspect of any monitoring programme is **consistency and continuity**. This will ensure a level of scientific accuracy to determine baselines / thresholds and measure changes / deviations, which then drive management reactions.

Any required monitoring reports must be made available to the competent authority as required.

The type and frequency of monitoring must include:

- During construction photographs must be taken from pre identified fixed points and a comprehensive record maintained;
- Incident Reports;
- Site meeting minutes.

12.1 MONITORING TIMEFRAMES SUMMARY

Table 4: Monitoring Timeframe Summary

MONITORING TIMEFRAMES		
Type	Frequency	Criteria
ECO visits	As per section 5.4	Site photographs / site diary
Record keeping	Monthly	Site photographs, method statements, site meeting minutes (if applicable)
	3-month post construction	Completion Statement
Auditing	One year post construction	Compliance with the EA, EMPr, municipal permits and any other approvals

12.2 ENVIRONMENTAL AUDITS

A final construction phase Completion Statement must be submitted within 6 months of completion of construction / site handover.

This Completion Statement must include the monitoring results as above, where applicable to construction.

An Environmental Audit should be undertaken two (2) years post construction.

12.3 AUDIT REPORTS FREQUENCIES AND FORMAT

The table below provides a summary of the timeframes for the various Audit Reports specified in the EA.

Table 5: Audit Reports Timeframe Summary

ENVIRONMENTAL AUDIT TIMEFRAMES		
Type	Frequency	Criteria
Final Construction Audit	Two years post construction	Audit on operational aspects of the EA and EMPr

In terms of the 2014 EIA Regulations, Audit Reports must be submitted to the registered Interested & Affected Parties within 7 days of submission to the competent authority.

In order to comply with the 2014 EIA Regulations, any audits must be undertaken using the following format:

Table 6: Environmental Audit Requirements

Appendix 7 of Regulation 326 of the 2014 EIA Regulations, as amended contains the required contents of an Environmental Audit Report. The checklist below serves as a summary of how these objectives & requirements were incorporated into this Audit Report.	
Objective	**Description**
The objective of the environmental audit report is to -	
(a) Report on – (i) the level of compliance with the conditions of the environmental authorisation and the EMPr, and where applicable, the closure plan; and (ii) the extent to which the avoidance, management and mitigation measures provided for in the EMPr, and where applicable, the closure plan achieve the objectives and outcomes of the EMPr, and closure plan.	
(b) Identify and assess any new impacts and risks as a result of undertaking the activity.	
(c) Evaluate the effectiveness of the EMPr, and where applicable, the closure plan.	

Appendix 7 of Regulation 326 of the 2014 EIA Regulations, as amended contains the required contents of an Environmental Audit Report. The checklist below serves as a summary of how these objectives & requirements were incorporated into this Audit Report.	
Objective	**Description**
(d) Identify shortcomings in the EMPr, and where applicable, the closure plan.	
(e) Identify the need for any changes to the avoidance, management and mitigation measures provided for in the EMPr, and where applicable, the closure plan.	
Requirement	**Description**
(1) An Environmental audit report prepared in terms of these Regulations must contain -	
(a) Details of – (i) The independent person who prepared the environmental audit report; and (ii) The expertise of independent person that compiled the environmental audit report.	
(b) A declaration that the independent auditor is independent in a form as may be specified by the competent authority.	
(c) An indication of the scope of, and the purpose for which, the environmental audit report was prepared.	
(d) A description of the methodology adopted in preparing the environmental audit report.	
(e) An indication of the ability of the EMPr, and where applicable the closure plan to – (i) Sufficiently provide for the avoidance, management and mitigation of environmental impacts associated with the undertaking of the activity on an on-going basis; (ii) Sufficiently provide for the avoidance, management and mitigation of environmental impacts associated with the closure of the facility; and (iii) Ensure compliance with the provisions of environmental authorisation, EMPr, and where applicable, the closure plan.	
(f) A description of any assumptions made, and any uncertainties or gaps in knowledge.	
(g) A description of an consultation process that was undertaken during the course of carrying out the environmental audit report.	
(h) A summary and copies of any comments that were received during any consultation process.	
(i) Any other information requested by the competent authority.	

Any other requirements of the EA or any other authorisations must be incorporated into an Audit where necessary.

13 DECOMMISSIONING PHASE ENVIRONMENTAL MANAGEMENT REQUIREMENTS

It is not likely that decommissioning of this facility will take place in the near future. However, in the event that decommissioning does occur, all relevant legislation and policies must be complied with for the given period.

In general, in the future event that the facility be decommissioned, the following must be undertaken:

- Demolition of buildings and removal of rubble must be undertaken without impacting on areas outside of the development area.
- Rubble must be disposed of correctly and to a registered site if not reused on site.
- Decommissioning must comply with any relevant legislation valid at that time.

14 NON-COMPLIANCE

Any person is liable on conviction of an offence in terms of regulation 49(a) of the National Environmental Laws Second Amendment Act (Act 30 of 2013) to imprisonment for a period not exceeding ten (10) years or to a fine not exceeding R10 million or an amount prescribed in terms of the Adjustment of Fines Act, 1991 (Act No. 101 of 1991).

It is the responsibility of the ECO to report matters of non-compliance to the Employer's Representative or the Holder of the EA if no representative is in place. It is the responsibility of the Holder of the EA, and not the ECO, to report such matters of non-compliance to the competent Authority.

14.1 PROCEDURES

The Holder of the EA shall comply with the environmental specifications and requirements of this EMPr, any Approval / License issued and Section 28 of NEMA, on an on-going basis and any failure on his part to do so will entitle the authorities to **impose a penalty**[1].

In the event of non-compliance the following recommended process shall be followed:

- The competent authority shall issue a **Notice of Non-compliance** to the Holder of the EA, stating the nature and magnitude of the contravention.
- The Holder of the EA shall **act to correct the transgression** within the period specified in by the authority.
- The Holder of the EA shall provide the competent authority with a **written statement** describing the actions to be taken to discontinue the non-conformance, the actions taken to mitigate its effects and the expected results of the actions.
- In the case of the Holder of the EA failing to remedy the situation within the predetermined time frame, the competent authority may recommend halting the activity.

[1] A penalty may not necessarily be a monetary fine but could also be a stoppage in work time, additional mechanisms to prevent pollution or degradation at the cost of the proponent or even a directive to cease activities from the competent authority.

- In the case of non-compliance giving rise to physical environmental damage or destruction, the competent authority shall be entitled to undertake or to cause to be undertaken such **remedial works** as may be required to make good such damage at the cost of the Project applicant.
- In the event of a dispute, difference of opinion, etc. between any parties in regard to or arising out of interpretation of the conditions of the EMPr, disagreement regarding the implementation or method of implementation of conditions of the EMPr, etc. any party shall be entitled to require that the issue be referred to **specialists and / or the competent authority** for determination.
- The competent authority shall at all times have the right to **stop work** and/or certain activities on site in the case of non-compliance or failure to implement remediation measures.

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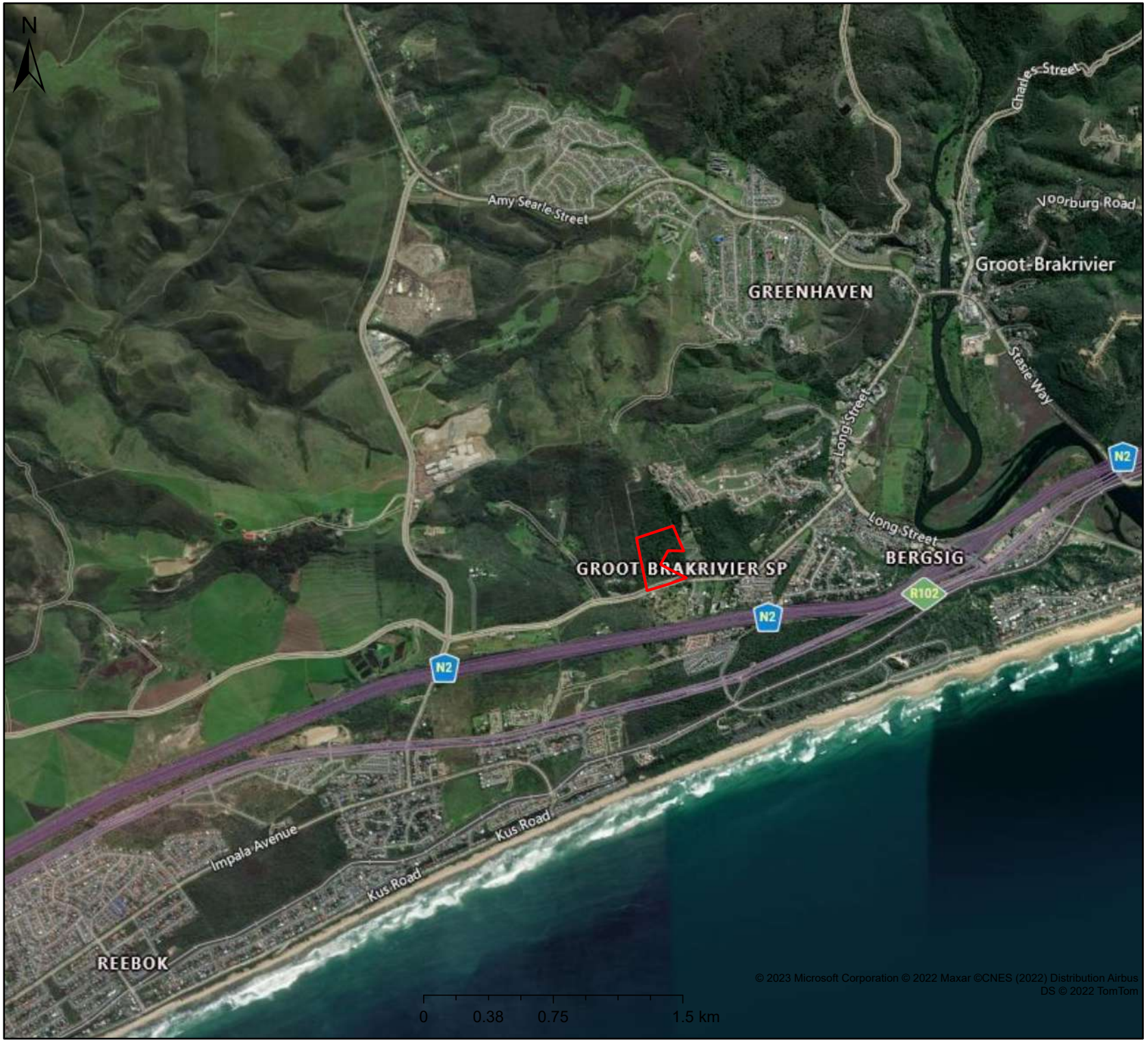


Locality Map

Legend

Map Center: Lon: 22°11'51.8"E
Lat: 34°3'12.1"S

Scale: 1:36 112

Date created: March 1, 2023

Western Cape Government
Agriculture
FOR YOU

Locality Map

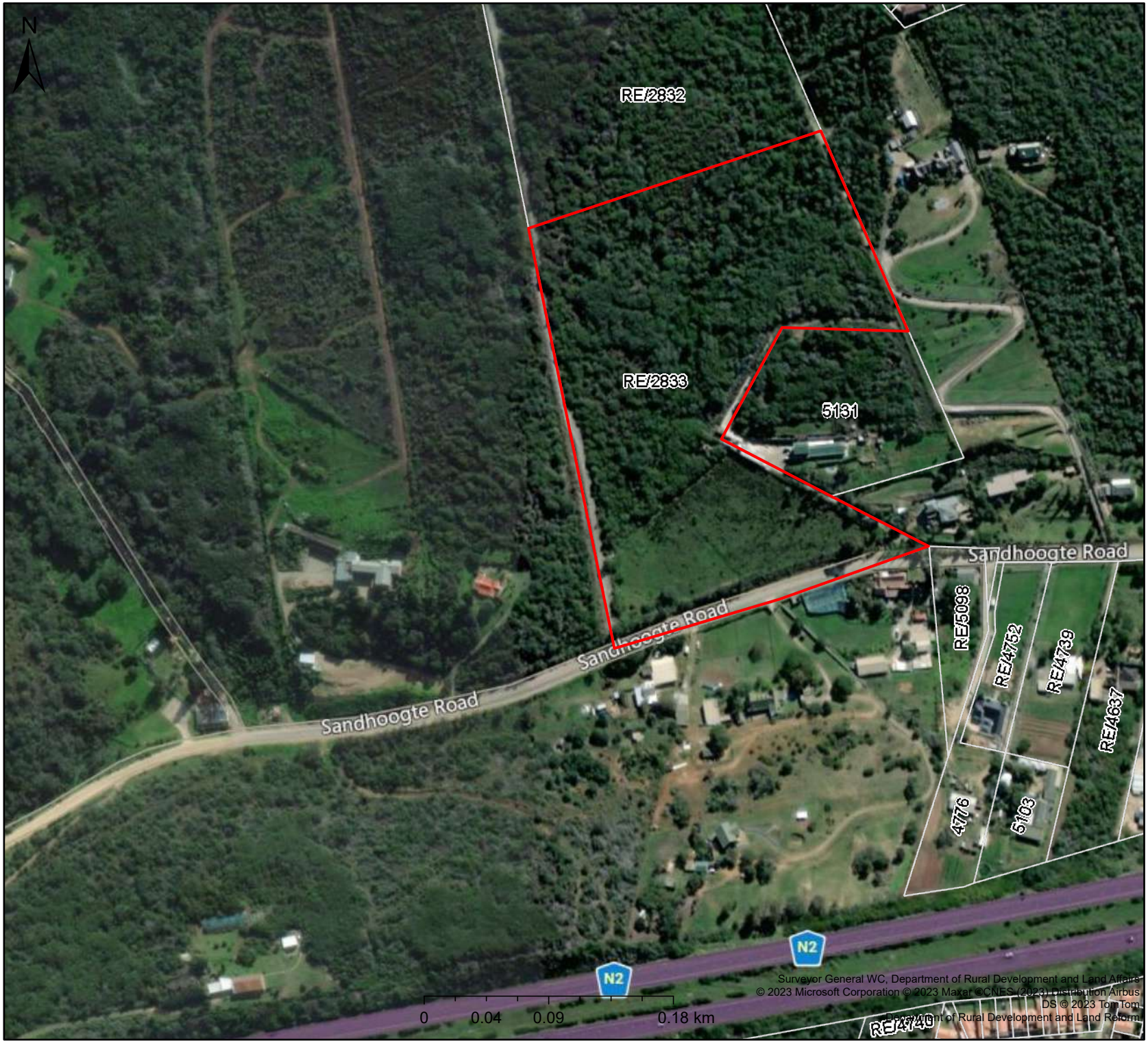
Legend

Map Center: Lon: 22°12'6.2"E
Lat: 34°3'20.3"S

Scale: 1:9 028

Date created: March 1, 2023

Western Cape Government
Agriculture
FOR YOU



Locality Map

Legend

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Map Center: Lon: 22°12'7.3"E
Lat: 34°3'22.1"S

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Date created: April 11, 2023

Western Cape Government
Agriculture
FOR YOU

AANSOEK:

- Aansoek word in terme van Artikel 15(2)(a) van die Verordening op Grondgebruikbeplanning vir Mosselbaai Munisipaliteit, 2021 gedoen vir die hersonering van die Restant van Erf 2833 Groot Brakrivier vanaf Landbousone I na 'n Onderverdelingsgebied bestaande uit Algemene Residensiële Sone I erwe (± 1.11 hektaar), 1 Nutssone erf (± 0, 03 hektaar), 4 Oopruimtesone II erwe (± 3, 56 hektaar), 'n Vervoersone III erf (Privaat straat) (± 0, 99 hektaar) en 'n Vervoersone II erf (Publieke straat) (± 0, 35 hektaar).

- Aansoek word in terme van Artikel 15(2)(d) van die Verordening op Grondgebruikbeplanning vir Mosselbaai Munisipaliteit, 2021 gedoen vir die onderverdeling van die Onderverdelingsgebied in die volgende erwe:

  i. 41 Algemene Residensiële Sone I erwe (Gedeeltes 1 tot 3, 6 tot 12 en 14 tot 44);
  ii. 4 Oopruimtesone II erf (Gedeeltes 4, 13, 45 en 46);
  iii. 1 Nutssone erf (Gedeelte 5);
  iv. 1 Vervoersone III (Privaat Straat) erf (Gedeelte 47), en
  v. 1 Vervoersone II (Publieke Straat) erf (Gedeelte 48).

NOTA

Serwituut: Reg van Weg (Landmeter Generaal Diagram Nommer 5859/2003), 20 meter wyd. Serwituut word gehandhaaf om vrye toegang tot Erf 2832 Groot Brakrivier te verseker.

N

0 5 10 15 20 30 40 50 60 70
SKAAL IN METER

TABEL 1: GRONDGEBRUIKE

Gedeelte No	Sonering verwysing	Sonering	Oppervlakte (ha)	% van totaal
1 tot 3, 6 tot 12 en 14 tot 44		Algemene Residensiële Sone I	1.11	19.00
5		Nutsone	0.03	0.05
4, 13, 45 en 46		Oopruimtesone II	3.56	58.77
47		Vervoersone III (Privaat straat)	0.99	16.39
48		Vervoersone II (Publieke straat)	0.35	5.79
TOTAAL			6.04	100

cell: 082 464 7871 | email: janvrolijk@vodmail.co.za

PROJECT
VOORGESTELDE HERSONERING EN ONDERVERDELING: RESTANT VAN ERF 2833 GROOT BRAKRIVIER

DRAWING TITLE
HERSONERING EN ONDERVERDELINGSPLAN

PROJECT No.	DWG No.	REVISION No.	DATE OF PRINT
ERF 2833 G BRAK		4	25.04.2024
SCALE	PROJECT DATE	DRAWN BY	CHECKED BY
NTS	SEPT 2023		JV

JANVROLIJK TOWN PLANNER • STADSBEPLANNER

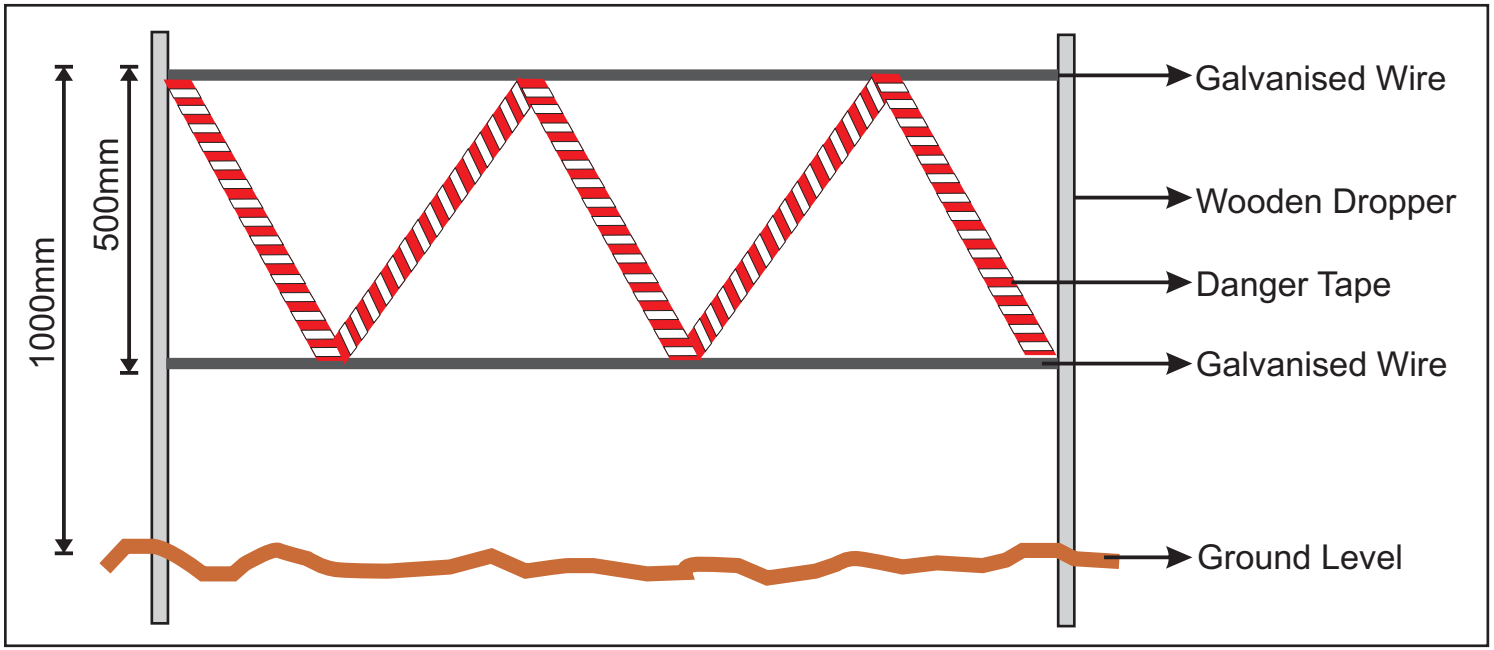

Plate A: Showing a cross section of a typical method of demarcation of no-go areas.

Where demarcation is required on a down slope, it can be more cost effective to include the required silt protection mechanisms on the same support structure as the demarcation. This is detailed in **Plate B** below and must be read in conjunction with the details on erosion control included in the previous diagram.

GENERAL CONSIDERATIONS FOR DEMARCATION OF NO GO AREAS

- The demarcation must include all areas that are going to be disturbed in the total construction (including all service lines)
- The no -go areas may not be accessed by any person (including lunch, tea breaks etc.). Without the explicit written permission from te ECO.
- Maximum fines will be issued for any non compliance with regards to the no go policy.

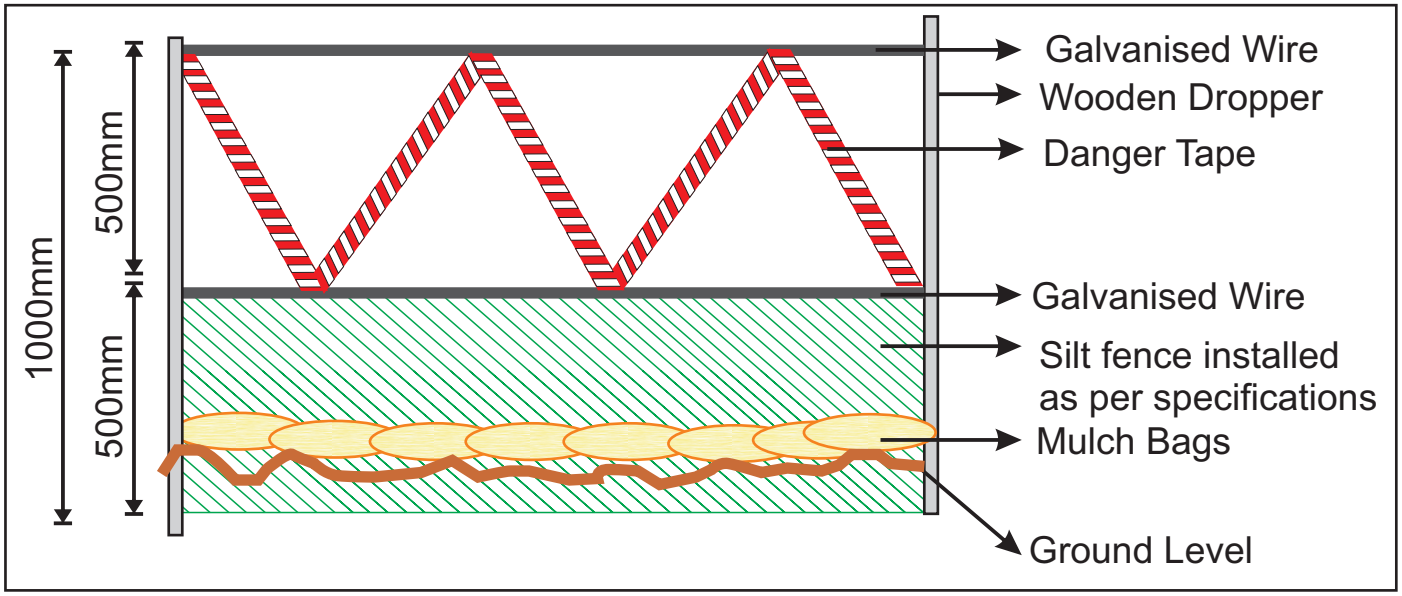

Figure 1: Demarcation of No - Go Areas During Construction

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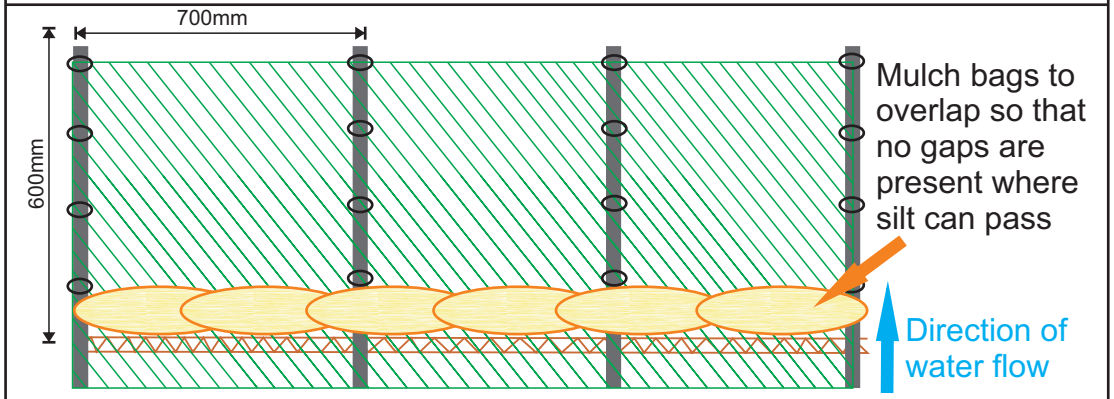
Frontal View



The purpose of a silt fence is to create a temporary barrier to maintain sediment on a construction site in order to prevent soil erosion and pollution through sediment and nutrient loading. Silt fences are designed to detain sediment from the disturbed construction area and also prevent sheet erosion by decreasing the velocity of the run off.

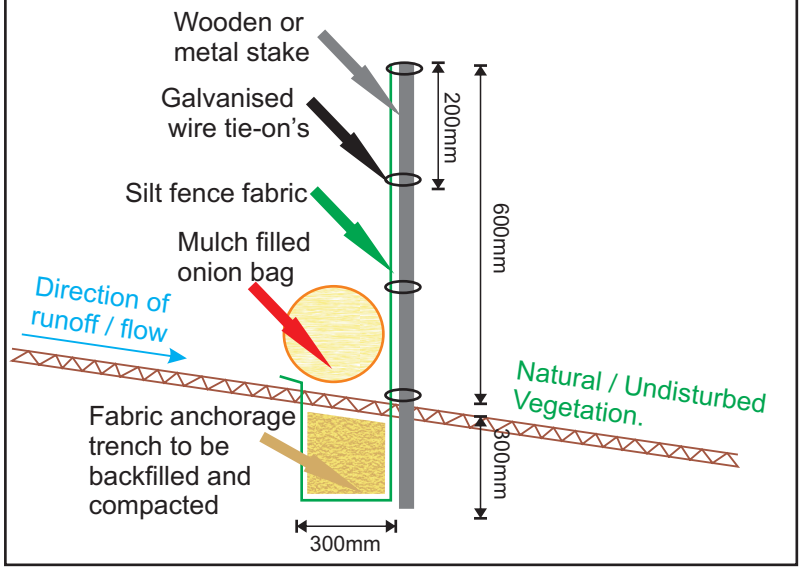
Technical Specifications

- Silt fence fabric to consist out of 50% shade cloth or a geotextile such as biddim (if biddum is used, it is not necessary to place mulch bags).
- Wooden droppers are suitable for the stakes. If the construction program takes place over an extended time frame it may be necessary to use treated droppers or metal stakes.
- The support stakes should not be placed further than 700mm apart on the down slope side of the fabric.
- The fabric should be secured to the stakes using galvanised wire ties not further than 200mm apart.
- The fabric anchorage trench should be at least 300mm deep.

Planning, Placing and Maintenance

- The silt fence is to be installed on all disturbed slopes where sheet erosion may take place.
- This type of silt fence is not suitable for areas where water is concentrated. i.e. gulleys and storm-water outlets.
- The silt fences should be along the contour lines
- The rows of silt fences should be bowed to prevent erosion and loss of silt on the ends of the fence line.
- Silt fences should be inspected weekly and before every forecast rainfall event. Any damage must be repaired immediately.
- Silt deposits should be cleared after each rainfall event. CLEARED SILT MUST NOT BE PLACED DOWN SLOPE OF THE FENCE.

Cross-section View



Top View

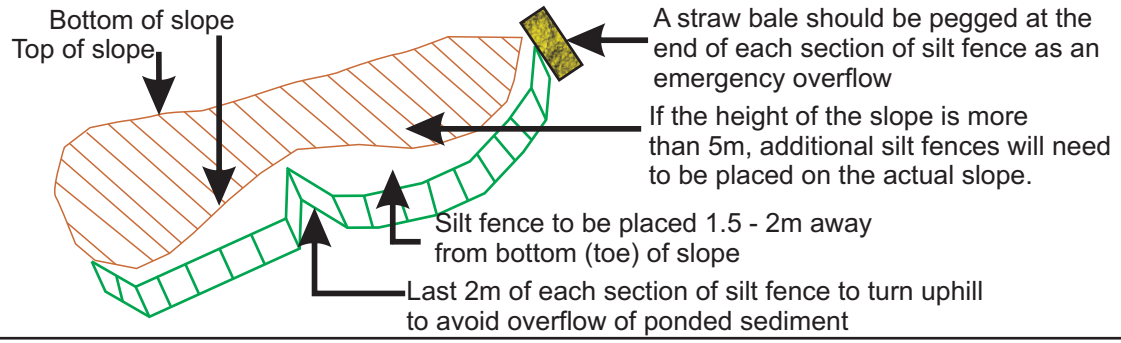


Figure 2: Specifications for Silt Fences

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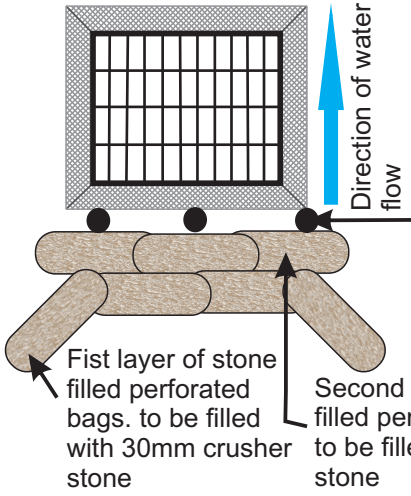
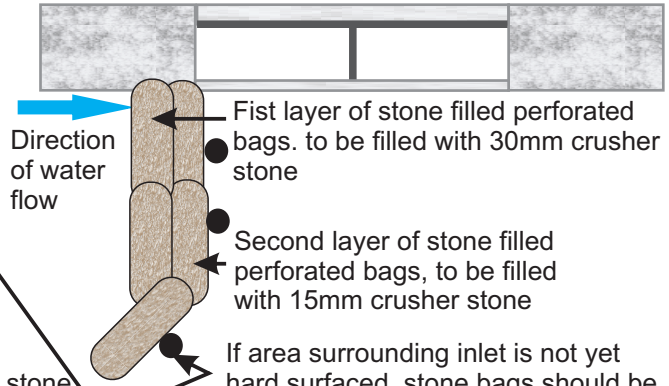
Inlet Protection

Drop Inlets



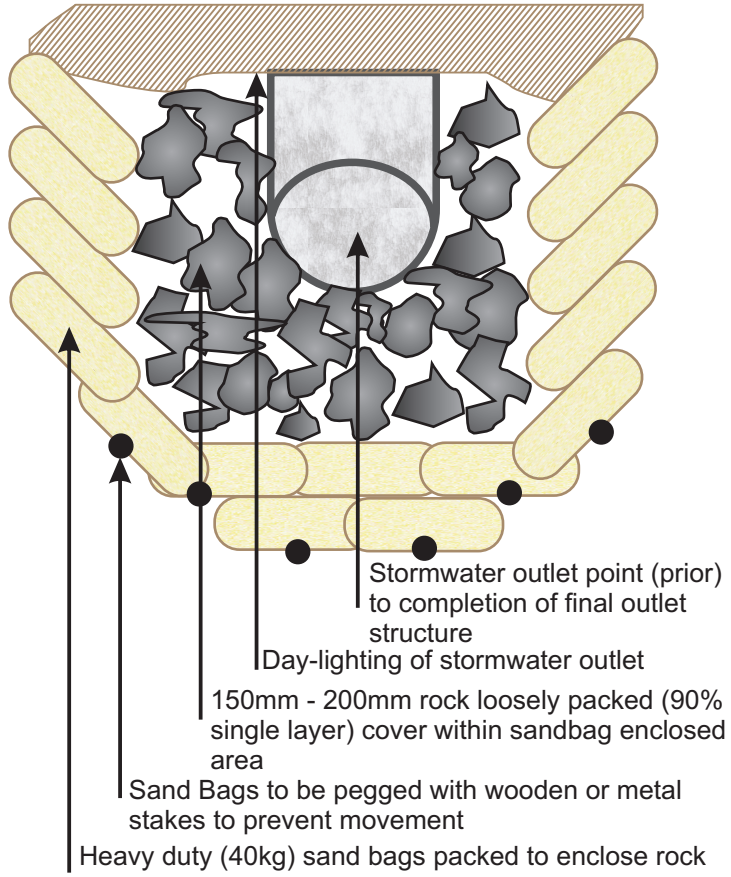
Kerb Inlets



- Should the inlet be positioned at a low point with water entering from a number of sides, a double row of stone bags (as detailed above) should be placed at each side where water enters.

- In low flow, high sediment areas, consideration should be given to cover the inlet structures with biddum (this will only work in low flow areas.)

Outlet Protection



- The methodology referred to above is effective as a temporary measure to be used during construction and is in no way intended to replace the permanent measures that must be installed. These permanent measures must be constructed as per the engineers specifications.
- Stormwater systems should ideally be constructed during low rainfall periods in order to allow for permanent protection measures to be put in place before the rainy season.
- Consideration should be given to encase the outlet structure with a geo-fabric such as biddum. This should first be clarified with the site engineer to ensure compatibility with the stormwater system.

Figure 3: Specifications for Temporary Stormwater Management During Construction

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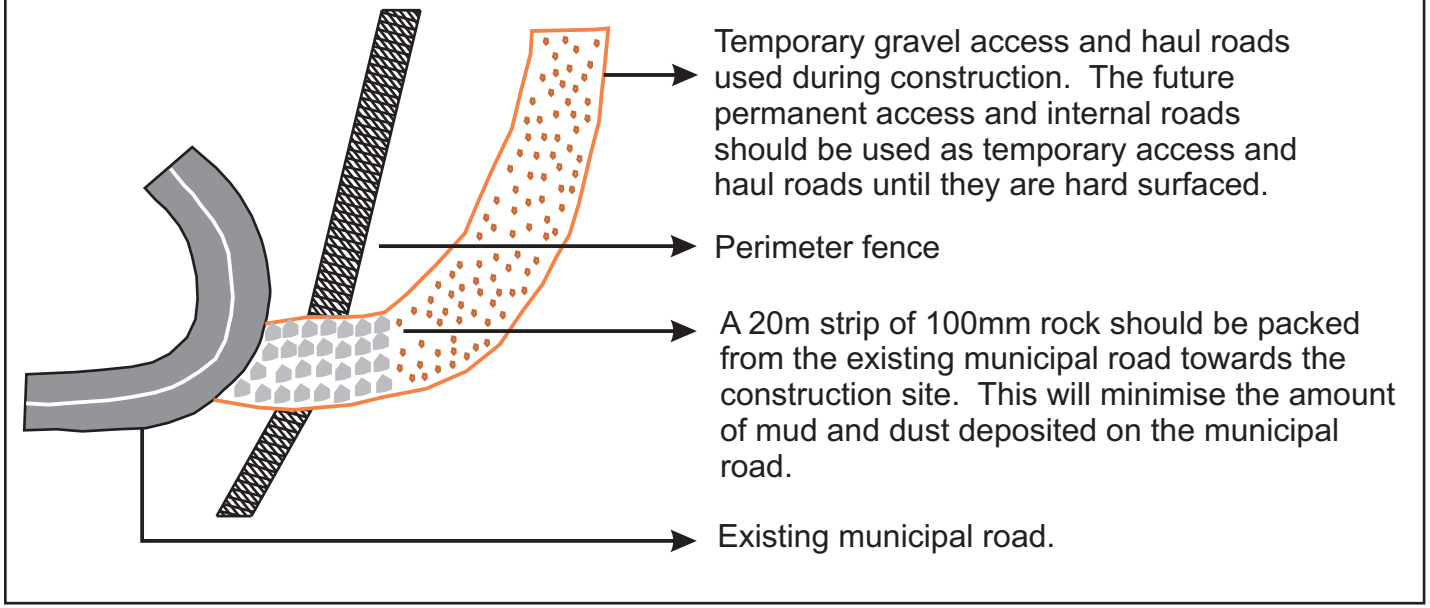
Key Environmental Considerations for Haul Roads

The most important environmental factor to be considered regarding access and haul roads, is the location thereof. Haul roads should be designed to make use of future permanent internal roads and access points.

The haul roads should never be construction in areas that will not be permanently transformed with the development. Nor should they be constructed in any sensitive area.

Another safety and environmental hazard caused by haul road surface is dust problems. Roads should be designed with enough fines to act as binders for the larger particles. However, an excess of fines will result in these particles being released to the atmosphere when repeated stress is applied by the equipment tires. All haul roads that do not have a "sealed" surface, will create dust. The dust problem is mainly dealt with by application of water.



Minimisation of Dust on Haul Roads

- Every effort to minimize dust pollution on the site must be undertaken.

- Construction vehicles must adhere to speed limits and minimization of haul roads must be implemented. During dry, dusty periods haul roads should be kept dampened to prevent excess dust.

- No potable water may be used for damping haul roads.

- As an alternative, products such as road environment dust suppressants (Reds) would be recommended in order to minimize the use of water for controlling dust pollution. This is to be determined by the ECO during construction as required.

Figure 4: Management of Haul and Access Control During Construction

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WWF
SOUTH AFRICA

A PRACTICAL GUIDE TO MANAGING INVASIVE ALIEN PLANTS

A concise handbook for land users in the Cape Floral Region

This handbook has been produced in collaboration with these partners to guide the management of invasive alien plants in the Cape Floral Region.

ARC • LNR

CITY OF CAPE TOWN
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Department:
Environment, Forestry and Fisheries
REPUBLIC OF SOUTH AFRICA

Fynbos Trust
Landscape Scale Conservation

LANDWORKS™
Working with people in the landscape

ncc

Authors: Chris Martens (Fynbos Trust), Guy Deacon (LANDWORKS), Dean Ferreira (NCC), Willie Auret (Corteva), Clifford Dorse (City of Cape Town), Helen Stuart (WWF), Fiona Impson (ARC), Garth Barnes (DEFF), Clarrisa Molteno (Private)

Reviewers: Rudolph Röscher (LandCare), Andrew Turner (CapeNature), Rodney February (WWF)

WWF editorial team: Dimpho Lephaila, Sue Northam-Ras

Text editors: Emily Botts, Marlene Rose

Design and layout: Design for Development (www.d4d.co.za)

Cover photo: Member of a clearing team stacking biomass in the Vyeboom Wetland near the Theewaterskloof Dam.
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The Afrikaans version is available at www.wwf.org.za/report/invasive_plants_handbook_Afr

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Supporting documents for more information are available as appendices at www.wwf.org.za/report/invasive_plants_appendices

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WWF is one of the world's largest and most experienced independent conservation organisations with over 6 million supporters and a global network active in more than 100 countries.

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WWF South Africa is a national office in the global WWF network. Started in South Africa in 1968, we are a local NGO with a vision of building a sustainable and equitable future in which humans and nature thrive. We work to champion the Earth's capacity to provide a source of inspiration, sustainable food, freshwater and clean energy for all. For Nature. For You.

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Funders: Corteva Agriscience, the Fynbos Trust, Nedbank, Sanlam and Woolworths.

Corteva Agriscience, through its local subsidiaries, has introduced environmentally accepted herbicides in South Africa since the early 1980s. As global market leader in Green Chemistry Principles, Corteva is committed to new innovations for the control of introduced invader plants that threaten the biodiversity and functioning of our forests, wetlands and especially the species diversity of the Cape Floral Kingdom, without negative impacts to the environment.

The Fynbos Trust is an NGO that promotes and supports landscape-scale conservation (primarily in the Overberg). Conservation leadership and innovation, partnerships with communities, technical support and collaboration with land users, decision-makers and other stakeholders are key areas of focus to ensure that natural diversity and processes persist across the landscape. Integrated invasive alien plant and fire management are key elements of the Fynbos Trust's landscape-scale conservation approach.

Nedbank is proud to fund the production of this guide as part of its support for WWF as we work together to safeguard South Africa's water source areas, improve rural livelihoods and promote land stewardship. WWF and Nedbank have been working together in various forms for almost 30 years – a long-term NGO/business partnership that continues to evolve and innovate to find solutions to complex sustainability challenges in South Africa.

WWF South Africa's partnership with Sanlam works to conserve and ensure the healthy functioning of South Africa's important freshwater ecosystems and, in so doing, the well-being of people that depend on this natural resource. This practical guideline to managing invasive alien plants is one of the tools contributing towards this purpose.

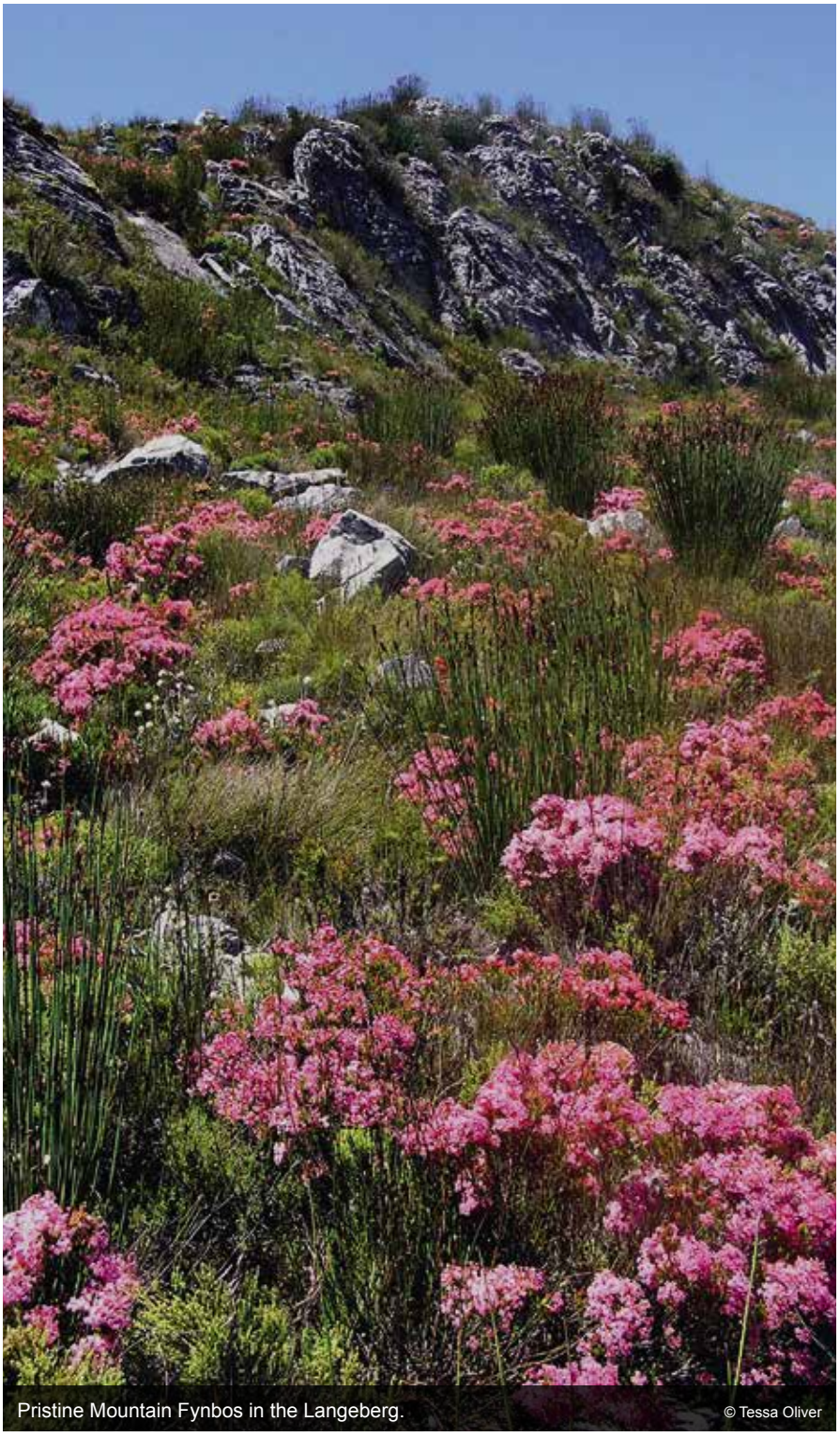
The WWF–Woolworths partnership seeks to improve the stewardship of water resources nationally, explore low-carbon pathways, reduce potential negative impacts of agriculture, improve seafood production and reduce food waste throughout the supply chain. The management of invasive alien plants contributes towards this mission. Therefore, Woolworths is proud to be part of this publication that summarises the lessons and tips for land users who want to join the practice of keeping alien plants at bay.

Indigenous common pagoda (*Mimetes spp*) after a fire in Luiperdskloof, Betty's Bay. © Tessa Oliver

CONTENTS

INTRODUCTION

This practical guide aims to empower land users (landowners, land managers and contractors) in the Cape Floral Region to understand the threat of invasive alien plants (IAPs) and manage the IAPs on their land.



Pristine Mountain Fynbos in the Langeberg. © Tessa Oliver

The guide was developed by WWF South Africa in collaboration with the Agricultural Research Council; the City of Cape Town; Corteva Agriscience; the Department of Environment, Forestry and Fisheries; LANDWORKS; the Fynbos Trust; and NCC Environmental Services. It not only contains a detailed set of instructions on how to proceed when clearing IAPs (this often differs per context) but also aims to be a first-stop resource that can be adapted to local conditions, while giving useful pointers for where to find further information from numerous other sources.

Land users are given an overview of how to approach an IAP management programme: understanding what IAPs are, the relevant legislation, planning, the methods that are available, health and safety considerations, the safe use of herbicides, and successfully rehabilitating the cleared land, if that is the end goal. The authors' intentions are to update the necessary sections on an annual basis, and it is in the reader's best interest to use the latest version of the guide at www.wwf.org.za/report/invasive_plants_handbook and of the supporting Appendices at www.wwf.org.za/invasive_plants_appendices/.

Additional resources are noted throughout the guide in the "For more information (page xx)" sections, and options to source funding for IAP management are given.

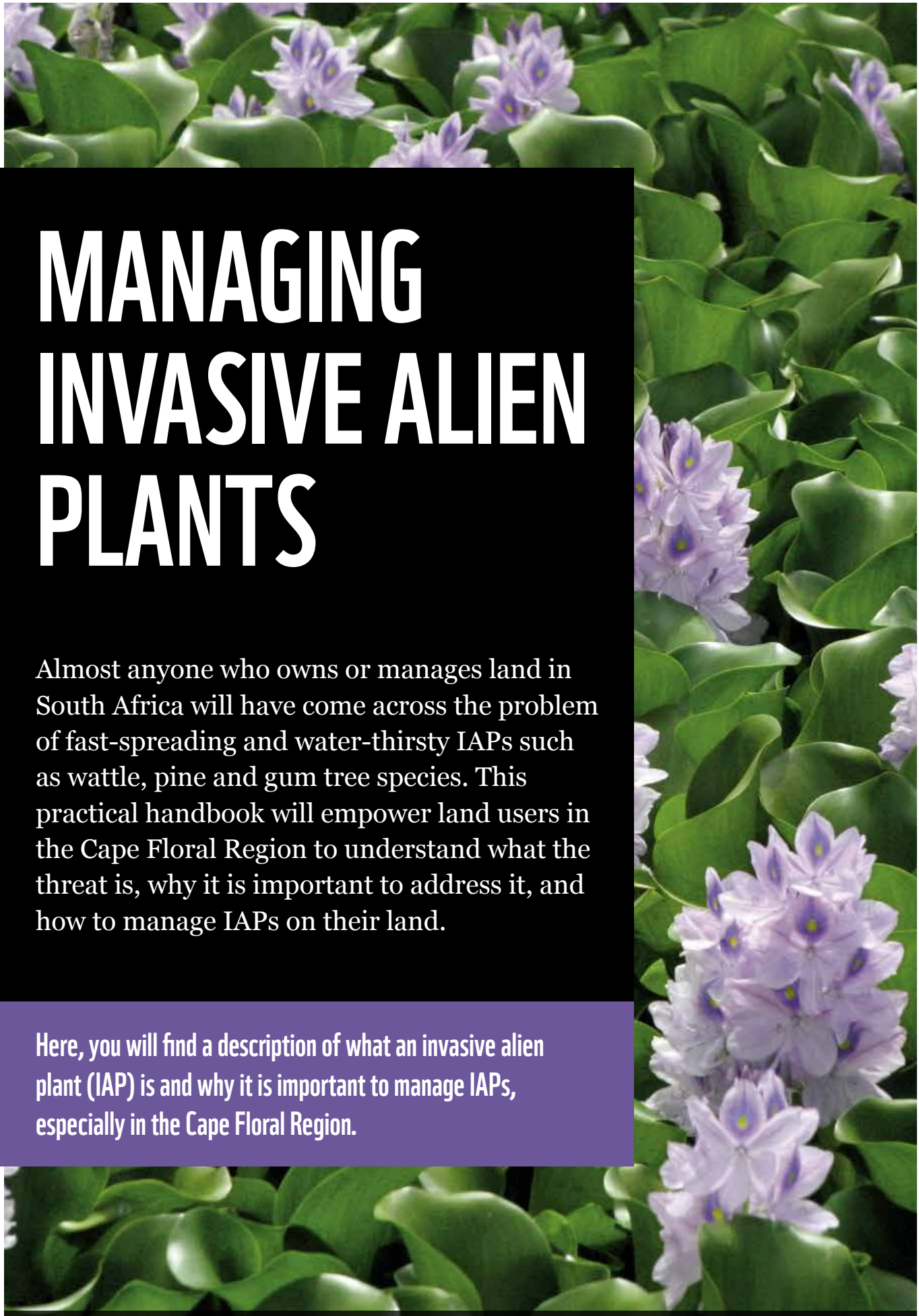
A land user can mean the legal owner of the land, or a land manager, someone leasing land or an IAP contractor.

Introduction	In this section, the origin and purpose of this guide is explained.
Managing IAPs	Here, you will find a description of what an invasive alien plant (IAP) is and why it is important to manage IAPs, especially in the Cape Floral Region.
Legal	The legal obligations of landowners with IAPs on their land are summarised in this section. You will find a brief explanation of the relevant laws and regulations relating to IAPs, including what actions are required for different categories of IAPs.
Planning	This section provides the main considerations to think about before beginning an IAP management operation, including steps to develop a management plan, how to prioritise IAP clearing, mapping management units, planning for wildfires, and the labour and budget requirements.
Methods	Here, you will find simple instructions for the four main methods of managing IAPs: manual, mechanical, chemical, and biological control. Further information is given on how to dispose of plant and waste material.
Health and Safety	This section covers the legal background for health and safety, as well as minimum safety requirements. You will also find information on safety in the field, fire preparedness and a list of personal protective equipment.
Herbicide safety	In this section, information is given on herbicide labels and the safe storage, mixing and disposal of herbicides. Following these precautions will help to reduce the risks associated with these dangerous chemicals.
Rehabilitation	Here, you will find an overview of the reasons for rehabilitating cleared land, the types of rehabilitation and the phases in a rehabilitation project. Useful resources with more detailed information on rehabilitation are suggested.
Funding	This section contains information about government and other funding opportunities for IAP management. Options include accessing government programmes, working cost effectively with neighbours, and finding resourceful ways to recoup funds from IAPs.

MANAGING INVASIVE ALIEN PLANTS

Almost anyone who owns or manages land in South Africa will have come across the problem of fast-spreading and water-thirsty IAPs such as wattle, pine and gum tree species. This practical handbook will empower land users in the Cape Floral Region to understand what the threat is, why it is important to address it, and how to manage IAPs on their land.

Here, you will find a description of what an invasive alien plant (IAP) is and why it is important to manage IAPs, especially in the Cape Floral Region.



Water hyacinth (*Eichhornia crassipes*), an aquatic invasive alien plant native to the Amazon basin, is widely spread throughout South Africa and is found in many of our water bodies.

THE CAPE FLORAL REGION – WHAT ARE WE CONSERVING?

The Cape Floral Region is an area of special and unique biodiversity. It is the smallest of only six floral kingdoms around the world and the only one found within a single country.

The Cape Floral Kingdom extends across the Western Cape and parts of the Northern and Eastern Cape provinces of South Africa, from Gqeberha (formerly Port Elizabeth) to Cape Town and north towards Nieuwoudtville. There are many ways in which the natural ecosystems in this area are recognised as extraordinary.

Cape Floral Region

Biodiversity and endemism

The Cape Floral Region is home to more than 9 000 different species. This is one of the highest concentrations of plant species anywhere in the world. Covering only 0,5% of Africa's area, the Cape Floral Region hosts more than 20% of the continent's plant species. About two-thirds of these plants are endemic, meaning they are not found anywhere else.

Fynbos, Renosterveld and Strandveld

The Fynbos biome comprises various Fynbos, Renosterveld and Strandveld vegetation types. These are the dominant vegetation communities of the Cape Floral Region. Fynbos is a type of shrubland adapted to a mild climate with winter rainfall, poor soils and regular wildfires. It is known for its unique proteas, ericas and restios. Renosterveld is also part of the Fynbos biome but occurs on more fertile soils. It has more grasses, annual plants and bulbs than typical Fynbos. All lowland types of Renosterveld are considered critically endangered, because only small fragments of natural vegetation remain. Strandveld vegetation grows in deep, well-drained alkaline sand along the West Coast and on the Cape Flats. Many Strandveld plants are succulent, so the vegetation does not burn as regularly as Fynbos and Renosterveld.

Biodiversity hotspot

The high biodiversity and endemism of the Cape Floral Region have led to it being considered a biodiversity hotspot. There are 36 recognised biodiversity hotspots around the world. These are areas with very high levels of biodiversity that are also under significant threat from human activities.

World Heritage Site

In 2004, the Cape Floral Region was designated as a World Heritage Site in recognition of its unique biodiversity. The World Heritage Site currently consists of 13 clusters of national parks, nature reserves and wilderness areas, covering more than a million hectares. It is considered of global value because of the unique ecological processes and high biodiversity associated with the Fynbos biome.

Water Source Area

The mountain catchments of the Cape Floral Region are part of South Africa's Strategic Water Source Areas. These are areas that cover only 10% of the country's land but contribute a disproportionate 50% of its water supply. The rainwater that fills the rivers of the Cape Floral Region is a vital water source for millions of people, farms and industries downstream.

Threats

Invasive alien plants are one of the biggest threats to the Cape Floral Region. Fynbos is a shrubland and is vulnerable to invasion by wildfire-adapted tree species. Pines, woody acacia and hakea have the most negative impacts, particularly on water supply, and are the most difficult to deal with. Infestation levels vary from areas that are completely infested to areas free of IAPs. If IAPs are not controlled, they will continue to be an ever-expanding threat to this remarkable biodiversity area and all the benefits provided by a functioning environment. It is therefore critical to maintain IAP-free land and prioritise low infestations for clearing.

INVASIVE ALIEN PLANTS – WHY ARE THEY A PROBLEM?

Invasive alien plants are problem plants. They are plants that are not native to an ecosystem. They spread rapidly and cause harm to the environment, the economy and even to human health.

Purple loosestrife (*Lythrum salicaria*), native to Eurasia, spreads easily and replaces indigenous vegetation, creating its own dense stands. © Debbie Muir / NRM

4 MAIN CHARACTERISTICS OF INVASIVE ALIEN PLANTS

1 Non-indigenous

Alien species are those that do not occur naturally in an area. They are brought in by people, either on purpose (as garden plants or plantation trees) or by accident (such as seeds in bags of animal feed).

2 From a similar climate

Many IAPs in South Africa come from Australia, Europe or North and South America. They are well adapted in their natural habitat to enjoy similar temperatures, rainfall patterns and fire regimes. This means they can spread easily and thrive in the place to which they have been introduced.

3 No natural enemies

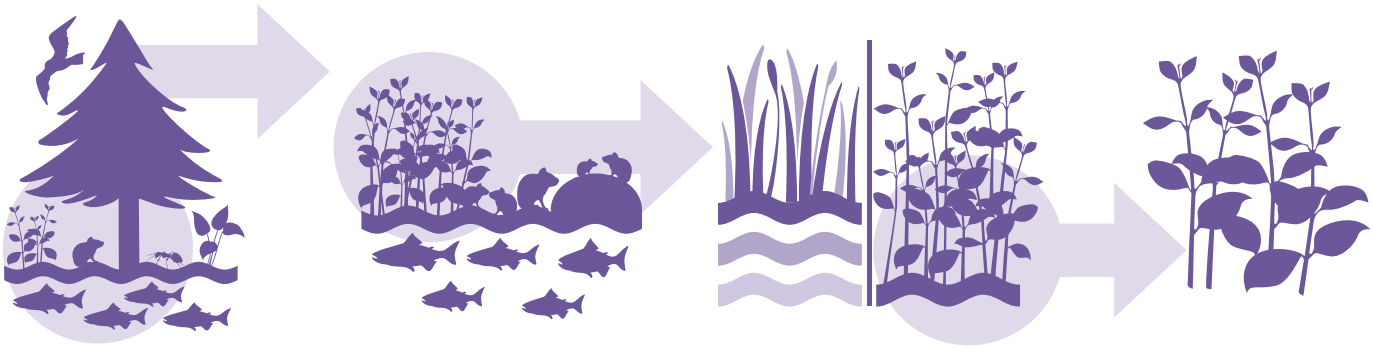
Because IAPs have been artificially introduced to an area by humans, they have not evolved to be a part of the local ecosystem. In their country of origin, they are kept in check by insects, diseases or fungi that feed on them and control their numbers. These natural enemies are often missing in the new environment, which means the IAPs can grow without anything to stop them.

4 Invasive and competitive

Not all alien plants become invaders. But those that find themselves in a suitable climate where there are no natural enemies can quickly become a serious problem. Many IAPs can grow fast, produce large, long-lived seedbanks and disperse easily. IAPs, especially trees, tend to use more water than natural indigenous vegetation. Pines (*Pinus* species), wattle (*Acacia* species) and gum trees (*Eucalyptus* species) invade water courses and can form dense stands.

INVASIVE ALIEN SPECIES IN THE SOUTH AFRICAN CONTEXT

There are currently 2 033 listed alien species in South Africa, consisting of marine organisms, freshwater fish, insects and plants. Altogether 771 of these are invasive, while 107 of them are found to have a major impact on the environment. Of the 107 problem species, 80 of them are plants. This practical guide focuses only on the invasive alien plant species.



2 033
ALIEN SPECIES IN SOUTH AFRICA

771
OF THESE ARE INVASIVE

107
OF THESE CAUSE MAJOR IMPACTS

80
OF THESE ARE PLANTS

European blackberry (*Rubus fruticosus*) originates from the Mediterranean region of Europe. It outcompetes indigenous woody and grassland species.

MANAGING INVASIVE PLANTS – WHY IS IT NEEDED?

By disrupting natural ecosystems, taking up space and using natural freshwater resources – especially in a water-scarce country like South Africa – IAPs can cause serious damage to the natural environment. Clearing and controlling IAPs can help to prevent some of these negative impacts.

7 NEGATIVE IMPACTS OF INVASIVE ALIEN PLANTS

1 Overuse of water

A single large invasive alien tree can use between 100 and 1 000 litres of water per day, significantly more than the average indigenous plant. They use so much water that they decrease the flow of streams and reduce the amount of water that reaches dams. South Africa loses as much as 2 500 million m^3 of water to IAPs every year. This is a significant amount in a country that is already suffering from water shortages. Some of the worst-affected river catchments are in the Western Cape.

2 Decreased agricultural production

IAPs that spread through agricultural land reduce the space available for crops or livestock and this can decrease agricultural production. Managing IAPs is an added expense for farmers. The consequence is that these plants have a negative impact on the agricultural economy and ultimately affect food security.

3 Increased impact of wildfires

IAPs increase the risk of wildfires by increasing the amount of fuel available. Woody IAPs grow in dense stands that increase the biomass available to burn. Some species also contain flammable compounds. Wildfires in IAP-infested areas burn hotter and more intensely than wildfires in natural vegetation, and are more difficult to contain, increasing the danger to lives, livelihoods and the environment.

4 Reduced ecosystem services

IAP-infested habitats have a reduced capacity to deliver ecosystem services – such as providing clean water and healthy soils – that support a healthy living environment for people and animals. They can also cause a decrease in the availability of natural products such as medicinal plants, fodder and building materials.

5 Lower land values

IAP invasions have a significant impact on the sale value of land because the land has lower agricultural production value or the new owner will not want the expense of dealing with the problem.

6 Impacts of climate change

Many IAPs can easily adapt to take advantage of the changing climate and global warming. The Western Cape is predicted to get hotter, drier and have more extreme weather events, leading to significant shifts in biomes like the Fynbos. These changes favour the growth of IAPs. This means that some IAPs will become more aggressive and spread faster. There may also be new and emerging ones that benefit from a changing climate. Some species, like the Acacia, are legumes that can fix nitrogen, changing the chemical composition of the soil. This can make the natural ecosystems less resilient to climate change and more susceptible to secondary invasive species.

7 Biodiversity loss

Biodiversity is the variety of natural species living in an area and the relationship between them. IAPs outcompete and replace indigenous plants, causing a decline or even disappearance of biodiversity. Because IAPs tend to form dense stands where very little else can survive, they can have a devastating impact on local biodiversity. IAPs are one of the biggest causes of biodiversity loss worldwide. This is especially severe in places with unique and rich biodiversity, like the Cape Floral Region (see The Cape Floral Region – What are we conserving? page 7).

To address these negative impacts of IAPs, the government has put in place laws and regulations. The regulations identify which IAPs need to be eradicated or controlled based on their degree of impact. There are also measures to detect and prevent new invasions (see Legal requirements, page 14).

MANAGING IAPS – WHAT ARE THE KEY PRINCIPLES?

The management of IAPs is driven by two fundamental principles: **acting early and following up**.

1 Act early

Taking action to manage IAPs when they first appear is much easier and cheaper than addressing severe infestations. Younger IAPs that cover smaller areas of land can be controlled with less time, labour and equipment. So, making an investment in IAP management at an early stage will save costs over the long term. Monitoring land for new IAP infestations will help to combat them in good time.

2 Follow-up

Follow-up and ongoing maintenance are essential to protect the investment made in IAP management. Regular follow-up treatment will stop any regrowth and prevent secondary infestation.

Any IAP management programme should follow three phases:

Phase 1 – Initial control

Drastically reducing the existing population (potentially including biocontrol)

Phase 2 – Follow-up

Controlling seedlings, root suckers and regrowth

Phase 3 – Maintenance

Sustaining low and decreasing IAP numbers with annual control

A clearing team in the Vyeboom Wetland near Theewaterskloof Dam in the Western Cape stacking cut black wattle. © WWF

TYPES OF IAPS – HOW DO THEY DIFFER?

Invasive alien plants are often grouped into different types. The management methods for each type can be more or less effective depending on where the IAPs grow, how they grow or how they reproduce. The types of seeds will influence how they need to be managed.

Water hyacinth (*Eichhornia crassipes*) is often labelled as the world's worst aquatic weed because of its invasive potential, negative impact on aquatic ecosystems and the costs involved in controlling it. © Debbie Muir / NRM

WHERE THEY GROW

In water

These IAPs are known as aquatic IAPs, live mainly in water and can tolerate very wet conditions. Aquatic species invade rivers, dams and wetlands. Water Hyacinth (*Eichhornia crassipes*), for example, is a floating plant that is highly invasive in South Africa.

On land

These IAPs are known as terrestrial IAPs and grow on land. Silky hakea (*Hakea sericea*) is an example. Because so many IAPs fall into this type, they are usually further categorised according to other growth forms.

On riverbanks

These IAPs are plants that grow on the land along the edge of a river, also known as riverbanks or riparian areas. Black wattle (*Acacia mearnsii*) is an example. This can be viewed as a subset of the terrestrial grouping. The interface between land (terrestrial) and water (aquatic) areas are particularly susceptible to severe infestations that cause serious impacts.

HOW THEY GROW

Root systems

Some IAPs have long, deep taproots that make pulling out the plant difficult. Port Jackson (*Acacia saligna*), for example, has a tap root system. If pulled it can break off at the base and the plant will resprout. IAPs with shallow root systems can be pulled out more easily. Some plants grow from root suckers or rhizomes (underground stems) that connect plants below the ground. Saplings of invasive poplars (*Populus* species), for example, are connected to the parent tree. Both need to be treated during clearing operations.

Dormancy

Some IAPs may go through periods of dormancy, which is when growth stops for a while and the plant may lose its leaves. *Populus* species, for example, are widely invasive in South Africa and are deciduous. Some control methods are more effective when the plant is actively growing or has leaves, so it is important to know which IAPs have a dormant period, and when it is.

Bark types

Some IAPs have very thick bark. This will influence the method of control that should be used. The bark of *Eucalyptus*, for example, is thick, so tougher ring-barking methods will be needed.

Climbers

Some climbing plants are particularly serious invaders, like the Madeira vine (*Anredera cordifolia*). Invasive climbers can grow over and overwhelm natural plants. They spread rapidly and can be difficult to control.

An invasive alien weed: pampas grass (*Cortaderia jubata*), which is native to South America. © Ed February

Other ways of grouping IAPs

Emerging IAPs

Some plants with invasive tendencies are already present outside of their natural distribution, but have not become widely established as yet. They often have horticultural value, but can have a negative impact on natural ecosystems, biodiversity, livelihoods and human health if allowed to continue to expand outside of their natural range. It is important to be on the lookout for new invasive species.

Indigenous invasive plants

A few native species can become invasive due to human-made changes to the environment, such as altered wildfire regimes or pollution. The indigenous bitou (*Osteospermum moniliferum*), for example, can become dominant and cover large areas, reducing the species diversity in smaller isolated remnants in Fynbos systems. Nutrient enrichment (eutrophication) of wetlands also leads to indigenous reeds such as bulrush (*Typha capensis*) becoming dominant.

HOW THEY REPRODUCE

Reseeders

These are plants that reproduce by producing lots of seeds. The parent plant may be killed, but new plants will grow from the seedbank in the soil or from seeds released from cones which had stored the seeds in the canopy. Different species have various methods of spreading their seeds, such as wind or water dispersal. Many species also exhibit fire-activated seed germination. Hakea, for example, is a serious invasive plant in South Africa. It produces seed pods that split open after a wildfire to release winged seeds that disperse in the wind.

Resprouters

These types of plants can grow back after they have been damaged by wildfire or cut down. New shoots grow from the base after the top of the plant has been removed. This is also known as coppicing. Invasive eucalypts in South Africa, for example, will grow new stems if the main trunk is felled. Resprouting may mean that more than one control method, including herbicide, will be required for follow-up treatment.

Vegetative regrowth

Some plants do not only rely on their seeds for survival. Some IAPs can grow from a piece of the parent plant, like a leaf or stem. This is called vegetative regrowth. In some invasive cactus species, for example, each leaf has the potential to grow into a new plant if it comes into contact with the ground.

LEGAL REQUIREMENTS

Landowners have certain legal responsibilities relating to invasive alien plants on their land. These are specified in laws about environmental management, agriculture, water, heritage, health and safety, and the application of herbicides.

The legal obligations of landowners with IAPs on their land are summarised in this section. You will find a brief explanation of the relevant laws and regulations relating to IAPs, including what actions are required for different categories of IAPs.

The headwaters of the Jonkershoek / Eerste River in the Jonkershoek Nature Reserve near Stellenbosch in the Western Cape.

BIODIVERSITY LAWS – WHAT ARE THE LEGAL OBLIGATIONS?

As invasive alien plants can have a negative impact on biodiversity, laws protecting biodiversity include regulations to control the spread of IAPs. The owner of land where IAPs occur carries responsibilities under these laws.

BIODIVERSITY ACT

The National Environmental Management: Biodiversity Act 10 of 2004 is administered by the Department of Environment, Forestry and Fisheries. Its purpose is to conserve South Africa's biodiversity. The Alien and Invasive Species Regulations are published under the Act. These regulations go together with a national list of invasive species that puts IAPs into categories.

Duty of care

Certain sections of the Biodiversity Act impose a 'duty of care' that applies to landowners. A duty of care means that people must take reasonable action to prevent harm to the environment. A person who owns land where IAPs occur needs to take steps to control them, prevent them from spreading and minimise harm to biodiversity.

Categories

The list of invasive species under the Biodiversity Act has four different categories. Different obligations apply to each of these categories (Table 1).

Table 1: Categories of IAPs under the Biodiversity Act

	Category 1a	Category 1b	Category 2	Category 3
Definition	A species that must be combated or eradicated	A species that must be controlled	A species that requires a permit	A species that is subject to certain prohibitions
Actions required	• Take immediate steps to eradicate the invasive species using appropriate methods.	• Take steps to control the invasive species using appropriate methods.	• Apply for, and comply with, a permit to conduct restricted activities (e.g. import, possess, grow, move, trade, dispose of or spread the species).	• Control the species if it spreads to riverbanks. • Planting, propagating, and trading in the species are not allowed.

Obligations

Landowners are required to do the following:

- Notify the responsible provincial agricultural authority in writing if a Category 1 invasive species occurs on their land.
- Comply with any relevant Invasive Species Management Programme.
- Allow an official onto the land to monitor, assist with, or implement control of a listed invasive species.
- Take measures to control the invasive species, depending on the category it is listed under.
- Conduct control activities cautiously to cause the least harm to biodiversity and the environment.
- Inform the buyer in writing of invasive species on the land, if the land is to be sold.

Offences

If a landowner does not obtain the necessary permit or does not take the required steps to control an invasive species, they can be found guilty of an offence. They may be sentenced to a fine of up to R10 million, or imprisonment for up to 10 years, or both.

AGRICULTURAL LAWS – WHAT ARE THE LEGAL OBLIGATIONS?

Invasive alien plants can have a negative impact on agriculture, so agricultural laws include regulations to prevent their spread. Requirements under agricultural laws may apply to a landowner, or to a land user who has a right to use the land for a certain purpose.

CARA

The Conservation of Agricultural Resources Act 43 of 1983 (CARA) is administered by the Department of Agriculture, Land Reform and Rural Development. Its purpose is to look after South Africa's agricultural resources. The CARA does not use the term IAPs but refers to "declared weeds" or "declared invader plants".

Methods

The CARA places a general ban on any conduct that would disperse a declared weed (e.g. selling, advertising, keeping, delivering). It can also require land users to use specific methods to control weeds, depending on what is most appropriate for the species and ecosystem concerned (see IAP management methods, page 32). Methods include:

- Uprooting, felling, cutting or burning
- Treatment with a registered herbicide
- Biological control
- Any other method of treatment
- A combination of one or more methods.

Categories

The actions required depend on which category the plant falls under in the CARA regulations (which might differ from province to province) (Table 2).

Table 2: Categories of IAPs under the CARA

	Category 1	Category 2	Category 3
Definition	Alien plants that are absolutely prohibited and will no longer be tolerated. Their harmfulness outweighs any useful properties they might have.	Alien plants with proven potential to become invasive, but which have some beneficial properties that warrant their continued presence in some circumstances.	Alien plants with proven potential to become invasive but that are popular ornamentals or shade trees that will take a long time to replace.
Actions required	• Take steps to prevent the occurrence of these plants on any land or water surface. • These plants may no longer be planted, and all trade in them is prohibited. • They may not be transported or allowed to disperse.	• Take steps to prevent the occurrence of these plants on any land or water surface. • An exemption can be obtained. • These plants may be kept in special areas, demarcated for that purpose. • Growing these plants is a "water use" in terms of the National Water Act 36 of 1998.	• These plants are allowed to remain where they are, as long as they do not grow in watercourses and steps are taken to prevent them from spreading.

Offences

Failure to comply with any measure in terms of the CARA regulations can attract a fine of up to R5 000 or up to two years in prison (or double for a second conviction).

WHICH OTHER LAWS REFER TO IAPS?

Several other national laws may have some relevance to invasive alien plants. These are listed below. There may also be some regional requirements, like municipal by-laws, but those are not covered here.

Environmental laws

The National Environmental Management Act 107 of 1998 (NEMA) is the main law governing environmental management in South Africa, including environmental impact assessments. It too contains a "duty of care": every person must take reasonable care to prevent harm to the environment. Importantly for IAP management, it allows employers or company directors to be held responsible for offences under the Biodiversity Act or the CARA. If a person is convicted, the court can also ask them to pay the costs to deal with environmental damage that was caused.

Water laws

The National Water Act 36 of 1998 places all South Africa's water resources under the ownership and governance of the state. Anyone who wants to use water for certain purposes must apply for authorisation. There are some water uses that may be relevant to IAPs. Planting IAPs is considered a "stream flow reduction activity" that requires a water-use licence. Also, if mechanical removal of IAPs alters the banks of a river, or changes the flow, it can be considered a water use.

Forest laws

The National Forests Act 84 of 1998 can declare some trees, including IAPs, as "champion trees". The River Red Gum (*Eucalyptus camaldulensis*) that was planted in Bergzicht market square, Stellenbosch, in 1880 is an example of a "champion tree". These individual trees are protected and it is illegal to cut them down.

Agricultural remedies

The Fertilisers, Farm Feeds, Agricultural Remedies and Stock Remedies Act 36 of 1947 regulates fertilisers, feeds and remedies used in agriculture. The chemicals used for IAP management are regarded as agricultural remedies. The Farm Feeds Act contains some requirements for the registration, proper use and handling of these chemicals (see Herbicide safety, page 52).

Health and safety laws

The Occupational Health and Safety Act 85 of 1993 promotes the health and safety of workers in the workplace. It contains information on the duties of employers and employees to ensure safe working conditions (see Health and safety, page 46). It also has some provisions that may be relevant for handling IAPs that are dangerous to human health.

Heritage laws

The National Heritage Resources Act 25 of 1999 protects South Africa's heritage resources. IAPs are sometimes protected under these laws, e.g. trees growing on heritage sites.

Fire management laws

The purpose of the National Veld and Forest Fire Act 101 of 1998 is to prevent and combat wildfires. It requires every owner of land where a fire may start, burn or spread to maintain a firebreak that is free from flammable material (see Integrated planning for fire and IAPs – Why is it important? page 24).

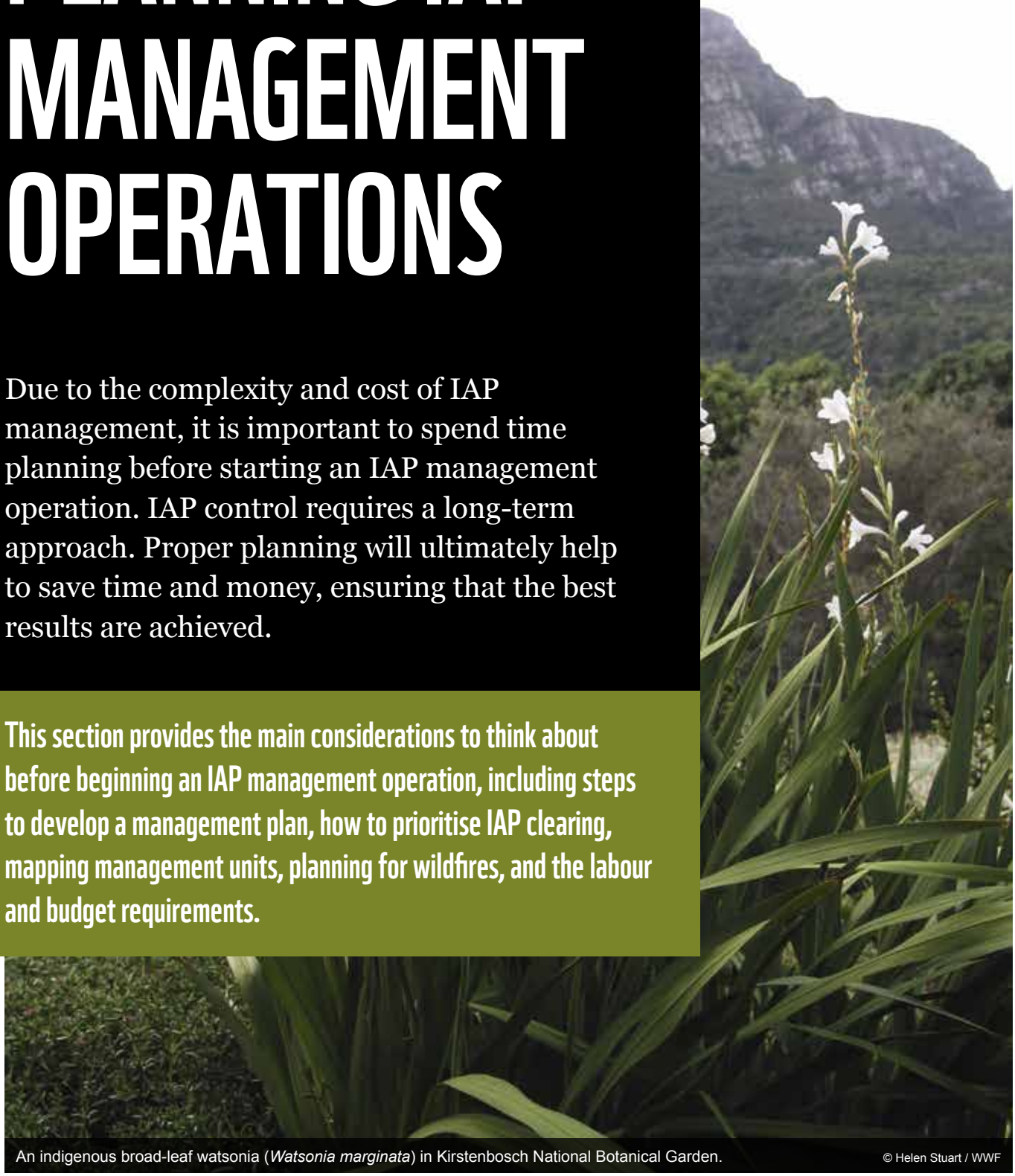
For more information, see Appendix 1: Legislation guideline for invasive alien species (page 66).

Houses in Lakeside, Cape Town, coming under threat from a wildfire above Boyes Drive during 2005. © Bruce Sutherland

PLANNING IAP MANAGEMENT OPERATIONS

Due to the complexity and cost of IAP management, it is important to spend time planning before starting an IAP management operation. IAP control requires a long-term approach. Proper planning will ultimately help to save time and money, ensuring that the best results are achieved.

This section provides the main considerations to think about before beginning an IAP management operation, including steps to develop a management plan, how to prioritise IAP clearing, mapping management units, planning for wildfires, and the labour and budget requirements.



An indigenous broad-leaf watsonia (*Watsonia marginata*) in Kirstenbosch National Botanical Garden. © Helen Stuart / WWF

IAP MANAGEMENT APPROACH – WHAT SHOULD A LAND USER CONSIDER?

The context within which IAP management is planned will determine the approach taken to the management programme.

CONSIDER THE CONTEXT

Goals

Much depends on your goals for the future management of the invaded area. Clearing IAPs for immediate development of the land, for example, will require different methods compared to managing IAPs to restore functioning of the natural environment.

Environment

The type and condition of natural vegetation in the area may determine the IAP control methods so as to limit a negative impact on the surrounding environment.

Season

The season of the year may influence accessibility to the site, visual identification of species through flowering, the safe and effective use of herbicide and fire, and the ecological impact of IAP management. All these factors will have an impact on the number of available work days for clearing.

A Genadendal community member collecting firewood along the densely invaded Riviersonderend River. © Helen Stuart / WWF

4 STEPS TO DEVELOPING A LOGICAL IAP MANAGEMENT PLAN

As important as considering the context within which one is planning IAP management, is considering the steps to develop a logical plan and set priorities for the IAP clearing process. By following a few basic steps, it is relatively easy to put together a simple but effective IAP management plan for a property.

1. SURVEY THE AREA

- Walk the area
- Take photographs
- Review aerial photographs
- Identify IAPs

2. IDENTIFY UNITS

- Uniform areas
- Similar IAPs
- Topography
- Manageable size
- Fire history

3. PLAN ACTIONS

- IAP control methods
- Burning schedule
- Optimal sequence
- Seasons

4. CALCULATE COSTS

- Equipment needed
- Labour required
- Areas and norms
- Keep records

1 Survey the area

A suitably experienced person should survey the areas to be cleared and identify the IAPs that occur there. For very large areas, mapping of IAP coverage is essential, but for small sites it may not be necessary. It is best to walk the area to be mapped, and not just to rely on viewing the area from a distance or via an aerial photo. Photographs of the site should be taken to assist the process of monitoring the impact of the IAP management programme (see Mapping management units – What does this involve? page 23).

2 Identify units

Break the property down into sensible management units. A management unit is a uniform block of land, with similar soil, slope, history, etc. that will respond in a similar way to a management action. For IAP management, a management unit may be an area of uniform species, age classes and densities (and the potential for the use of fire as an IAP management method, if appropriate) (see Mapping management units – What does this involve? page 23).

Give each management unit a unique identification number. Compile an inventory for each management unit, including the density and age of IAPs.

3 Plan actions

Identify what management actions are needed in each management unit, taking into account the integration of fire and IAP management, if appropriate. Determine the sequence and which methods or combination of methods is best for the site and target species. Consider what field equipment and herbicides are required. Plan the order in which management actions should be implemented, taking into account the effect or advantage of implementing actions in a particular season (see 9 priorities when clearing IAPs, page 21).

Check with your local Fire Protection Association (FPA) to ensure that your operation has received approval from the relevant authorities.

4 Calculate costs

Using the information gathered on the size of the management units, the density of IAPs and selected control methods, calculate the labour required and the costs (see How much labour and budget will a land user need? page 26).

Land users should keep a note of all expenses incurred from IAP management as these are tax deductible.

For more information, see Appendix 5: Template for a farm-level alien plant control plan (page 66).

9 PRIORITIES WHEN CLEARING IAPs

It is often not possible to tackle all stands of IAPs at once. It is also important not to take on too much at one time, remembering that each area will require follow-up treatments. For this reason, it is useful to plan where to start by setting priorities.

1 Prevent new invasions

Target emerging or new species before they have a chance to set seed and spread.

2 Follow-up first

Areas that require follow-up treatment should be prioritised over areas that still require initial clearing. Follow-up treatment is essential to curb the further growth and spread of IAPs. Follow-up reinforces previous efforts in which you have already invested time and money, so it is important not to waste this investment. This also applies to an area that has recently been burnt: the fire acts as an initial clearing mechanism, so if these areas are prioritised, it will cost less to clear while the growth is young.

3 Limit wildfire risk

Areas of IAPs that pose a wildfire risk to houses or infrastructure should be targeted as a priority. Effective firebreaks should be created where woody or fire-prone IAPs are located in dense stands near settlements, power lines, etc.

4 Start with less dense stands

Treatment of low-density, young invasions should be a priority to halt the invasion and prevent the build-up of IAP seedbanks. This is especially important in fast-maturing, wind-dispersed species such as hakea and pine (*Pinus* species). Less dense areas will also require fewer resources and easier follow-up treatment. Dense mature stands should be left for last, as they probably will not increase in density or pose a greater threat than they do at present. Clearing very dense areas requires a commitment to expensive, long-term follow-up treatments.

5 Start upslope

Consider the natural gradient of the area being cleared. All operations should ideally follow the slope or drainage lines. Clearing needs to start from the highest point and move downstream and downslope. This ensures that potential sources of IAPs – seeds and other regenerative material – are eliminated upstream of the working area to avoid reinfestation.

6 Work from the outside inwards

On gentle gradients, clearing should start from the outside of a work block and move inwards towards the centre, to contain IAPs within a confined area.

7 Follow contours

To avoid the threat of soil erosion when clearing dense infestations of IAPs on steep slopes, work should progress horizontally along the contours. IAPs should be cut in bands of 3 m wide along the slope contour and the cut material should then be rolled back so that it forms a “frill” along the band. Openings between contoured stacks should be staggered to further reduce water run-off.

8 Focus on riparian areas

Rivers, streams and wetlands are a priority when planning the clearing of IAPs. IAPs often use a lot of water and can reduce water flow and quality if water systems are heavily invaded. Waterways also provide a way for IAPs to spread rapidly downstream.

9 Collaborate with neighbours

Collective management and planning with neighbours allow for more cost-effective clearing and maintenance. This reduces reinfestation. It also allows a more integrated approach with respect to fire and fuel-load management.

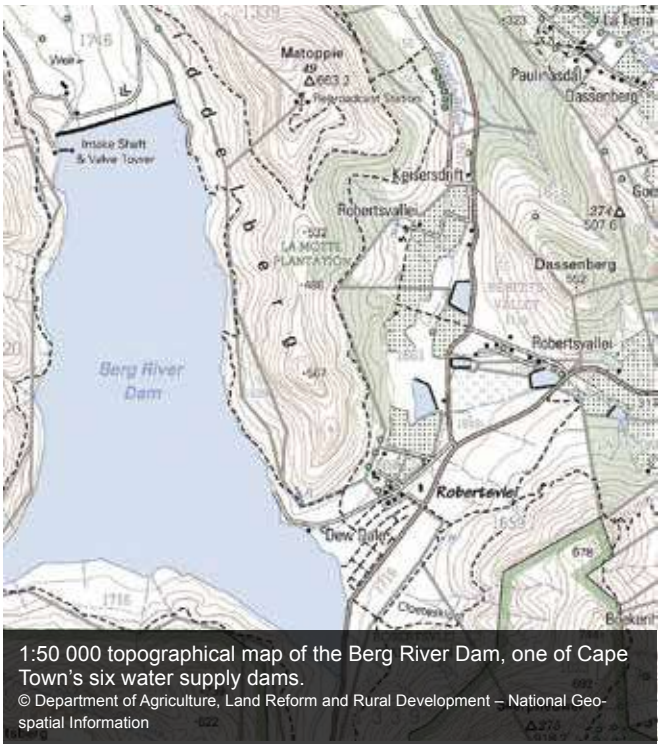
Cleared material stacked along contour lines. © Saskia Fourie / WWF

MAPPING – WHY IS IT ESSENTIAL?

Mapping skills are useful for anyone undertaking the management of IAPs. Maps such as topographical and aerial maps can help land users to understand the location of the area, its boundaries and the layout of the landscape to successfully plan and carry out the IAP management work.

Maps can be used to show where the IAP infestations are, and how management operations should be approached. They can also be used to schedule IAP control treatments and calculate costs.

TYPES OF MAPS NEEDED FOR PLANNING IAP MANAGEMENT



1:50 000 topographical map of the Berg River Dam, one of Cape Town's six water supply dams.

1:10 000 aerial photograph used for mapping invasive alien plants.

Topographical maps

A topographical map shows the layout (or the topography) of the land. It shows the height above sea level using contour lines, which also gives an indication of the slope of the land. This type of map is useful for assessing accessibility and walking time to an area. Rivers, roads and compass bearings are shown on these maps.[1]

It is advisable that a contractor has a topographical map of the area where the work is to be conducted.

Aerial maps

Aerial maps are made from photographs taken from aeroplanes, drones or satellites. These types of maps are easy to understand because they provide a picture and not just a line drawing of the area. But they give less detail than topographical maps. It is important to remember that you need to get the most up-to-date aerial map, as landscapes change over time due to fires, development, etc.

Free open source GIS software is available to anyone to view and manipulate spatial information, e.g. Quantum GIS, Google Earth.

For more information, topographical and aerial maps are available from the National Geospatial Information (NGI) agency (Appendix 9) (page 66).

[1] Deacon, G. and Harding, G. 2007. *Worksite Management Manual.*

MAPPING MANAGEMENT UNITS – WHAT DOES THIS INVOLVE?

Walk the area

Before starting the clearing work, it is essential to walk through the whole area in a set pattern. Walking the area will help to gather information about the IAPs on the land. This information can be used to map out management units.

Information will need to be gathered about:

Species

Managing IAPs cannot be done if the IAP species have not been identified. Only once the species has been identified can the appropriate IAP control methods be selected.

Growth form

How the IAP grows is known as its growth form or habit (see Types of IAPs – How do they differ? page 12). There are many different growth forms for plants, each with different control strategies.

Age classes

The age, stem thickness and height of the IAPs will determine the type of control method. The age of a plant is usually divided into the following classes:

- Seedling (diameter at ankle height: 0–15 mm)
- Young (diameter at ankle height: 16–50 mm)
- Adult (diameter at ankle height: > 50 mm)

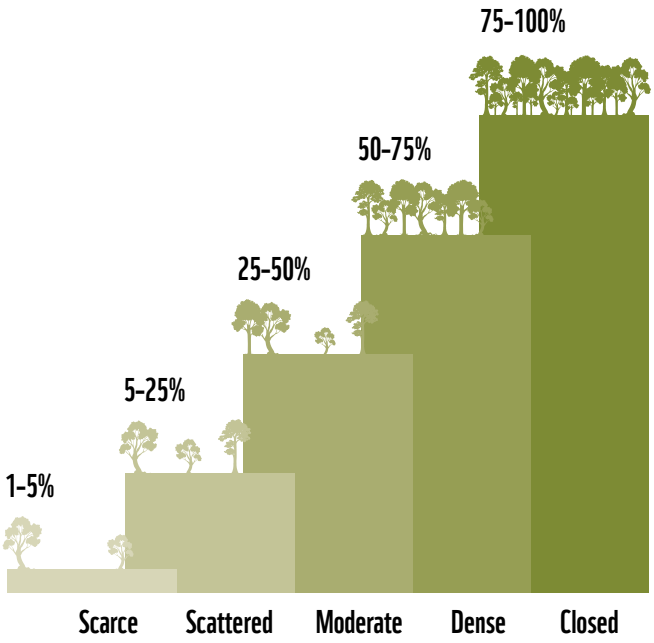
See IAP management methods (page 32).

Remember, height does not equate to age. Some mature plants do not grow very tall. Generally, anything lower than hip height is classified as a seedling.

Density class

The density of IAPs refers to how closely packed they are. It is measured by estimating the ground cover or the number of stems in an area. Density is usually expressed in percentage, ranging from 0% (no IAPs) to 100% (fully covered with IAPs). It is commonly estimated using simple visual methods to assess the coverage of each IAP species within a set area. The categories generally used are shown in Figure 1. Densities will be a significant determinant of how much time and money it will take to clear the area.

Figure 1: Density class categories for IAPs



Size of area

The size of the area, measured in hectares, will affect the number of working days needed to complete the treatment area. Integrated fire and IAP management may include smaller IAP management units within larger fire management units. In these cases, a fire management unit is an area that can be burnt in a prescribed burn. The rule of thumb is that the unit size is determined by what can be burnt in one day.

Ensure that the boundaries of the area to be cleared are visibly marked to orientate the team.

The information gathered on the species, growth form, age and density across the land will help to decide on management units. A useful management unit is one where the IAPs are of the same species, age and density. Then the most appropriate control treatment can be applied to each unit (see 4 steps to developing an IAP management plan, page 20). Also consider appropriate units for Integrated planning for fire and IAPs – Why is it important? (page 24).

For more information, see Appendix 6: Basic mapping skills (page 66).

INTEGRATED PLANNING FOR FIRE AND IAPS – WHY IS IT IMPORTANT?

Fire management and the management of IAPs are inextricably linked. The role of wildfire is central to planning IAP control as it presents both a threat to IAP management operations and an opportunity for IAP control.

Threat

Wildfire management is necessary to reduce fire hazards and control unscheduled wildfires that threaten property, crops, infrastructure and IAP management investments already made. In the absence of IAP control, successive wildfires in areas invaded by IAPs lead to densification and further invasion. This in turn increases fuel loads and rate of spread, fuelling a vicious cycle. Uncontrolled wildfires often defeat the purpose of mechanical and biological control. Only once a sound level of wildfire management is in place should alternate IAP control strategies be implemented and integrated.

Opportunity

Fire, with appropriate management, is a cost-effective IAP control method. Fire can be used to control IAPs and maintain optimal water yield in catchments. It is critical to understand the effect of fire as a driver in Fynbos and other fire-driven systems and recognise that fire may be used as an effective management tool.

Integrated planning is required to coordinate the management of fire and IAPs to take advantage of the opportunities and limit the threats. Planning firebreaks (fuel breaks) and treatment blocks, and being adequately prepared are essential for successful fire management. Land users should devise a joint strategy guided by both legal and practical management requirements. An understanding of fire ecology and the natural processes will further enhance land users' wildfire management capabilities. There are significant benefits to membership of a Fire Protection Association, which promotes and supports fuel-load management.

For more information, see Appendix 7: Fire Protection Associations in the Western Cape (page 66).

To set up integrated fire and IAP management, it is necessary to identify management units that can be subjected to planned burns. Management actions can then be scheduled in these units to optimise both ecological burning and IAP management at the right time. It is important to note that too frequent or unseasonal fires can have a significant negative ecological impact. It is also crucial to strive for a mosaic of different veld ages across the greater landscape.

For more information, see CapeNature's fact sheet Appendix 10: What a landowner needs to know about fire management (page 67).

A member of a fire management team in action. © Tessa Oliver

HOW TO PREPARE FOR AND MANAGE WILDFIRES

Landowners should take measures to prevent wildfires from starting and spreading to neighbouring land. They should be ready to manage any wildfire that occurs on the property.

Legislation

The requirements for fire prevention and preparedness are covered in the National Veld and Forest Fire Act 101 of 1998. There are penalties if landowners fail to follow these provisions (e.g. firebreaks, notification of intention to burn).

Invasive alien plants

Bringing IAP infestations under control is an important step towards preventing wildfires, as these fires burn hotter than Fynbos fires. Wildfires on IAP-infested land are very difficult to control, especially under dry, windy and hot conditions.

Firebreaks

A firebreak (fuel break) should be prepared and maintained around the property, or firebreak exemption should be sought. It should be wide and long enough to assist in managing a wildfire. It should also be reasonably free of flammable material that might carry a fire across it. The firebreak should not cause soil erosion.

Fire Protection Association (FPA)

The landowner should join the local FPA. Landowners should notify the FPA and neighbouring landowners about fires. Landowners should be ready to fight fires by acquiring equipment and having competent personnel available to fight fires, or appoint an agent to do so. In an emergency, fire services and FPA officials should be given permission to enter the land to fight fires.

For more infomation, see Appendix 7: Fire Protection Associations in the Western Cape (page 66).

A member of a fire management team using a drip torch to set fire to the veld. © Tessa Oliver

HOW MUCH LABOUR AND BUDGET WILL A LAND USER NEED?

The amount of labour (in person days) and the budget a land user will need will depend on the size of the area to be cleared of IAPs, the nature of the terrain, the species present and the age and density of the IAPs.

By mapping out management units, the area can be worked out in hectares (see Mapping management units – What does this involve? page 23). This information can be used to estimate labour (see Funding opportunities, page 64) and herbicide costs. Also see Figure 2.

Person days

Labour required for IAP management is measured in person days (Pd). A person day is the amount of work that one person can do in one day. The number of person days needed for certain species, ages and densities of IAPs have already been worked out and these norms are available on norm sheets.

> Norm sheets are available from the Department of Environment, Forestry and Fisheries Natural Resource Management Programmes offices.

To calculate person days, the area to be cleared (ha) is multiplied by the "norms". If working in a riparian area, add 50% to the total person days to include time for carrying out the material from the natural flood zone. If cutting and stacking is required, add an additional 20%.

The cost of labour can be calculated by multiplying the total person days by the cost per person per day. Every team's dynamics are different, so it is advisable to eventually work out one's own norms over time. Keep records of production against the norms and adapt the norms to local conditions.

Person days	=	area (ha) × norm
Cost	=	total person days × cost per person day

Herbicide cost

Herbicide norms appear on the herbicide norm sheets, which are included when the product is purchased, and are used to calculate herbicide requirements and costs. Herbicide cost is calculated by multiplying the area (ha), the density of IAPs, the litres of herbicide required according to the norm sheet, and the cost per litre.

Herbicide required	=	area (ha) × density (proportion) × dilution factor (ha/litre)
Cost	=	total litres required × cost per litre

Figure 2: Aspects that may influence the costing of an IAP management operation

Vegetation
- Species
- Density (coverage % or stems/ha)
- Area (ha)
- Height (m)
- Growth stage

Terrain
- Slope
- Access
- Transport costs

Herbicide
- Herbicide type
- Rate spray volume (per ha or %)
- Knapsacks/sprayers/nozzles
- Herbicide costs

Equipment
- Slashers/brush cutters
- Maintenance
- Equipment costs and depreciation

Labour
- Type (skilled/unskilled)
- Task rate (person days/ha)
- Number of labourers
- Availability
- Salaries/wages
- Benefits/bonuses
- Training costs

Programme
- Duration
- Number of treatments

For more information, see:
Appendix 3: Work sheet for field verification (page 66).
Appendix 4: Guidelines for clearing time (Person days/ha norms) (page 66).

An indigenous pincushion protea (*Leucospermum spp*.) in Kirstenbosch National Botanical Garden. © Helen Stuart / WWF

WHAT OTHER FACTORS SHOULD ONE CONSIDER FOR IAP MANAGEMENT?

In addition to the context, methodology and priorities, other factors may influence the methods, extent and location of an initial IAP management operation, and warrant consideration.

A chainsaw operator undertaking alien clearing in the Kouga River in the Eastern Cape, an important catchment for water supply to the Nelson Mandela Metro. © Rodney February / WWF

Combinations of control methods

An IAP control plan should integrate the various control methods to optimise effectiveness and limit environmental impact. Moderate to low IAP infestations in wetland areas, for example, can be treated by implementing controlled burning at the beginning of autumn, followed by mechanical removal or herbicide application in mid-spring (see IAP management methods, page 32).

Infestations in wetlands

Note that wetlands are protected by the National Water Act 36 of 1998 and the National Environmental Management Act 107 of 1998. No heavy machinery may be used to remove IAPs in wetland areas without prior authorisation from the relevant government departments.

Disposal of material

Disposal of the cut IAP material needs to be carefully considered. Whatever disposal method is selected must meet all the legal requirements and must not create a risk for residents and infrastructure (see How can one responsibly manage plant material? page 45).

Biomass potential

Dense stands of IAPs may have the potential to be harvested for additional value, e.g. timber, firewood, briquettes or biochar, or even fuel for boilers. Using biomass provides additional benefits, as reducing fuel loads improves fire safety and rehabilitation potential.

Indigenous vegetation

Natural vegetation – including individual indigenous trees located among stands of IAPs – must be protected from damage during the clearing process. Indigenous trees and vegetation can be cordoned off or marked using danger tape to make sure workers know what must be protected. This approach will reduce the long-term cost of managing invasive alien plants by reducing the need for active rehabilitation, and protecting the cleared area from erosion and regrowth. In very sensitive ecosystems, IAP clearing interventions should ideally be done during the dry season when the vegetation is less sensitive to disturbance.

Rehabilitation potential

If the intention is to rehabilitate the area, further restoration methods may be needed. If appropriate in terms of locality and wildfire risk, stands of alien trees can be used to create nursery stands for forest species. This may be managed by selective removal of alien trees to allow indigenous forest to emerge over time (see Long-term rehabilitation, page 58).

Labour considerations

Consider the possible seasonal availability of human resources (e.g. personnel shortage in spring and summer due to irrigation, harvesting and other activities). Also consider the level of skills required.

Practical considerations

Think about the location of the site, the distances to travel and the accessibility for machinery. Plan to use existing access roads.

Threat to pastures and planted crops

Think about how the IAP management operation may enhance the essential economic activity on the property.

Ability to follow up

Follow-up treatments will be needed to maintain the initial investment. Do not start clearing an area if you will be unable to follow up as this can make infestations worse. IAPs are quick to regrow in disturbed areas and often out-compete indigenous vegetation. Different follow-up schedules (e.g. in terms of timing, frequency and approach to follow-up treatments) may be required for different species.

Management history

Previous management actions in the area that you intend to clear could play a role. Understanding the fire and IAP management history of the site will help to choose the appropriate methods and sequence of treatments. Wildfires, for example, may stimulate Acacia seedbanks in areas where seed-limiting biocontrol methods are not yet present. This will determine the appropriate follow-up methodology and costs (see What is biocontrol? page 41).

Ongoing evaluation

Land users will need to continually evaluate the success of the IAP management operations and potentially adjust the methods used. Other species may invade after initial clearing – this is known as secondary invasion – which may require different management methods.

For more information, see CapeNature's fact file Appendix 8: A landowner's guide to planning alien control (page 66).

An active restoration site on the Meul River, a tributary of the Riviersonderend near Greyton in the Western Cape. © Rodney February / WWF

WHAT BASIC TOOLS ARE REQUIRED FOR IAP MANAGEMENT OPERATIONS?

Conducting an IAP management operation will require a basic set of tools and equipment. Further requirements may depend on the specific control methods used.

Table 3: Tools and equipment for IAP management operations

(also see Personal protective equipment – What does it include?, page 50)

Item	Supervisor	Machine operator	General workers	Herbicide applicator
First-aid kit (and maintenance)	✔			
Fire beaters	✔			
Wajax can[2]	✔			
Chainsaw		✔		
Chainsaw maintenance items Chain lube Fuel mix Chain Bar Sprocket Sparkplug Round files Flat files		✔		
Combi-can		✔		
Fire extinguisher[3]		✔		
Sharpening kit		✔		
Sharpening kit tool pouch		✔		
Axe Axe handles Sharpening stones			✔	
Bow-saw/pruning saw Blades			✔	
Lopping shears			✔	
Spray can hand-held			✔	
Drip tray or sheet		✔		✔
Measuring jug, bucket, container				✔
Knapsack maintenance Parts				✔
Knapsack sprayer				✔
Stopwatch				✔
Tape measure (> 30 m)				✔

[2] A specially designed, rugged knapsack with a pump action that has been developed to squirt water on a fire. Very effective in extinguishing small fires.

[3] A fire extinguisher must be kept at the refuelling area to extinguish fires that can start when petrol lands on the exhaust of a hot chainsaw.

CHECKLIST FOR AN IAP MANAGEMENT OPERATION

When embarking on an IAP clearing programme, land users should bear in mind certain general principles. This will help them to choose the appropriate clearing method, be it manual, mechanical, chemical, biological or a combination thereof.

10 POINTS TO REMEMBER WHEN CONDUCTING AN IAP MANAGEMENT OPERATION

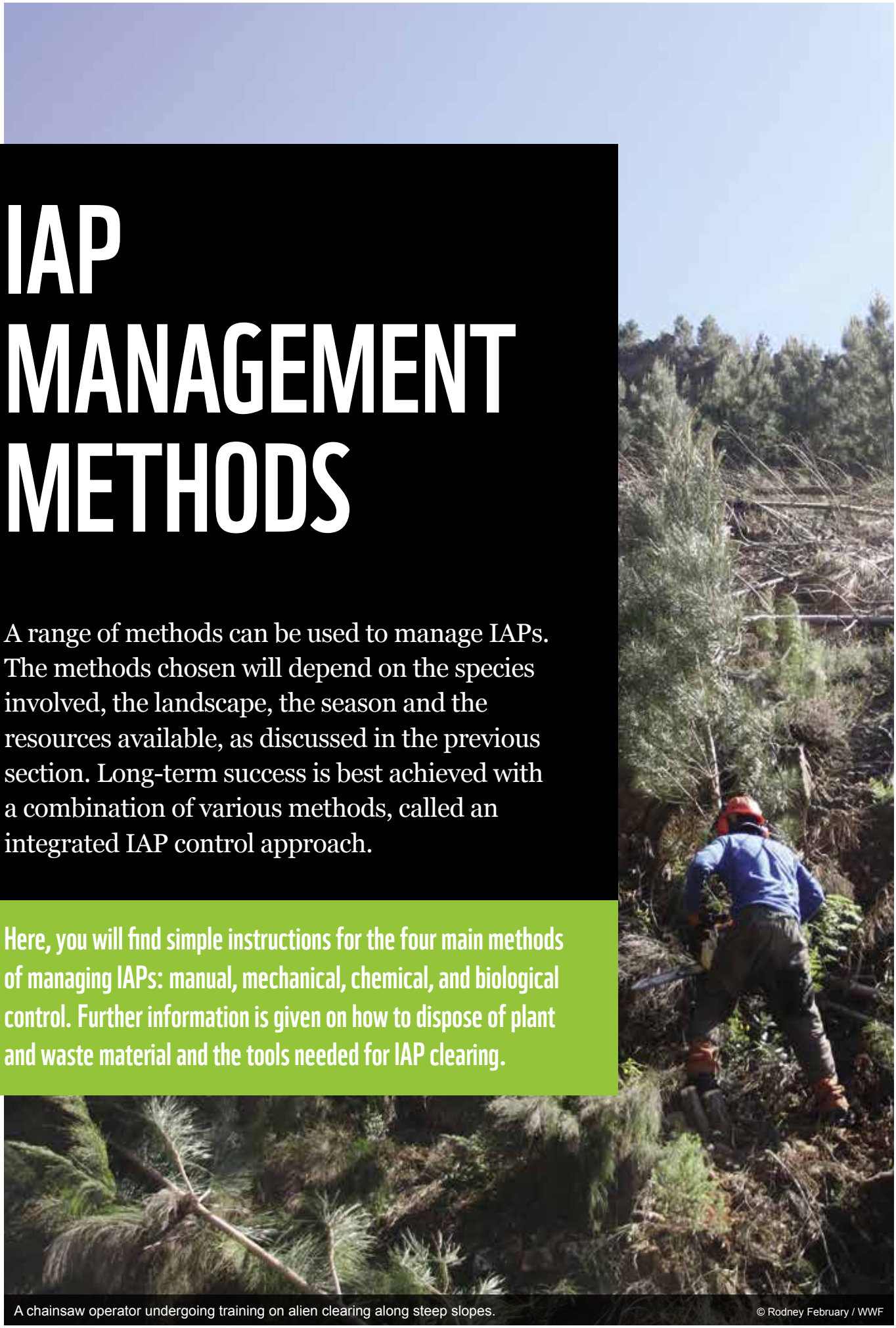
1. Always start at the highest point and work downwards, downhill or downstream.
2. Start from the edge of the infestation and work towards the centre.
3. Take care to prevent the spread of cuttings, which could take root further downstream.
4. Once plants have been removed, unstable slopes should be stabilised by erosion protection measures (such as geotextiles or other suitable material).
5. Keep accurate records of actions and costs to assist with future planning.
6. Control IAPs when the plants are young, rather than waiting until they are woody and difficult to remove by hand.
7. Manage IAPs before a wildfire burns the area, as the mechanical control thereafter is substantially more expensive (see Mapping – Why is it essential? page 22).
8. Set up an integrated fire and IAP management plan (see Integrated planning for fire and IAPs – Why is it important? page 24).
9. Take care to distinguish between young invasive species and Fynbos species (this could be difficult). Keurboom seedlings are remarkably similar to that of many acacia species seedlings.
10. Select the quickest and most effective way to efficiently kill a plant – time is money.

A Working for Water team untertaking slashing and stacking of the invasive weed lantana (*Lantana camara*). © LANDWORKS

IAP MANAGEMENT METHODS

A range of methods can be used to manage IAPs. The methods chosen will depend on the species involved, the landscape, the season and the resources available, as discussed in the previous section. Long-term success is best achieved with a combination of various methods, called an integrated IAP control approach.

Here, you will find simple instructions for the four main methods of managing IAPs: manual, mechanical, chemical, and biological control. Further information is given on how to dispose of plant and waste material and the tools needed for IAP clearing.



A chainsaw operator undergoing training on alien clearing along steep slopes.

MANUAL CONTROL OF IAPS – WHAT DOES IT ENTAIL?

Manual control is when a worker removes or kills each IAP through hand pulling, cutting, digging out, ring barking or bark stripping. Because it is so labour intensive, it is best used for lighter infestations, seedlings, single plants, plants that have shallow roots, or in very sensitive areas.

Hand pulling

Hand pulling is most effective when plants are small (30 cm), immature or shallow-rooted, and after rain.

- Use a pair of gloves and grip the plant firmly around the stem just above the root.
- Pull hard and remove the plant, roots and all.
- Kicking around the root area of the plant may help to loosen the root system, making it easier to pull out the plant.
- Shake the excess sandy material from the plant to ensure a higher mortality rate and make the plant easier to stockpile and lighter to transport.

Cutting

Chopping or slashing is most effective for young plants that are too large to pull out by hand, or for plants that have woody stems. It is best used on plants that are not resprouters. In the case of resprouters (coppicing), chopping must be combined with chemical treatment of the cut stumps.

- Use implements such as pangas (slashers/machetes), handsaws, bow-saws and axes to cut plants down as low as possible.
- Remember to wear protective clothing and keep team members at least two arm-lengths apart (see Health and safety, page 46).
- Stack removed material into piles of 2 m high and 3 m wide.

A team using the technique of cutting close to the ground combined with bark stripping, which eliminates the use of herbicide.

Digging out

Digging out IAPs involves the use of tools like hoes, sticks, tree poppers or spades. The entire plant and root must be removed.

- 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.
- Stack removed material into piles of 2 m high and 3 m wide.

Ring barking

Since this method means the tree is left standing, it is recommended only for single trees or very low-density invasions, not for stands. Ring barking on smaller diameter stems is ineffective and it would be quicker to just cut the tree down. Ring barking should be used on trees with stem diameters greater than 150 mm, where the time taken to fell, de-branch and stack would be excessive. Basal bark treatment could be considered as an alternative in some cases (see Chemical control of IAPs – What does it involve? page 36).

- Slashers or axes should be used for debarking.
- Remove the bark and cambium (outer rings where the trunk grows) in a continuous band around the trunk of the tree at least 25 cm wide, starting as low as possible.
- Where clean debarking 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, combine with bark stripping (right).

Bark stripping

Bark stripping is the removal of bark from the trunk between ground level and up to 1 m above ground. A suitable herbicide can be applied along 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 paint brush.

Bark stripping, ring barking and frilling should not be used as methods on any trees located next to rivers or infrastructure. Treated trees that are either dying or dead could fall into rivers and block the flow of water, or cause damage to infrastructure such as roads, fences, buildings and power lines.

Bark stripping removes the phloem layer of the plant, which will cause the tree to die over time. © Rodney February / WWF

Ring barking is used for larger trees. © Saskia Fourie / WWF

MECHANICAL CONTROL OF IAPS – WHAT ARE THE OPTIONS?

Mechanical control involves the use of machinery to clear IAPs and is often the most effective for larger individual plants. Cost effectiveness, personnel competency and safety remain important considerations.

Bulldozers

Although machines like bulldozers can bring additional strength to clearing more stubborn infestations, the use of heavy machinery has serious limitations:

- The disturbance to the soil and vegetation will lead to loss of natural biodiversity.
- Bulldozers create a fresh seedbed for germination of more invasive species.
- There are also unforeseen impacts caused by compacting the soil.

Because of these limitations, laws protecting natural veld, riparian areas and wetlands only allow heavy machinery to be used in areas that are already disturbed (e.g. cultivated lands, firebreaks and road verges).

Bulldozers have been used for IAP clearing with varied results.

- Use of machinery for IAP clearing must be compliant with the relevant legislation.
- The blade should be kept 15 to 20 cm above the ground to catch and push plants without gathering too much soil.
- The mix of soil and plants that is created makes disposal of plant material difficult and costly. Stacking into rows is the best option (see How can one responsibly manage plant material? page 45).

Felling equipment

Felling is appropriate where trees can be cut down and removed using chainsaws, bow-saws, brush cutters or slashers. Where trees cannot be removed (on steep slopes), it is better not to fell trees, but rather to control them where they stand. Where possible, large trees should be felled so that they fall uphill. Cut trees should be debranched.

Take wind direction into account when felling large trees with chainsaws. Always start downwind.

Heavy rollers

Heavy-duty forestry rollers are used to mulch plantation waste after clear-felling. They have been usefully applied to IAP clearing as part of a combined programme where fire is also used. The heavy roller can be used after fires on medium to dense stands of young saplings (saplings up to 2 m in height and < 30 cm in diameter). Fire can also be used to remove the flattened material.

Heavy machinery can be used in various ways to help dispose of plant waste from IAP clearing, such as by chipping or stacking (see How can one responsibly manage plant material? page 45).

A chainsaw operator felling a pine tree in the Vyeboom Wetland in the Theewaterskloof catchment. © Rodney February / WWF

CHEMICAL CONTROL OF IAPS – WHAT DOES IT INVOLVE?

Chemical control makes use of herbicides to kill target IAPs by foliar application, blanket spraying, aerial application or cut stump treatment. Other chemical methods are chemical frilling, basal bark treatment and stem injection.

A herbicide is a substance that is toxic to plants, either killing the plant or interfering with its growth. Several effective herbicides are available. Herbicides are usually applied to IAPs using special equipment such as knapsacks with spraying nozzles.

Chemical methods are a good choice when the IAPs are still seedlings or young. At this stage of a plant's life it is growing fast, so herbicides will be quickly translocated through the plant to reach the roots. The leaves and stem are young and green with a large surface area, allowing for good absorption of the herbicide.

Chemical control should not be applied when it is raining. It is important to note that herbicide can also harm many non-target species and must always be used with the greatest of care. Wetlands require special care and only herbicide appropriate for wetlands should be used.

Foliar application of herbcide using the correct PPE. © Peter Emsile

Foliar application of herbicide. © Peter Emsile

Foliar treatment

Foliar treatment is when herbicide is applied to the leaves of the plant, usually by spraying.

- Spray herbicide with a knapsack sprayer, mist-blower or high-pressure sprayer firefighting unit, e.g. a bakkie-sakkie.
- The correct choice of nozzle is important to achieve an even spray cover.
- The best results can be expected in the active growing season (but some species are more susceptible to chemical absorption when they are sprayed in summer).

Blanket spraying

Blanket spraying, or broadcast spraying, is when herbicide is sprayed across an entire area of over 70% infestation. While this method is recognised, it should be used with a high level of caution due to the significant environmental risk. It is the most cost-effective way to eradicate young, dense, uniform stands of IAPs. Some IAPs, like introduced acacias, germinate by the thousands after fire. The first line of attack to reduce these numbers is the use of broadcast spraying. Calibration is crucial to ensure even distribution of herbicide over the target area (see What you need to know when calibrating your equipment, page 40, and Herbicide safety, page 52).

For more information, see Appendix 11: Choice of nozzles for invader plant control (page 67).

Aerial application

Aerial application is spraying either large-scale infestations or targeted inaccessible plants from an aircraft. While aerial application is a recognised method of IAP control, it is still under development and should be used with a high level of caution due to the significant environmental risk. Aerial spraying can only be done by registered and certified operators according to strict regulations. The pilot must ensure that the spray mixture is distributed evenly over the target area and that the wastage of herbicide, as well as drift onto indigenous species, is kept to a minimum. It is essential that the following criteria be met:

- Inform your neighbours well in advance before spraying commences.
- Use only an aerial registered product. Port Jackson (*Acacia saligna*) and rooikrans (*Acacia cyclops)* have herbicides registered for aerial application.
- Adult Port Jackson and rooikrans must be sprayed in summer (i.e. November–March) for optimum results.

Applying herbicide from a helicopter using the wand method is the most targeted, although it is still under development. © Andrew Turner

Any aerial application of herbicide needs to be certified for in-field use. © Andrew Turner

Cut stump treatment

Applying herbicide to cut stumps is a highly effective method for larger woody IAPs.

- Fell the target tree horizontally and as low as possible to the ground.
- Ensure a smooth cut surface to expose the cambium (outer rings where the trunk grows).
- Clear around the cut stump to expose side branches that also need to be cut and treated.
- Spray the herbicide mixture at a very low pressure on the freshly cut surface.
- Treat only the outside cambium layer for stumps with a diameter larger than 10 cm.
- Apply the herbicide mixture as soon as possible after the tree has been felled.
- When using a product that is mixed with penetrant oil, the entire stump and exposed roots must be treated.

The correct application of herbicide for cut stump treatment. © Peter Emsile

The correct method for the chemical frilling of trees. © Peter Emsile

Application of herbicide once the frill has been completed. © Peter Emsile

Chemical frilling

The frill method can be used to kill standing trees where felling is too difficult. Frilling refers to a series of downward cuts made in the bark around the tree.

- Use an axe to frill trees smaller than 10 cm in diameter. A chainsaw can be used for larger diameter trees, but take care to ensure that the chain is sharp because cauterising the cambium layer can prevent absorption of the herbicide.
- The cut must penetrate the bark and must be deep enough to reach the cambium layer.
- The cuts must be made horizontally and as close to the ground as possible.
- Enough herbicide must be sprayed into the cut to ensure that it runs down to the cambium layer.
- The entire circumference of the tree must be treated.

Basal bark treatment

Basal bark application can only be carried out with an oil miscible product. Oil miscible products are formulated with penetrant oil, which acts as a carrier that moves the herbicide through the bark to the cambium and eventually to the roots. Young trees and shrubs with green bark can be treated while standing with no need for felling.

- Spray the herbicide onto the stem.
- Ensure wetting of the root crown, exposed roots and stem up to a height of 0,5 m.
- Low-pressure spraying or stem paint is required to minimise spillage onto the soil.
- The entire circumference of the trunk must be treated.

Basal bark application of herbicide. © Peter Emsile

Stem injection

This treatment, whereby the chemical is directly injected into the base of the plant, is only used for prickly pear (*Opuntia* species), but is still under development. Methods suitable for use on woody species are being investigated.

9 THINGS YOU NEED TO KNOW WHEN APPLYING HERBICIDES

1 Registration

Only herbicide products registered for the particular IAP species being treated must be used.

2 Safety

Appropriate protective clothing must be worn and should be changed and washed regularly. Clothing should be removed immediately if grossly contaminated. Hygiene aids – clean water, soap, towels and eyewash – must always be available to spray operators (see Herbicide safety, page 52).

3 Weather

Application should not be carried out during unfavourable weather such as rain, wind or hot, dry conditions. Weather conditions could affect the ability to control the spread of herbicide and endanger desirable vegetation, water bodies or personnel. Poor results may be achieved if the target plants are not in a suitable condition for treatment – this includes plants that are either water stressed or waterlogged.

4 Drift

Caution must be observed to limit wind drift when using minimum output nozzles.

5 Inspection

Equipment should be inspected regularly between and during applications. Ensure that the correct nozzles are fitted and that pressure settings are checked regularly.

6 Filling

Always ensure that knapsacks are filled to the desired level (generally only 95% of the tank volume). Ensure that there is a sufficient quantity of water on site to prevent operators from running out of spray water.

An example of a herbicide camp in the field. © Rodney February / WWF

7 Spillage

Spillage must be attended to immediately and appropriately disposed of. Where spillage occurs in a storage facility with a hard surface, the following steps should be followed:

- If available, an appropriate spill kit should be used to clear up the spill.
- Alternatively, contain the spillage with lime sand or a suitable material. Never use sawdust, as this could lead to spontaneous combustion.
- Bag and dispose of the material using a reputable hazardous waste disposal company.

If a spill occurs at a clearing site:

- Bag the spill material in thick plastic bags and take it off-site.
- Dispose of the bagged material in the same way as for a spill in the storage facility.

8 Repairs

Leaking sprayers or sprayers not applying correctly should be withdrawn until repairs have been carried out. Spare applicators and parts should always be available so as not to impede operations.

9 Cleaning

Equipment must be emptied and cleaned thoroughly after spraying. The spray mixture must not be left in the apparatus overnight.

Do not under any circumstances use metal objects to clean clogged spray nozzles, as this will cause damage, affecting the flow rate, spray pattern and droplet size. Use a soft bristled brush or compressed air to clean.

Spray water that is left over after cleaning the sprayers can be sprayed out on dense stands of IAPs, but remember to respray the area the next day with the correct concentration.

Important tips to remember

- Herbicide mixing and refuelling must be conducted on a spill blanket.
- A spade must be on-site to deal with any accidental spillage.
- Keep spill kits at hand when working with hydrocarbons.
- Do not decant or mix herbicide near water bodies.
- Do not rinse herbicide equipment in water courses.
- Do not use metal objects to clean clogged spray nozzles.

THE DOS AND DON'TS OF CHEMICAL CONTROL

WHAT TO DO

- ✔ Plan the use of herbicides before the operation starts.
- ✔ Wear the appropriate safety clothing (see Personal protective equipment – What does it include? page 50).
- ✔ Use only approved herbicides.
- ✔ Only use designated knapsacks or spray bottles.
- ✔ Follow the manufacturer's instructions.
- ✔ Mix herbicide according to the label.
- ✔ For some species, an adjuvant (wetter, spreader, sticker) will be added to the spray mixture to increase the efficacy of the herbicide.
- ✔ Spray when plants are actively growing.
- ✔ Spray when the leaves are dry.
- ✔ Apply spray mixture to the entire leaf surface including green stems and branches.
- ✔ Add dye to the spray mixture to prevent over-spraying.
- ✔ Keep herbicide in a demarcated area at the spraying site, out of direct sunlight.

WHAT NOT TO DO

- ✘ Do not spray without the appropriate personal protective clothing and the correct equipment.
- ✘ Do not spray during wind, or when there is a likelihood of spray drift.
- ✘ Do not apply herbicide in the rain or on wet, damp leaves.
- ✘ Do not spray when the temperature exceeds 30 ^{0}C.
- ✘ Do not spray plants that have signs of drought stress, frost damage or have not fully developed after winter dormancy.
- ✘ Do not spray plants that are above hip height.

Cut stump herbicide application using the correct PPE.
© Rodney February / WWF

The correct set-up of a herbicide storage camp in the field.
© Guy Deacon

WHAT YOU NEED TO KNOW WHEN CALIBRATING YOUR EQUIPMENT

Calibration is the adjustment of spray equipment in order to deliver the recommended volumes of water and herbicide, taking into account the operator or machine speed across the terrain to be treated. All spraying equipment must be correctly calibrated to obtain best results and prevent wastage. Calibration is needed for every knapsack since equipment and nozzles differ. The calibration results from one knapsack cannot be used for other knapsacks.

Calibration should be carried out on site and checked frequently during application. The following should be checked:

- Correct spray pressure
- Correct nozzle size and spray pattern
- Correct nozzle output (delivery rate in litres per hectare, suggested in the herbicide label)
- Volume of application over a specific area.

WHAT IS BIOCONTROL?

Biological control, or biocontrol, is bringing in natural enemies of an IAP from their country of origin. The natural enemies will feed on and damage the IAPs, making them easier to manage and reduce the rate of spread.

Biocontrol is a good management option for several reasons:

- It is environmentally responsible as it does not cause pollution and only affects the target plant.
- It does not disturb the soil or create large empty areas where other IAPs could invade.
- Biocontrol can be self-sustaining without the need for ongoing management.
- It is a cost-effective option that is often a key part of an integrated control plan.

BIOCONTROL AGENTS

The natural enemies used in biocontrol are called biocontrol agents. They are usually plant-feeding insects, mites or plant diseases. Biocontrol agents may control an IAP in different ways, e.g. by damaging vegetative growth, or by lowering the number of seeds produced.

More than 700 biocontrol agents have been tested and released around the world. Biocontrol agents are host specific. This means they only feed on the target IAP, and cannot survive by switching to indigenous plants or crops.

If the target IAP population eventually dies out, the introduced biocontrol agents will die out with it. It is sometimes necessary to establish small reserves of healthy, mature IAPs on which the agents can survive and spread to IAPs that may have escaped the clearing process.

Galls formed as a result of *Dasineura rubiformis*, the biological control agent for black wattle (*Acacia mearnsii*). Female midges lay their eggs in the flowers and the flowers become galled rather than going on to produce bunches of seed pods.

SAFETY REGARDING THE USE OF BIOCONTROL

The use of living organisms is never entirely risk free, but modern methods of biocontrol are very safe. Biocontrol has been used for over 100 years in South Africa. It has become an accepted and common practice in many countries. There are safety measures in place to ensure that biocontrol does not harm natural ecosystems.

Scientific research

There is a lot of scientific research on biocontrol. Biocontrol scientists are constantly working to expand and build on the current knowledge. They publish their research in reputable scientific journals and share their results at international conferences. Biocontrol scientists are careful to maintain their excellent safety record.

Choice of agents

Biocontrol agents are very carefully selected before release. They are usually chosen to be specific to the target IAP, so they cannot harm any other plants. There have been advances in molecular techniques that have made host-specificity testing more accurate and less time consuming.

Testing

Before any biocontrol is carried out, rigorous scientific safety tests are conducted under strict quarantine. It may take several years to test a single biocontrol agent before it is released.

Regulation

Different countries have different regulatory processes for biocontrol. Regulations are used to decide whether or not a biocontrol agent is safe for release in a particular country. Scientists and regulators are getting better at weighing up the risks and benefits. Usually, approval from the relevant authority is required before biocontrol agents are released.

THE BENEFITS OF BIOCONTROL

Around the world, the benefits of biocontrol are impressive. Biocontrol has been responsible for ending some very damaging IAP invasions. It is also more cost effective than many other IAP control methods. It was estimated in 1998 that biocontrol programmes had already saved South Africa R1,38 billion in IAP control costs. However, biocontrol agents can have varying degrees of effectiveness.

Complete control

Some biocontrol agents have been very successful at suppressing the target IAPs. When biocontrol is successful, it can sustain this benefit for decades, without any further investment or management.

Management aid

Biocontrol agents can help to reduce the density or spread of IAPs to a more easily managed level. These invasions can then be addressed using other control methods. The land user must then consider how best to integrate the use of the biocontrol agents with other control methods.

Limited effect

There are some instances where a biocontrol agent does inflict damage on the IAPs, but it is not enough to bring the invasion under control. In a few cases, biocontrol agents fail to become established in the introduced environment. A suitable biocontrol agent may not be available for some IAPs.

Long term

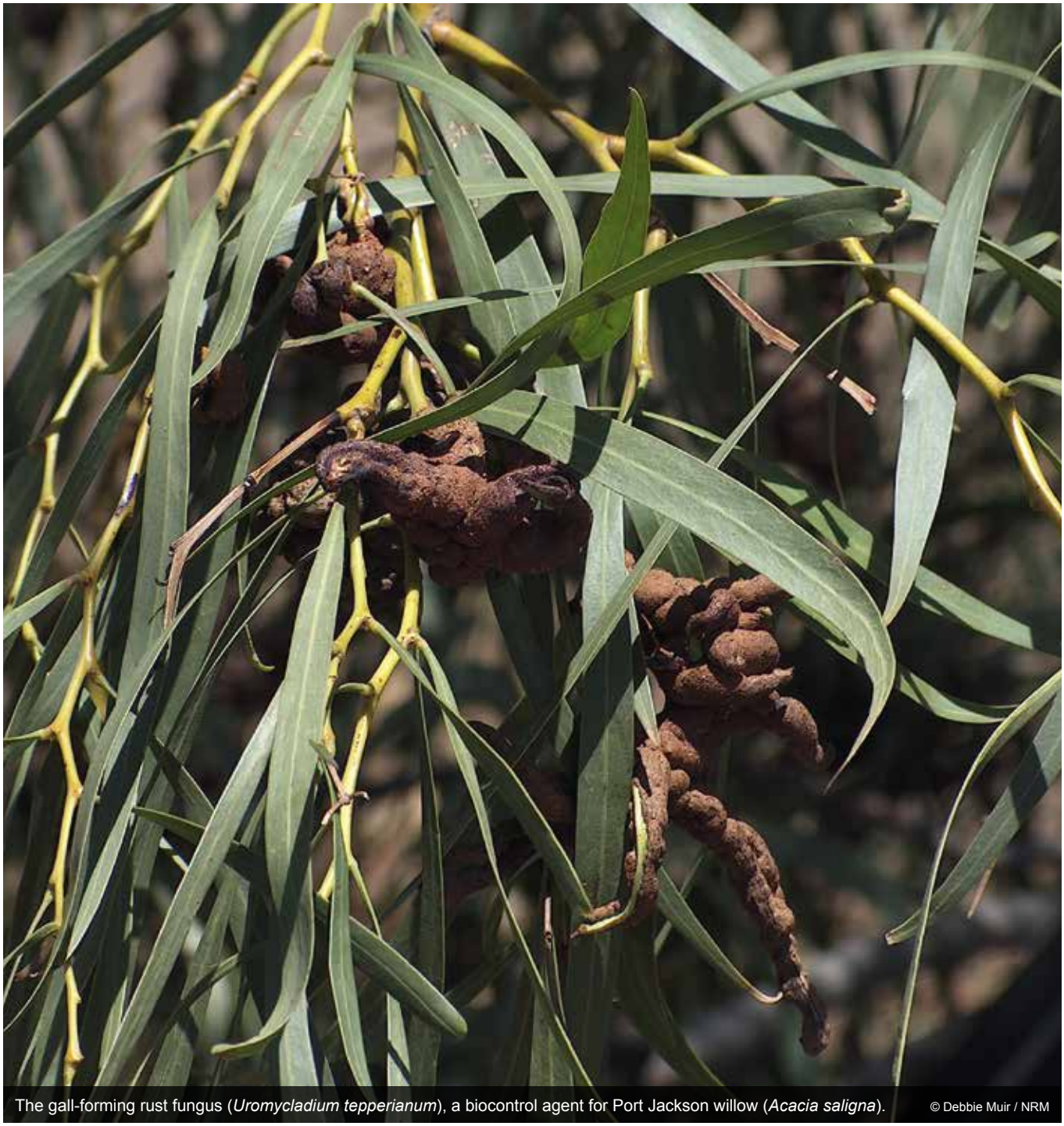
It is important to understand that biocontrol is often a long-term strategy. It is usual for biocontrol agents to take 10 to 20 years to build up large enough numbers to control the target IAPs. Often, biocontrol has been discounted too early because the IAP problem is not solved within a few months or years.

Dr Alan Wood of the Agricultural Research Council applying the biocontrol stink bean fungus spores to stink bean plants in the field.

EXAMPLES OF BIOCONTROL AGENTS IN SOUTH AFRICA

Over the years, several biocontrol agents have been approved and released for IAPs in South Africa (Table 4 on the next page). Some invasive alien plants are at present under effective biological control. In these instances, further time and money need not be wasted on additional clearing methods. Examples are:

- Silky hakea (*Hakea sericea*) in areas where the climate enhances gummosis disease and other agents;
- Sesbania (*Sesbania punicea*) after the introduction of all three insect agents;
- Red water fern (*Azolla filiculoides*) which has been brought under control by a frond-feeding weevil;
- Harrisia cactus (*Harrisia martinii*) after the establishment of the mealy bug;
- Australian pest pear (*Opuntia stricta*) after the establishment of cochineal.



The gall-forming rust fungus (*Uromycladium tepperianum*), a biocontrol agent for Port Jackson willow (*Acacia saligna*). © Debbie Muir / NRM

Table 4: Biocontrol agents and their effectiveness

Biocontrol agent	Year introduced	Damage to plant	Comments
Silky hakea (*Hakea sericea*)			
Erytenna consputa (seed-feeding weevil)	1970	Extensive	
Carposina autologa (seed-feeding moth)	1970	Moderate	
Cydmaea binotata (leaf/shoot-boring weevil)	1979	Trivial	
Aphanasium australe (stem-boring beetle)	2001	Moderate	Limited in distribution and destroyed in areas prone to wildfires
Dicomada rufa (flower bud-feeding weevil)	2006	Moderate	Established only in the southern Cape to date
Colletotrichum acutatum (gummosis fungus)	Indigenous	Considerable	Performs best in wet cold conditions
Rock hakea (*Hakea gibbosa*)			
Erytenna consputa (seed-feeding weevil)	1979	Trivial	Negligible, but priority species for future biocontrol
Carposina autologa (seed-feeding moth)	1979	Trivial	
Port Jackson willow (*Acacia saligna*)			
Uromycladium morrisii (gall rust fungus)	1987	Extensive	Control almost complete; around 85% of adult plants killed
Melanterius castanaeus (seed-feeding weevil)	2001	Considerable	Seedling regrowth problems
Long-leaved wattle (*Acacia longifolia*)			
Trichilogaster acaciaelongifoliae (bud-galling wasp)	1982	Extensive	Almost complete control achieved
Melanterius ventralis (seed-feeding weevil)	1985	Extensive	
Golden wattle (*Acacia pycnantha*)			
Trichilogaster signiventris (bud-galling wasp)	1987	Extensive	Almost complete control achieved
Melanterius maculatus (seed feeding weevil)	2005	Moderate	
Baileys wattle (*Acacia baileyana*)			
Melanterius maculatus (seed-feeding weevil)	2006	Trivial	*D. pilifera* first released and established in 2016
Dasineura pilifera (bud-galling midge fly)	2016	Too early to tell	Site destroyed by fire; new releases in 2019
Pearl acacia (*Acacia podalyriifolia*)			
Melanterius maculatus (seed-feeding weevil)	2008	Trivial	
Black wattle (*Acacia mearnsii*)			
Melanterius maculatus (seed-feeding weevil)	1995	Moderate	Both agents have most impact in winter rainfall regions
Dasineura rubiformis (flower-galling fly)	2001–06	Extensive	Establishment and impact far less successful in summer rainfall regions
Silver wattle (*Acacia dealbata*)			
Melanterius maculatus (seed-feeding weevil)	2001	Moderate	Moderate in the Western Cape, trivial elsewhere
Dasineura pilifera (flower-galling fly)	2018	Unknown	The fly is a new introduction
Green wattle (*Acacia decurrens*)			
Melanterius maculatus (seed-feeding weevil)	2001	Moderate	Moderate in the Western Cape, trivial elsewhere
Australian black wood (*Acacia melanoxylon*)			
Melanterius maculatus (seed-feeding weevil)	1986	Extensive	Majority of seeds destroyed
Rooikrans (*Acacia cyclops*)			
Melanterius servulus (seed-feeding weevil)	1994	Extensive	High proportion of seeds destroyed (96% or more at many sites)
Dasineura dielsi (podlet-galling midge fly)	2002	Considerable	
Australian myrtle (*Leptospermum laevigatum*)			
Aristaea thalassias (leaf-mining moth)	1996	Trivial	Both agents are abundant but control is negligible
Dasineura strobila (bud-galling midge fly)	1994	Trivial	
Red sesbania (*Sesbania punicea*)			
Trichapion lativentre (bud-feeding weevil)	1970	Extensive	Complete control in most areas
Rhyssomatus marginatus (seed-feeding weevil)	1984	Extensive	Some isolated patches need weevils introduced
Neodiplogrammus quadrivittatus (stem-boring weevil)	1984	Extensive	
Stink bean (*Paraserianthes lophantha*)			
Melanterius servulus (seed-feeding weevil)	1989	Considerable	High levels of seeds destroyed at many sites
Uromycladium woodii (gall-forming rust fungus)	2016	Unknown	
Mesquite (various hybrids of *Prosopis* species)			
Algarobius prosopis (seed-feeding weevil)	1987	Considerable	High levels of seeds destroyed by *A. prosopis* but control is negligible
Neltumius arizonensis (seed-feeding weevil)	1993	Unknown	

HOW CAN ONE RESPONSIBLY MANAGE PLANT MATERIAL?

Invasive alien plant clearing produces large amounts of dead and dying plant material. An excessive amount of plant material can present a fire hazard and, if washed down rivers, can damage infrastructure and riverbanks. This plant waste needs to be responsibly disposed of.

Make use of the waste

Plant material should be used beneficially wherever possible. This includes a wide range of options like charcoal, timber, or even using the cut material to generate electricity where facilities are available. It may be possible to use some material for basket making or animal feed. Wood can be made available to the local community for firewood. This use can offset the costs of IAP management or create a local economic opportunity. However, care must be taken not to distribute seeds or vegetatively growing material (e.g. *Cactus cladodes*) as it could give rise to new infestations.

Chipping and composting

Woody and dry material can be chipped and used as mulch, but beware of the risks of using chips that may contain IAP seed. Wet material and aquatic weeds should be combined with other organic matter and composted. Composting is not appropriate if the material contains seeds. Chipping can also be used to make a range of products, such as pellets for animal feed or fertiliser.

Burning on site

Burning the material on site presents risks that need to be managed appropriately. Burning should only be attempted by suitably (in terms of the relevant legislation) equipped and competent personnel. Material can be stacked in several ways before being burnt (see Integrated planning for fires and IAPs – Why is it important? page 24).

Landfill

Material that cannot be used, stacked or burnt must be disposed of at a registered and approved disposal site. Plant material can take up valuable space in a landfill, so other disposal options are preferable first. When removing material, take care to remove all debris, including shoots and seeds.

Stacking

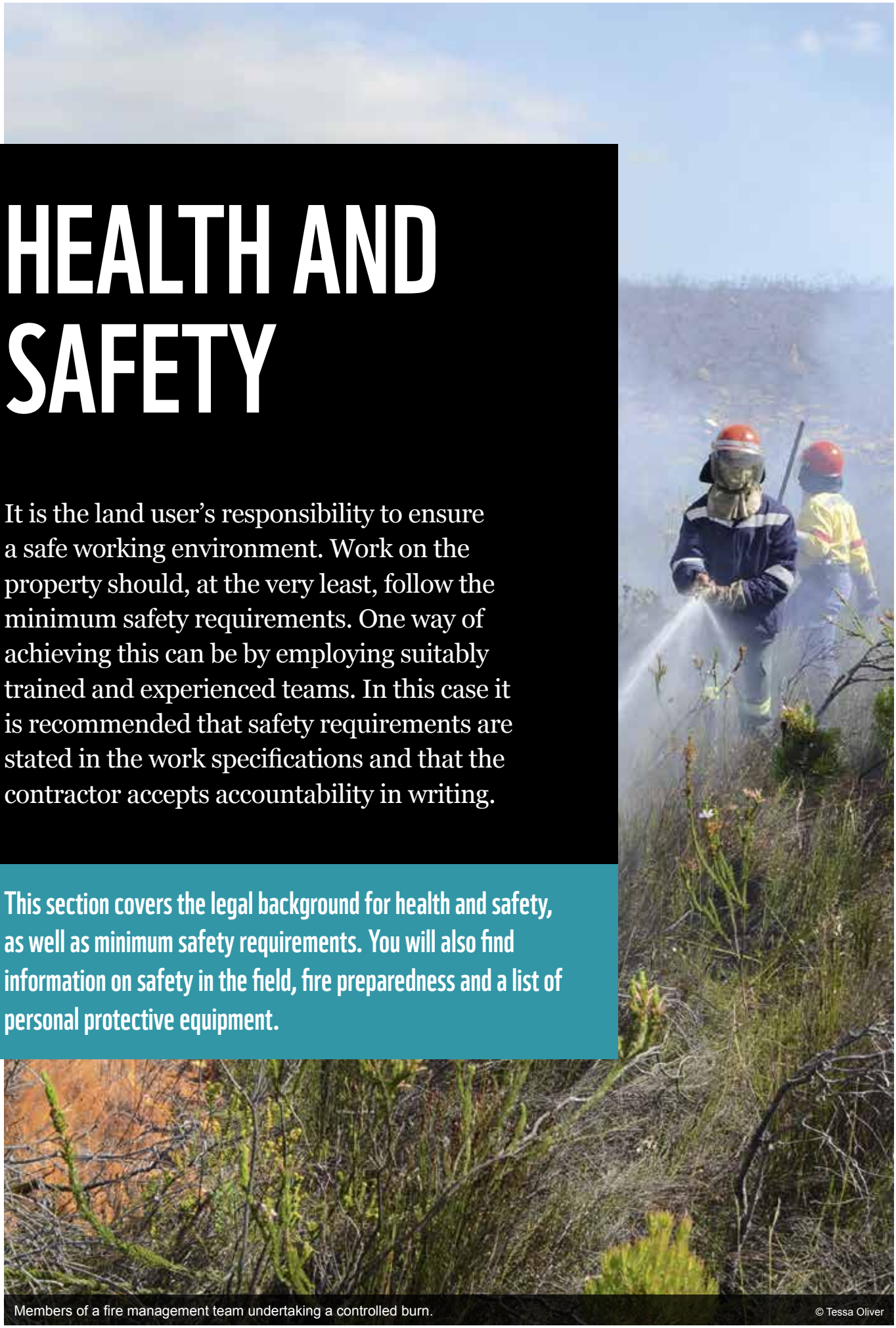
Stacking the cut material in heaps or windrows along mountain contours can help to reduce erosion. This also facilitates easy access for follow-up, and assists in containing the fuel load and reducing the risk of uncontrolled wildfires. The stacking method will depend on the IAP species, the clearing methods used, the habitat and the fire history of the invaded area.

- Stack removed material into piles of 2 m high and 3 m wide.
- Keep stacks well apart to prevent fires from crossing, not less than 10 m apart – this is naturally dependent on the size of the stack and the resulting fire intensity when the stacks burn.
- Stack light branches separately from heavy timber (diameter of 150 mm and more) – this helps if communities are dismantling stacks for firewood.
- Preferably remove heavy branches to reduce long-burning fuel loads that can result in soil scars from intensely hot fire, and the need for increased fire surveillance after burning.
- Stack brushwood rows along the contour if on a slope.
- Do not make stacks under trees, power and telephone lines, within 30 m of a firebreak or near water courses, houses and other infrastructure.
- Distribute the team along natural open areas for stacking as productivity will be improved if workers are not working too close to one another. In this way they will not get in one another's way and will be able to stack more freely and safely.

HEALTH AND SAFETY

It is the land user's responsibility to ensure a safe working environment. Work on the property should, at the very least, follow the minimum safety requirements. One way of achieving this can be by employing suitably trained and experienced teams. In this case it is recommended that safety requirements are stated in the work specifications and that the contractor accepts accountability in writing.

This section covers the legal background for health and safety, as well as minimum safety requirements. You will also find information on safety in the field, fire preparedness and a list of personal protective equipment.



Members of a fire management team undertaking a controlled burn. © Tessa Oliver

WHAT ARE THE MAIN PILLARS OF HEALTH AND SAFETY LEGISLATION?

IAP management involves manual labour with dangerous machinery and hazardous chemicals. It is important that everyone understands the risks and responsibilities. Taking the necessary measures to ensure health and safety makes the difference between a high-risk and a risk-free work environment.

In South Africa, the most important legislation for health and safety is the Occupational Health and Safety Act 85 of 1993 (OHSA). The two main pillars of this Act are:

1 Employer duties and responsibilities

Employers are responsible for making sure that all employees understand the risks and hazards in the workplace. Communication is critical under the OHSA, so workers must be informed of dangers at the workplace. Health and safety information must be communicated to all employees.

2 Employee duties and responsibilities

Employees are responsible for their own health and safety. They should also take reasonable care of those around them. Employees must cooperate with any health and safety rules by obeying all lawful instructions.

A Working for Water clearing team in the field, using the correct PPE. © Rodney February / WWF

WHAT ARE THE MINIMUM SAFETY REQUIREMENTS?

The landowner should check with the contractor or the contractor's staff to make sure the minimum health and safety requirements are met.

Safety representatives

Due to the risks (or the nature of the work) involved in IAP clearing, the employer should appoint a safety representative. The employer must explain to the workers' organisation what responsibilities the safety representatives will have. The safety representative should be available on site.

Safety committees

In every workplace where there are two or more safety representatives, there must also be a safety committee. This committee must meet at least every three months. The committee must deal with all health and safety issues that affect workers. Safety committees have certain functions and powers. You can find out more about these by contacting the Department of Labour.

Emergency contacts

All teams should be aware of the correct emergency contact details for the ambulance service, South African Police Service, Poisons Information Helpline, COVID-19 public helpline, as well as directions to the nearest hospital, clinic or doctor. Detailed procedures should be drawn up for dealing with emergencies, including fuel, oil and herbicide spills.

Water

Clean water must be available in suitable, clearly marked containers for drinking and mixing herbicides.

Toilet facilities

The contractor or land user should provide a mobile toilet on site for the duration of the work.

Training

Only correctly trained staff can perform quality work. If the land user or contractor is unaware of what training is required, they should consult the local Department of Labour office. It is the employer's duty to give training to workers who use dangerous machinery and materials, and to make sure they know the safety precautions.

Team skills

Chainsaw operators should have valid certificates and members of the team who apply the herbicide should be certified.

Work methods and equipment

Equipment must be suitable for the work and in good working order. All work methods set out in the project specifications should be followed. Dangerous machinery must carry warnings and notices. Workers should be prevented from using dangerous machinery and materials unless all safety rules have been followed.

Compensation for Occupational Injuries and Diseases (COID)

The contractor must have a valid certificate of good standing from the Compensation Commissioner. An indemnity form must be signed stating that the contractor accepts full liability for any COID-related matters and that the land user will not be held liable should the contractor not comply with the minimum health and safety standards.

Accident and incident register

Any incident must be reported to the land user. A register of near misses, incidents and accidents must be kept. If an accident occurs, evidence must not be moved until a Department of Labour inspector has given permission, unless someone has been badly injured and needs treatment.

Insurance

The contractor must be insured for vehicles and equipment, and must provide proof of third-party and liability insurance.

It is important to:

- Ensure that all Covid-19 safety protocols are adhered to.
- Sign an agreement whereby the contractor accepts liability for damages in case of negligence.

HOW CAN A LAND USER ENSURE SAFETY IN THE FIELD?

Safety is all important in the field. There are two areas of safety that the land user must be aware of: staff safety and environmental safety.

Staff safety is only possible if the team has the correct mental attitude and have had appropriate training. Only then is personal protective equipment (see Personal protective equipment – What does it include?, page 50) and first aid effective. Supervision by someone who knows the work will help to ensure the safety of workers.

Environmental safety is achieved through correct choice of IAP control methods and herbicides, proper field storage and waste disposal (in a waste bin or a refuse bag on site for the collection of waste material and to prevent littering), and good team training. It is important to keep the workplace open so that workers can escape from danger if necessary, and to have adequate field-safety measures in place.

Toolbox talks

A "toolbox talk" is a safety meeting that focuses on safety topics related to the specific job. Meetings are short and conducted at the job site before a job or work shift begins. They are an effective way to refresh workers' knowledge, cover last-minute safety checks, and exchange information with workers. Toolbox talks help to open up discussions about safety at the job site and to promote a culture of safety.

First aid

The regulations state that an employer should take reasonable steps to make sure that someone who is injured at work gets prompt first-aid treatment. If there are more than 10 employees at a workplace, the employer needs to appoint a first aider. This is a compulsory legal appointment, and the first aider should be readily available during normal working hours. The first aider should have a valid first-aid certificate, issued by a person or organisation approved by the chief inspector. Where pesticides, hazardous chemical substances or hazardous activities are involved, the first-aid worker should also be trained to treat the types of injuries that may result. A fully stocked first-aid kit must be available on site.

Camps

Camps and equipment should not be placed in environmentally sensitive areas, but in a shady spot that has been demarcated before activities commence on site. All rubbish should be collected and disposed of off site. Waste bins should have lids that shut firmly. No waste should be burnt.

Storage of herbicides and fuel

Fuel and herbicides must be left in a shady area, away from the resting/eating area. The area must be clearly marked with danger tape, which must be removed on completion of the job. Herbicide mixing must be conducted on a spill blanket. A spade must be on site to deal with any accidental spillage. Keep spill kits at hand when working with hydrocarbons. Do not decant or mix herbicide near water bodies and do not rinse herbicide equipment in water courses.

Herbicide equipment can be cleaned back at the herbicide store (shed) where there is running water. It should not be cleaned in the field, especially not near water courses. Collect the water still containing herbicide and apply it to dense stands of IAPs, which can be resprayed with the correct concentration later.

No oil, petrol or diesel should be allowed to spill onto the ground or into a stream or river. Drip trays should be used when refuelling, parking overnight or carrying out repairs to machinery. When refuelling on site (e.g. using 200 litre drums), the proper dispensing equipment must be used and the drum should not be tipped in order to dispense fuel.

Transport

The National Road Traffic Act 93 of 1996 is very clear on what is required for safe transport. It is the employer's responsibility to see that all transport meets these requirements. Some of the basic requirements include the following:

- Vehicles must be roadworthy
- Drivers must be in possession of a valid professional driving permit (PrDP)
- Passengers must be seated and have safety belts
- No hazardous substances should be carried in the same compartments as passengers or food and water
- Tools must be transported in a trailer, separately from the workers.

Preventing fires

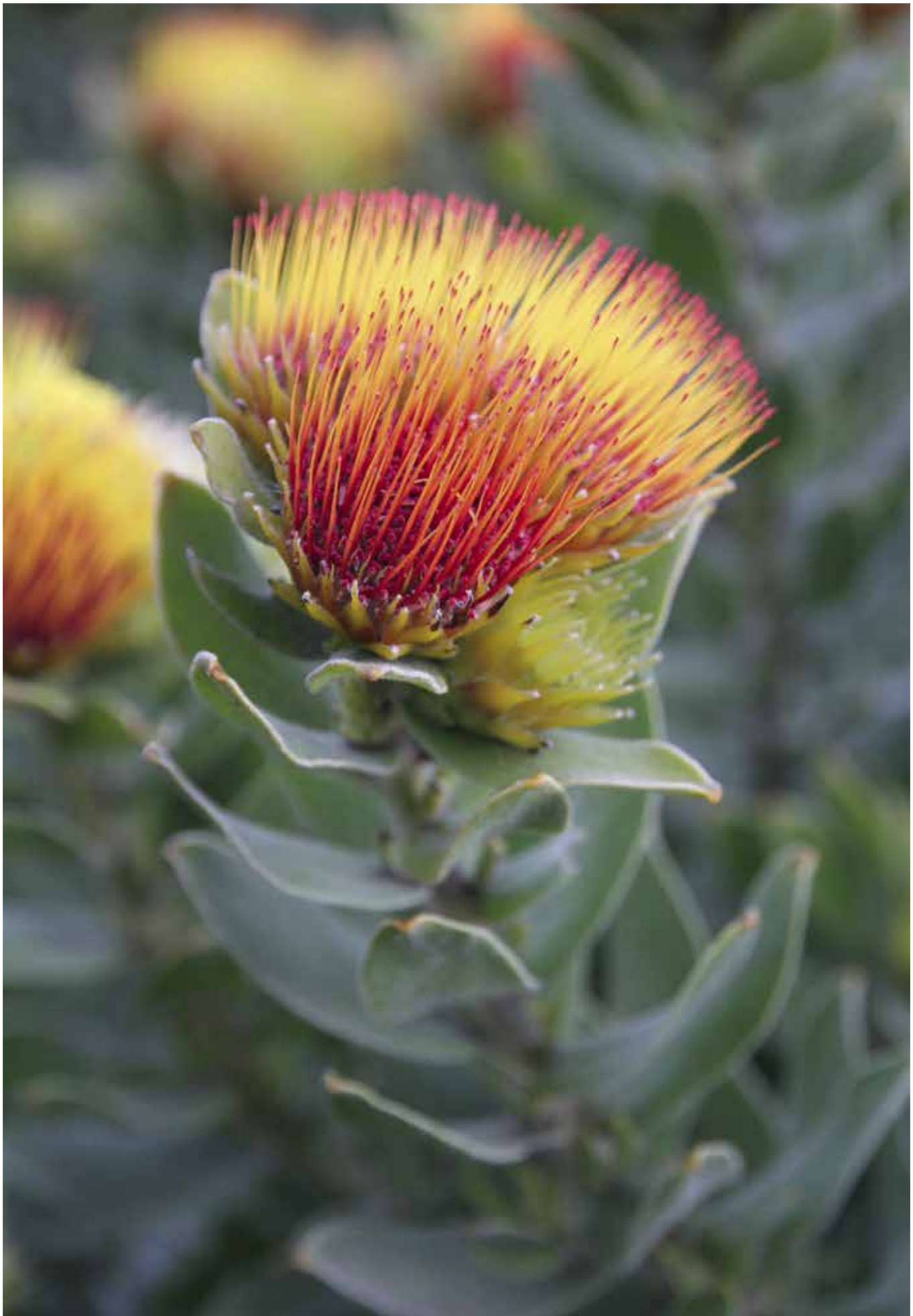
No smoking should be allowed while working. Assign a designated smoking area, remove cigarette butts, and prohibit smoking during windy conditions. No chainsaw work should be done during Code Orange and Red days (Fire Danger Indices are obtainable from the Fire Protection Association). Keep one fire beater for every team member within reach of the workers. A serviced and functional fire extinguisher must be kept at the fuel refilling area (see How to prepare for and manage wildfires, page 25).

PERSONAL PROTECTIVE EQUIPMENT – WHAT DOES IT INCLUDE?

Personal protective equipment (PPE) or personal protective clothing, such as chemical resistant plastic aprons, gloves and eye protection, is worn to protect workers from injury or harm when conducting IAP control. PPE should be of the correct standard (approved by the South African Bureau of Standards) for the task.

Table 5: Examples of personal protective equipment worn during IAP clearing operations

Item	Supervisor	Machine operator	General workers	Herbicide applicator
Conti suit (overall)	✔	✔	✔	✔
Gloves	✔	✔	✔	✔
Gumboots (when working in wet areas)	✔	✔	✔	✔
Rain suit (during rainy conditions)	✔	✔	✔	✔
Safety boots	✔	✔	✔	✔
Safety goggles	✔	✔	✔	✔
Sunhat	✔	✔	✔	✔
T-shirt	✔	✔	✔	✔
Hard hat	✔		✔	✔
Whistle	✔	✔		
Chainsaw operators' gloves		✔		
Chainsaw safety boots		✔		
Chainsaw safety pants (11 layers) with broad belt or braces		✔		
Safety helmet (EU standard)		✔		
Shin-guards for brush cutters		✔		
Cape (when using a knapsack)				✔
Mask (when applying herbicides)				✔
Rubber apron (for mixing herbicides)				✔
Rubber gloves (for mixing herbicides)				✔



Indigenous Overberg pincushion (*Leucospermum oleifolium*) in Kirstenbosch National Botanical Garden. © Helen Stuart / WWF

HERBICIDE SAFETY

Herbicides are chemicals used to kill unwanted plants. Herbicides can be very effective for controlling some types of IAPs. However, they can be hazardous or toxic, and cause harm to people, animals, other plants and the environment.

In this section, information is given on herbicide labels and the safe storage, mixing and disposal of herbicides. Following these precautions will help to reduce the risks associated with these chemicals.

A blue dye mixed with herbicide (which is often colourless) clearly identifies stumps that had been treated.

WHAT IS ON THE HERBICIDE LABEL?

The herbicide label will give details about how the herbicide should be prepared and applied. The Material Safety Data Sheet (MSDS) gives information on the hazardous ingredients, health risks, fire risk, emergency procedures, and more. MSDSs can be found on the Internet or from the dealer.

Concentration

The concentration gives the amount of herbicide that should be diluted in water for use in foliar spray. It is expressed as a percentage (%) or as a volume per volume (v/v). For example: 0,75% in 100 litres of water means you need 75 ml in 10 ℓ of water, or 7,5 ml in 1 ℓ.

Dosage

Dosage tells you the volume of herbicide that needs to be used per area for blanket spraying, e.g. 1,5 ℓ per hectare.

Rate of application

The rate of application gives the volume of mixture that needs to be used per area for blanket spraying, e.g. 1,5 ℓ of product to be applied in 400 ℓ of water per hectare.

For more information, see Appendix 12: Example of a herbicide mixing rate table (page 67).

An in-field herbicide mixing station with the correct safety precautions in place. © Carlo de Kock / SANParks

HOW TO STORE HERBICIDES

Herbicides should be stored correctly to prevent leakage and contamination.

Isolation

The herbicide store (shed) should be a separate building, more than 5 m from the dwelling house, livestock buildings or where fodder, fuel or flammable materials are stored. The store must be totally sealed off, with no free movement of air between the storage area and other areas. The location of the store must minimise possible pollution risk from spilt chemicals. It should be situated away from water sources, rivers, dams, boreholes and areas likely to be flooded. It should be in a location that can be supervised.

Accessibility

The store should have easy access for delivery and dispatch. In an emergency, it should be possible to approach the building from all sides.

Floor

Smooth, screeded concrete is the ideal flooring. Sealed steel-container floors are also acceptable. Earth, timber, bitumen, PVC, linoleum and coarse unscreeded or disintegrating concrete is not acceptable. The floor surrounding the doorway should be bunded (a ridge to contain spillage) to a height of 200 mm. The bunded area should be able to store 110% of the liquids kept in the store. All floor joints and doorways should be watertight.

Walls

Walls should be made of bricks or concrete blocks with vents 200 mm from the floor and near roof level. Repurposed shipping containers are acceptable if there is adequate ventilation. The container should be placed in a shaded area.

Roof

The roof should be leak-free and insulated to keep temperatures at a reasonable level. A vent in the roof will allow hot air to escape during the summer months. If possible, an extractor fan should be installed.

Doors

Steel doors with an effective locking system are preferred. Wooden doors should have security gates to reduce the risk of forced entry. Containers with fitted security gates can be left open to cool the contents during the heat of the day. Only authorised personnel should have access to keys and be allowed in the store.

Windows

Windows should allow enough light into the store to be able to read product labels. All windows should be weather proof, burglar barred and preferably at head height for security reasons.

Lighting

There should be sufficient lighting to allow for the reading of product labels. If electric lighting is required, it must be secure to reduce the risk of fire. The mains control should be outside the store itself.

Sanitation

Staff should have immediate access to washing facilities with running water, soap and towels. They should be encouraged to use these facilities frequently. An eyewash bottle or similar must always be available for the flushing of contamination from the eyes, should it occur. A shower facility is also recommended.

Equipment

The room should be equipped with a suitable table for the reading of labels and decanting and measuring of herbicides. Measuring jugs, funnels, pumps and buckets must be kept on hand. These items must be kept specifically for use with herbicides – do not use household items. Have on hand a broom, spade and a supply of dry, fine soil or spill-absorbing material (not sawdust) that is fire resistant to contain and absorb spills.

Fire extinguisher

A fire extinguisher should be mounted on the outside of the storage facility.

Emergency numbers

The store should have well-displayed emergency contact numbers, e.g. ambulance, medical doctor, Poisons Information Helpline, fire brigade, etc.

Labels

All containers should be labelled accordingly. The Material Safety Data Sheets should be placed on the wall behind the product.

For more information, see Appendix 13: AVCASA's Storing agrochemicals and stock remedies (page 67).

HOW TO MIX HERBICIDES

Many herbicides require mixing with water to dilute them, or with other additives to improve their effectiveness. Products should be mixed according to instructions on the label.

Water

Only clean water should be used for spray mixtures. The product label should be consulted regarding the quality of water suitable for a particular herbicide. Where particulate matter occurs in water (e.g. water from rivers), the water must be filtered to avoid nozzle blockages. When large volumes of water are transported over rough or uneven terrain, which causes the water to move from side to side, tanks should be fitted with tank baffles because the vehicle can be easily overturned by the pure weight of the water.

Adjuvants

There are several types of surfactants[4] that may need to be added to spray mixtures to increase the efficacy of the herbicide. Each product label will specify which adjuvant/surfactant is recommended with the product to optimise its performance. Contact the manufacturer or distributor for advice on the use of these agents. The contact numbers will be printed on the product label.

- Wetting and spreading agents should be mixed in accordance with label recommendations.
- Dye must be added where the product has no built-in dye. Dye helps to show where target species may have been missed or herbicide spilled.
- In areas where water is alkaline, a buffering agent may be necessary. Buffers should be added to water before the herbicide.
- In sensitive areas where drift must be controlled, the use of drift-control agents may be necessary.

Containers

All containers into which herbicides are decanted must be clearly marked with the contents and the dilution. A copy of the original label must be secured to the container. Mixtures should never be decanted into drinking bottles or food containers, as this is a serious safety risk. Suitable equipment must be available to prepare spray mixtures. These include plastic measuring cylinders and beakers, mixing containers (buckets) and funnels.

See What is on the herbicide label? (page 53) for more information.

Safety

The person responsible for mixing must take extra precaution since they are working with an undiluted product that can burn or irritate the skin and eyes.

- Wear suitable protective clothing when handling concentrates (see Personal protective equipment – What does it include? page 50).
- Mix the herbicide according to the label instructions, on a spill blanket.
- Add liquid concentrates to a half-full tank, and then top up the tank.
- Do not mix concentrates together before adding them to the tank.
- Follow the label instruction about when to add adjuvants – before or after mixing the herbicide.
- When a buffer is needed to stabilise the water at the desired pH, first add the buffer, measure the pH of the water to ensure that the correct pH has been reached, and only then add the herbicide to the spray water.
- Proper mixing in knapsacks and hand-held applicators is difficult; mix spray mixtures in bulk containers before pouring into the knapsacks or applicators.
- Agitate spray mixtures continuously, especially after they have been standing for a while.
- Do not wash or rinse spray equipment or containers in or near natural water systems, but take them back to the herbicide store (shed) where wash water can be safely stored in drums for future use as mixing water, without the risk of contaminating the natural environment.

[4] Surfactants lower the surface tension between substances and may act as wetting agents, emulsifiers, foaming agents or dispersants.

PRECAUTIONARY MEASURES WHEN HANDLING HERBICIDES

The handling of herbicides requires strict precautions to protect people, animals, non-target plants and the environment.

Clothing

Suitable protective clothing should be worn. These include chemical resistant plastic aprons, gloves and eye protection (see Personal protective equipment – What does it include? page 50).

In the field

Special care must be taken when handling herbicides in the field.

- Herbicides should only be kept on site in appropriate, clearly demarcated storage areas (see How can a land user ensure safety in the field? page 49).
- Care must be taken to prevent damage to desirable vegetation.
- Application equipment and containers should not be cleaned on site.
- Spray mixtures and equipment must not be left unattended where there is a danger of theft or misuse.
- Products should not be left uncovered in the sun.
- Plans must be in place to prevent spillage, and clean up and dispose of any spilled material.

Spillage

In the case of accidental spillage, the spill must be contained immediately. Suitable absorbent material, such as fine, dry soil, must be available to clean up spillage. Contaminated material should then be disposed of at an approved hazardous waste site. Adequate hygiene aids such as plentiful clean water, soap, towels and eyewash must be readily available.

Transporting

Herbicides and application equipment must be transported separately from people, food and clothing. Herbicides and equipment must be secured to prevent spillage and damage. Vehicles should carry absorbent material to absorb any spillage (see How can a land user ensure safety in the field? page 49).

For more information, see Appendix 14: CropLife International's Responsible Use Manual (page 67).

Since herbicides are hazardous to people and the environment, precautions must be taken to limit risks.

Public safety

Bystanders in the vicinity of herbicide storage and application areas must be well informed and protected from harm.

- The public should be kept out of operational areas where hazards exist.
- The public should be informed of control operations in their area by means of verbal communication, notices, pamphlets, the press, etc.
- Warning notices should be displayed where necessary.
- Product and spray mixtures should be stored so that they are inaccessible to the public.
- Treatment of areas within 50 m of homes and public areas (e.g. parks) should be avoided or only carried out in consultation with the parties affected.

Environmental safety

Steps must be taken to minimise the impact of herbicide use in IAP clearing operations on the natural environment.

- Area contamination must be minimised by careful, accurate application with the lowest amount of herbicide to achieve control of IAPs.
- To avoid damage to indigenous or other desirable vegetation (like crops), herbicides should be selected that will have the least effect on non-target vegetation.
- Coarse-droplet nozzles should be fitted to avoid drift onto neighbouring vegetation and crops.
- All care must be taken to prevent contamination of water bodies. This includes due care in storage, application, cleaning of equipment and disposal of containers, products and spray mixtures (see Safely disposing of empty containers and leftover spray mixtures, page 57).

SAFELY DISPOSING OF EMPTY CONTAINERS AND LEFTOVER SPRAY MIXTURES

In addition to taking care that the cleaning of equipment does not contaminate the environment, used containers and leftover spray mixtures should be disposed of with great care.

Used containers

Used herbicide containers must not be used for any other purpose and must be destroyed after use.

- A designated person should be responsible for safely disposing of used containers.
- Under no circumstances should containers be taken home for personal use.
- Empty herbicide containers will not be accepted back by the supplier. It is the purchaser of the product's responsibility to deal with empty herbicide containers according to the CropLife regulations.
- All empty containers must be returned to the herbicide store (shed) from where they were issued. The designated storeman will then triple rinse the containers, puncture and flatten them and send them away for recycling or destruction by an authorised organisation.

Leftover spray mixture

Only sufficient herbicide spray mixture that can be used in a day should be prepared. However, if it starts to rain and spraying cannot continue, leftover spray mixtures must be handled appropriately.

- Leftover mixed herbicide should be returned to the herbicide store (shed) for safe storage and reuse, if appropriate. Containers must be clearly labelled with the herbicide name and dilution.
- The spray mixture (or washings) can be kept in drums and used for 'spray water' when the same herbicide is required for the same species. In this case, the herbicide needs to be added to the spray mix again to compensate for chemical breakdown.
- Certain spray mixtures should not be left standing overnight and should be safely disposed of. Consult the product label.

Refilling herbicide spray bottles at a herbicide camp.

For more information, see Appendix 15: CropLife's Resources on Container Management (page 67).

LONG-TERM REHABILITATION

Clearing IAPs is an important part of rehabilitating infested land, and often a first step in any rehabilitation project. Rehabilitation work needs to be carried out by people with adequate skills to avoid damage to the remaining natural ecosystems.

Here, you will find an overview of the reasons for rehabilitating cleared land, the types of rehabilitation and the phases in a rehabilitation project. Useful resources with more detailed information on rehabilitation are suggested.

Regrowth of indigenous vegetation at an active restoration site in the Kouga catchment in the Eastern Cape. © Saskia Fourie / WWF

WHY REHABILITATE?

The need to tackle the threat of IAPs has been recognised for many years. But it is only more recently that we have started to realise what an important role rehabilitation can and should play in the process.

The removal of IAPs is the first step in addressing their negative impacts, but in some situations the natural area, such as rivers, have degraded to such a degree that they are not able to self-restore and their ability to deliver basic functions, e.g. flow and filtration, has been compromised. In these cases, additional interventions in the form of active restoration, such as seeding or planting, are required to return the area's natural functions and prevent further degradation. The establishment of an indigenous vegetation cover also suppresses alien regrowth and is a prerequisite for the long-term control of IAPs.

Intact, functioning natural ecosystems, which are called our "natural infrastructure", provide society with a number of goods and services (Figure 3).

Figure 3: Ecosystem services

CLEAN AIR	Ecosystems produce oxygen and also purify and detoxify the air
CLEAN WATER	Ecosystems provide us with clean water and store and cycle fresh water
CLIMATE	Ecosystems regulate the climate and provide resilience against the impacts of climate change
HEALTHY SOIL	Ecosystems form topsoil and prevent erosion and flood damage
RAW MATERIALS	Ecosystems produce raw materials, foods and medicines

Rehabilitating the cleared land will ensure that natural infrastructure can keep producing the benefits that people derive from nature. By planting back lost or endangered species, we can prevent extinction, maintain biodiversity, reverse the loss of species and help restore the way the natural environment functions.

WHAT ARE THE BASIC PRINCIPLES OF REHABILITATION?

Although one should always strive to avoid degradation in the first place, this is not always possible and rehabilitation might be necessary. Rehabilitation can differ from area to area, depending on the situation. However, all rehabilitation projects follow the same four basic principles.

4 BASIC PRINCIPLES OF REHABILITATION

1 Halt degradation

Identify what is causing degradation to the natural ecosystem and take measures to stop it. IAPs can be very damaging to natural ecosystems, so managing IAPs can help to prevent further destruction. Be careful not to inadvertently increase degradation through rehabilitation actions, either on or off site.

2 Address missing ecosystem processes

Ecosystem processes are processes that link organisms to their environment. These processes include things like nutrient cycles and food webs. Often, degraded systems are missing key ecosystem processes. Identifying and addressing these missing processes can help with rehabilitation. Local conservation offices or rehabilitation specialists could be consulted in this regard.

3 Conserve what remains

It is important to prevent the loss of remaining natural ecosystems, including seedbanks and soils. In this way, rehabilitation costs may be kept to a minimum.

4 Prioritise

Resources are usually limited, so it is important to carefully prioritise which areas should be rehabilitated. Studies in Brazil have shown that a well-prioritised approach is five times more effective than an unplanned approach. After clearing IAPs, areas most prone to further degradation should be prioritised for rehabilitation.

Cleared material at a restoration site that has been stacked along the contours to pervent erosion. © Saskia Fourie / WWF

WHAT METHODS CAN BE USED FOR REHABILITATION?

The type of rehabilitation will depend on the setting and the IAP management methods that were used. The extent, density, age and species of IAPs cleared will affect what type of rehabilitation – passive, active or manipulated succession – should be implemented.

Passive rehabilitation

After IAPs have been cleared or activities damaging the ecosystem stopped, the area is left to recover naturally. The causes of degradation are removed from the system and the system can repair itself over time. If the IAP infestation was minimal or if plenty of indigenous vegetation still exists around the IAP infestation and was not damaged during the clearing process, then one may rely on passive rehabilitation taking place. This will provide adequate ground cover to supress the regrowth of IAPs and prevent erosion.

Active rehabilitation

When IAP clearing has resulted in large exposed areas, active rehabilitation activities may be required. These may include activities that stabilise the soil, the planting of seedlings or the sowing of seeds to reintroduce natural species. Obtain indigenous seed and seedlings from as nearby as possible to ensure correctly adapted plant populations. If IAP management is implemented properly, it can reduce the need for any active rehabilitation, thus reducing the long-term costs involved.

Manipulated succession

Complete clearing of an area can cause the growth of secondary IAPs (weedy species). Many IAPs fall into this category and will take advantage of newly cleared ground. To prevent this, IAPs can be thinned in stages to support the gradual regrowth of natural vegetation (Figure 4).

It is useful to plan IAP clearing and rehabilitation at the same time. There may be different rehabilitation methodologies for riparian or terrestrial areas. It should be noted that full restoration cannot always be achieved. This is often due to the severity of the degradation, or a lack of resources.

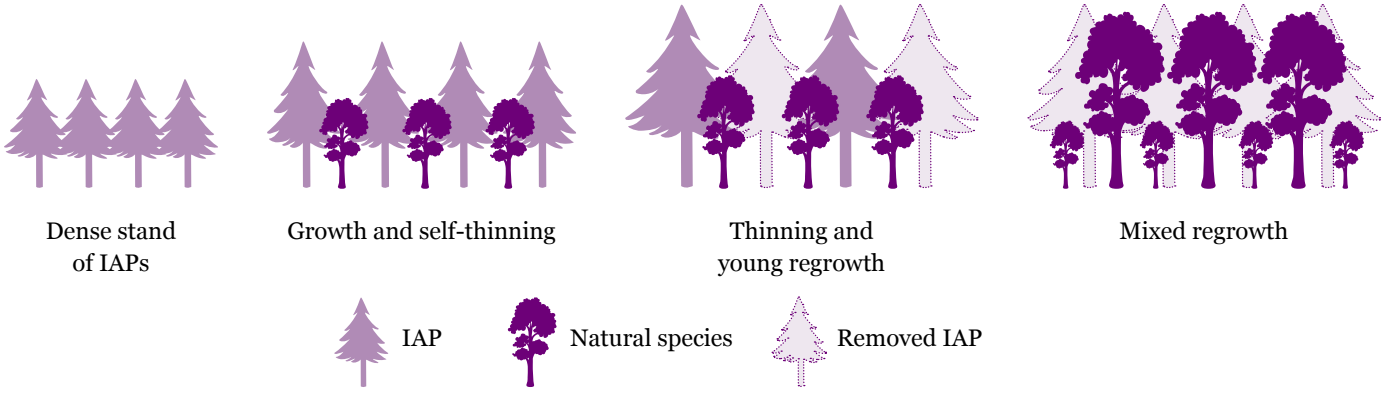
For more information, see:

Appendix 16: WWF: A practical guide for community-run nurseries (page 67).

Appendix 17: WWF: Restoration of alien-invaded riparian systems (page 67).

Appendix 18: Alien weeds and invasive plants (page 67).

Figure 4: Removing selected IAPs over time can support natural forest succession for rehabilitation [5]



[5] Geldenhuys, C.J. 2011. Most invasive plants facilitate natural forest recovery – how is that possible? *SAPIA News* 18: 2–5.

WHAT ARE THE PHASES OF A REHABILITATION PROJECT?

Rehabilitation projects invariably follow four distinct phases – a site assessment (getting an understanding of the site); planning (drawing up a detailed and cost-effective plan for the necessary interventions); executing the planned interventions; and monitoring the work (surveillance of the site and indicators of recovery, and identifying further interventions, as appropriate).

4 PHASES OF A REHABILITATION PROJECT

1 Site assessment

Before rehabilitation is even planned, a good background understanding of the site is needed. One should record the history of the site, look at its existing condition, and find out what has caused the degradation. They should collect baseline information over a period of time. Physical conditions such as slope, water quality, local climate and soils should be noted. A nearby natural ecosystem should be identified to understand what comprises the natural system, thus determining what rehabilitation efforts may be required. Information on plants and animals that make up the natural ecosystem should be gathered, including information about the reproduction and life cycles of key species. It may be necessary for a land user to consult experts on the above if they require additional assistance.

2 Planning

A rehabilitation management plan should be drawn up, building on the background information collected during the site assessment. Planning is essential to decide how feasible it is to carry out rehabilitation. The plan should clearly state the goal of the rehabilitation project. It should specify what rehabilitation activities will need to be undertaken over the course of the project. If necessary, trials should be carried out to test the rehabilitation methods. The plan should also identify the physical, human and financial resources that will be needed. It is also mandatory to get all the necessary approvals or permits, and to liaise with relevant organisations or government departments.

3 Implementation

Once planning is completed, staff can be hired to supervise and carry out the rehabilitation. Rehabilitation methods will vary depending on the situation. They will probably include the reintroduction of plants or animals, e.g. through collecting flower heads and mulch from surrounding areas to spread over the site. Beware of commercially available seed as it may contain other undesirable seed (especially alien species), which may compete with Fynbos seedlings or threaten the genetics of local plants. Other rehabilitation activities may include putting in place landscape restrictions, such as stopping land uses that reduce water quality.

4 Monitoring

Once active rehabilitation is complete, there are several follow-up tasks that should be done. These include protecting the site from vandals, pests or livestock, and performing ongoing maintenance, such as erosion repair and continued IAP control. Records should be kept of all rehabilitation sites. These records should include IAP management methods, dates, the results of IAP clearing and rehabilitation actions. Regular site inspections should be undertaken to address any threats to the recovering area.

For more information, see the resources listed under Rehabilitation and restoration (page 67).

Indigenous daisy (*S. elegans*) in Kirstenbosch National Botanical Garden. © Helen Stuart / WWF

FUNDING OPPORTUNITIES

Managing IAPs can be costly, but failing to manage IAPs before they get out of control can be even more costly. Land users do not need to wait until they have enough funds before starting with IAP management activities. There are many resources available to help them with their IAP management efforts.

This section contains information about government and other funding opportunities for IAP management. Options include accessing government programmes, working cost effectively with neighbours, and finding resourceful ways to recoup funds from IAPs.

An indigenous pincushion protea (*Leucospermum spp*).

AVAILABLE RESOURCES FOR IAP MANAGEMENT

To make the most of funding opportunities, it is vital that land users show that they are taking responsibility for the IAP problem that exists on their land. Funders often want to see what efforts the land user is already making towards IAP control.

Even if only limited funds are available, the management of IAPs still needs to be well planned (see Planning IAP management operations, page 18), with careful consideration of how activities can be sustained with the resources available.

The best way of finding potential co-funders is to think about where the property is situated in the landscape. Understanding who stands to gain from IAP clearing will help to determine who might be willing to provide funds. Is the area important for conservation, water production, or of high agricultural value? Linking up with other initiatives in the landscape can help to access funds from a variety of sources.

Neighbourhood initiatives and conservation stewardships

Often, extra resources can be found when IAP management is combined across neighbouring properties. It is best for land users to work together and develop a landscape or catchment approach to IAP management. This can be achieved by working through a Farmers' Association, Fire Protection Association or Water User Association, or by creating a new initiative like a conservancy, or by signing up with a conservation stewardship (see capenature.co.za/care-for-nature/stewardship). Conducting IAP management in this way is more cost effective because resources such as herbicide can be shared. A collaborative approach is also more likely to attract funding from outside sources.

LandCare Programme

Provincial departments of Agriculture sometimes fund IAP management through their LandCare Programme. If LandCare is active in an area, they may be willing to assist private land users by co-funding IAP clearing. However, in most instances they prefer to tackle large projects with many land users in priority areas.

Natural Resource Management (NRM) Programme

The Department of Environment, Forestry and Fisheries is another potential source of resources through its NRM provincial offices. Through the NRM Programme, a land user can get access to herbicide and IAP eradication assistance. Assistance will depend on various factors, including budget, the IAP management strategy in the catchment, and existing IAP control efforts. The land user and provincial office will negotiate contributions (financial and non-financial), and the land user will have to display a willingness to do their part. Due to the necessary checks and balances for disbursement of government funds, applying for and managing these resources may require a lot of administration.

Beneficiation

Additional funds can be gained by making use of the IAP biomass that is cut down (see What other factors should one consider for IAP management? page 28 and How can one responsibly manage plant material? page 45). The land user can get financial benefit if wood is processed into saleable products like charcoal, activated carbon, pellets, pallets, poles and many other wood products. The investment in these production processes can help to offset the costs of IAP management. However, this approach should always follow best practice for IAP management, as clearing only some IAPs may have no environmental benefit and could make the IAP problem worse.

Several green economy initiatives are emerging across the landscape, so it is wise to approach the government programmes mentioned above, local non-government organisations or local businesses to get involved.

FOR MORE INFORMATION

Supporting documentation and additional information have been compiled into a set of appendices, which are available at www.wwf.org.za/invasive_plants_appendices. All the documents are in PDF format, but the templates can be converted to MS Word using free PDF to MS Word conversion programs available on the internet.

LEGAL REQUIREMENTS

APPENDIX 1: LEGISLATION GUIDELINE FOR INVASIVE ALIEN SPECIES

A detailed guideline on the legislation relevant to landowners with invasive alien species on their land.

PLANNING IAP MANAGEMENT OPERATIONS

APPENDIX 2: GUIDELINES FOR THE PREPARATION OF AN IAP CONTROL PLAN

Guidelines for drawing up an IAP control plan for a farm, giving basic pointers on drawing up a plan, completing a field verification and determining working days for costing. A field verification worksheet (Appendix 3) and guidelines for clearing times (Appendix 4) are also included.

APPENDIX 3: WORK SHEET FOR FIELD VERIFICATION

A blank worksheet to fill in the species, age and density classes of IAPs and then calculate person days. The work sheet can be converted to MS Word using free PDF to Word conversion programs available on the internet. It is also available from the Department of Environment, Forestry and Fisheries Natural Resource Management (NRM) offices.

APPENDIX 4: GUIDELINES FOR CLEARING TIME (person days/ha NORMS)

The "norms" for person days required for different IAP types, ages and density classes. It is also available from Department of Environment, Forestry and Fisheries Natural Resource Management (NRM) offices.

APPENDIX 5: TEMPLATE FOR A FARM-LEVEL ALIEN CONTROL PLAN

A template to record listed alien species, distribution, objectives and actions, monitoring actions, planning and budget and a clearing schedule. It also provides a herbicide control sheet and useful checklists for landowners. The template can be converted to MS Word using free PDF to Word conversion programs available on the internet.

APPENDIX 6: BASIC MAPPING SKILLS

Some basics of map reading and mapping aids necessary to understand maps.

APPENDIX 7: FIRE PROTECTION ASSOCIATIONS IN THE WESTERN CAPE

Information about Fire Protection Associations are specific to the reader's location and can be found online. An example for the Western Cape is included here.

APPENDIX 8: CAPENATURE'S FACT FILE: A LANDOWNER'S GUIDE TO PLANNING ALIEN CONTROL

This two-page information sheet giving brief information on prioritisation, budget, clearing methods and common invasive alien species, in English and Afrikaans, is also available on CapeNature's website at www.capenature.co.za.

APPENDIX 9: NATIONAL GEOSPATIAL INFORMATION (NGI)

Topographical maps and aerial photos are available from the NGI at www.ngi.gov.za.

APPENDIX 10: CAPENATURE'S FACT SHEET: WHAT A LANDOWNER NEEDS TO KNOW ABOUT FIRE MANAGEMENT

A two-page information sheet on fire management for landowners, including principles of burning (frequency, intensity, season) and dos and don'ts, available in English at https://www.capenature.co.za/wp-content/uploads/2013/09/Landowners-Guide-to-Fire-Management-Fact-Sheet-English.pdf, and in Afrikaans at https://www.capenature.co.za/wp-content/uploads/2013/09/Landowners-Guide-to-Fire-Management-Fact-Sheet-Afrikaans.pdf.

IAP MANAGEMENT METHODS

APPENDIX 11: CHOICE OF NOZZLES FOR INVADER PLANT CONTROL

An introduction to the types of nozzles available and their uses. This information can be sourced from your herbicide provider.

HERBICIDE SAFETY

APPENDIX 12: EXAMPLE OF A HERBICIDE MIXING RATE TABLE

Most herbicide manufacturers supply a table of quantities for mixing common herbicides online. Additional information can be found on CropLife's website: https://croplife.co.za.

APPENDIX 13: AVCASA'S STORING AGROCHEMICALS AND STOCK REMEDIES

Guidance on the proper storage of chemicals to prevent the risk of agrochemicals being used to poison livestock, people and even to destroy crops is available at www.nda.agric.za/docs/peststore/storing.htm.

APPENDIX 14: CROPLIFE INTERNATIONAL'S RESPONSIBLE USE MANUAL

Comprehensive course material on the concepts and principles of the responsible use of pesticides is available at https://croplife.org/wp-content/uploads/2016/04/Responsible-Use-Manual.pdf.

APPENDIX 15: CROPLIFE'S RESOURCES ON CONTAINER MANAGEMENT

A set of resources on proper disposal of used herbicide containers is available at https://croplife.co.za/container-management.

REHABILITATION AND RESTORATION

APPENDIX 16: WWF: A PRACTICAL GUIDE FOR COMMUNITY-RUN NURSERIES

Wilman, V. 2019. *A Practical Guide for Community-run Nurseries: Growing Indigenous Plants for Restoration*. WWF South Africa, Cape Town, South Africa. This practical guide is available at https://www.wwf.org.za/our_research/publications/?29601/a-practical-guide-for-community-run-nurseries.

APPENDIX 17: WWF: RESTORATION OF ALIEN-INVADED RIPARIAN SYSTEMS

Fourie, S. and Wilman, V. n.d. *Restoration of Alien Invaded Riparian Systems*. Report ISBN 978-2-940443-06-2, WWF, Cape Town, South Africa.

APPENDIX 18: ALIEN WEEDS AND INVASIVE PLANTS

Henderson, L. 2001. *Alien weeds and invasive plants*. Plant Protection Research Institute Handbook No. 12. Plant Protection Research Institute, Agricultural Research Council, Pretoria, South Africa.

A complete guide to declared weeds and invaders in South Africa, including another 36 species invasive in that region, compiled by the Agricultural Research Council. This guide is available at www.wfw.org.za.

REFERENCES

Conservation of Agricultural Resources Act 43 of 1983

National Environmental Management: Biodiversity Act 10 of 2004

National Forest Act 84 of 1998

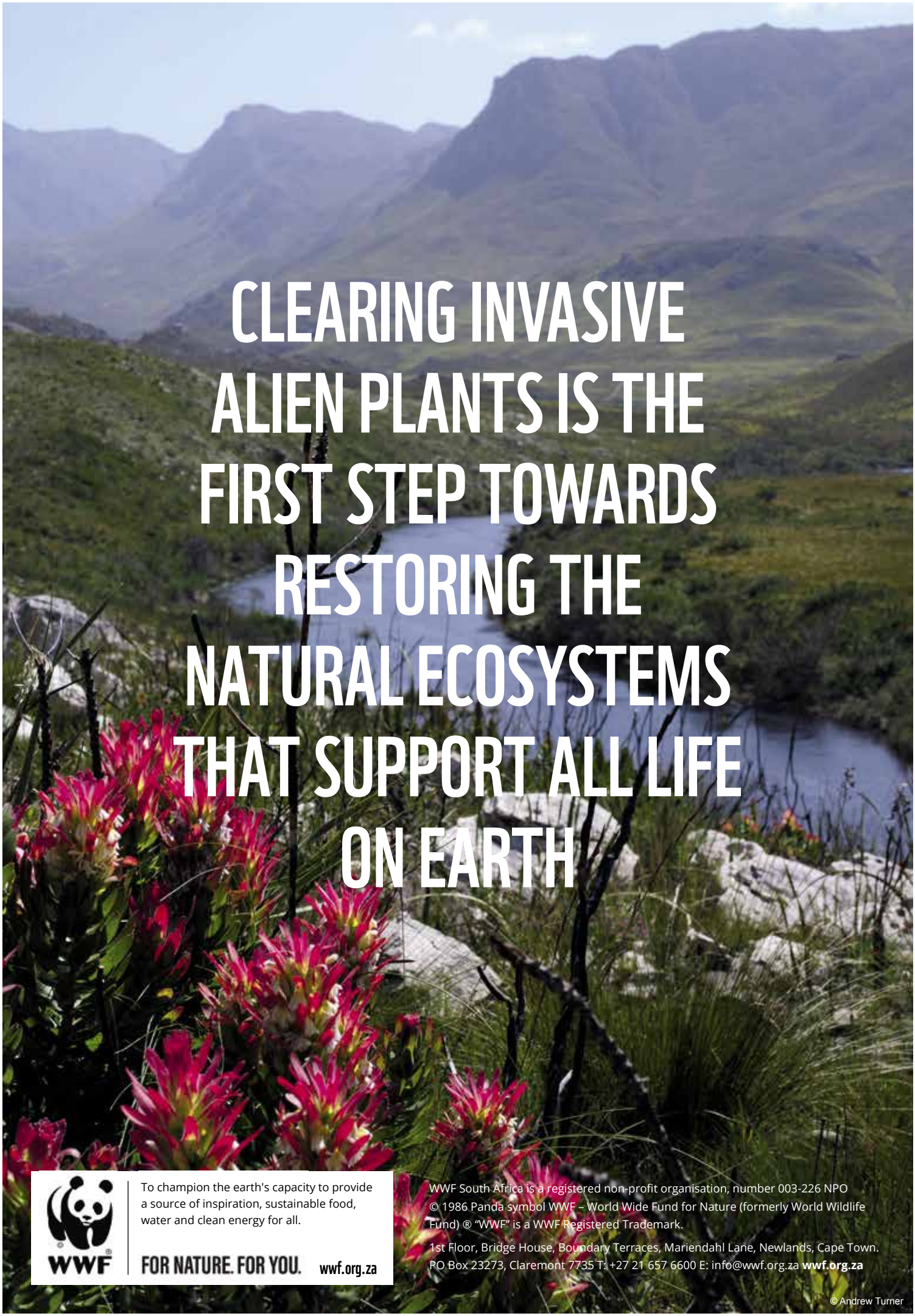
National Heritage Resources Act 25 of 1999

National Road Traffic Act 93 of 1996

National Veld and Forest Fire Act 101 of 1998

National Water Act 36 of 1998

Occupational Health and Safety Act 85 of 1993



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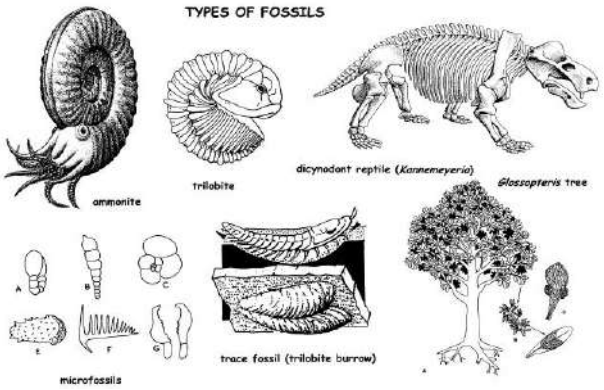
Palaeontology: what is a fossil?

Fossils are the traces of ancient life (animal, plant or microbial) preserved within rocks and come in two forms:

- Body fossils preserve parts, casts or impressions of the original tissues of an organism (e.g. bones, teeth, wood, pollen grains); and
- Trace fossils such as trackways and burrows record ancient animal behaviour.



How to report chance fossil finds: What should I do if I find a fossil during construction/mining?

If you think you have identified a fossil:

Immediately inform the ECO or Site Agent. He/she will then contact HWC and write a report and if necessary operations will stop in that specific area until the fossil is recovered

Heritage Western Cape
ceoheritage@westerncape.gov.za
021 483 5959
www.hwc.org.za

Types of palaeontological finding - What does a fossil look like?

Fossils vary in size, from fossilised tree trunks and dinosaur bones down to very small animals or plants. Finds can be **individual fossils** (one isolated wood log or bone) or **clusters and beds** (several bones, teeth, animal or plant remains, trace fossils in close proximity or bones resembling part of a skeleton). A bed of fossils is a layer with many fossil remains.

Below there is a list of few examples of fossils which may be identified during excavations in the Western Cape.

Image	Description	Image	Description
	Leaves		Snail shells and other shells
	Fossil wood		Bones of larger animals
	The remains of fish and marine life (e.g. teeth, scales, starfish)		Large burrows made by moles and other animals
	Stromatolites		Traces made by burrowing insects (ants, wasps, dung-beetles etc.).
	Animal footprints		

Images provided by Dr John Almond

Text by HWC's Archaeology, Palaeontology & Meteorites Committee June 2016

COMMON SNAKES OF THE SOUTHERN CAPE

Garden Route & Klein Karoo

VERY DANGEROUS — Has caused human fatalities

DANGEROUS — Painful bite, but does not require antivenom

MILDLY VENOMOUS — Not thought to be harmful

HARMLESS — Not dangerous to humans

AFRICAN SNAKEBITE INSTITUTE.com ®

Cape Cobra
(*Naja nivea*)

Cape Cobra - juvenile
(*Naja nivea*)

Cape Boomslang - male
(*Dispholidus typus typus*)

Cape Boomslang - female
(*Dispholidus typus typus*)

Puff Adder
(*Bitis arietans arietans*)

Berg Adder
(*Bitis atropos*)

Rinkhals - banded phase
(*Hemachatus haemachatus*)

Coral Shield Cobra
(*Aspidelaps lubricus lubricus*) Photo David Maguire

Karoo Sand Snake
(*Psammophis notostictus*)

Herald or **Red-lipped Snake**
(*Crotaphopeltis hotamboeia*)

Spotted Harlequin Snake
(*Homoroselaps lacteus*)

Rhombic Night Adder
(*Causus rhombeatus*)

Mole Snake
(*Pseudaspis cana*)

Rhombic Egg-eater
(*Dasypeltis scabra*)

Western Natal Green Snake Photo Tyrone Ping
(*Philothamnus natalensis occidentalis*)

Olive Snake
(*Lycodonomorphus inornatus*)

Brown House Snake
(*Boaedon capensis*)

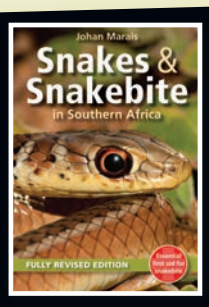
Common Brown Water Snake
(*Lycodonomorphus rufulus*) Photo Tyrone Ping

Delalande's Beaked Blind Snake
(*Rhinotyphlops lalandei*)

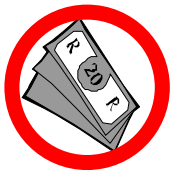
Common Slug-eater
(*Duberria lutrix lutrix*) Photo Tyrone Ping

Johan Marais | African Snakebite Institute
+27 82 494 2039 | johan@asiorg.co.za

www.AFRICANSNAKEBITEINSTITUTE.com



JOHAN MARAIS is the author of various books on reptiles including the best-seller *A Complete Guide to Snakes of Southern Africa*. He is a popular public speaker and offers a variety of courses including **Snake Awareness**, **Scorpion Awareness** and **Venomous Snake Handling**. Johan is accredited by the International Society of Zoological Sciences (ISZS) and is a Field Guides Association of Southern Africa (FGASA) and Travel Doctor-approved service provider. His courses are also accredited by the Health Professions Council of South Africa (HPCSA).

	ENVIRONMENTAL DO'S	ENVIRONMENTAL DON'TS
Work Site	 Workers and equipment to stay within site boundaries	 Do not enter no go areas
Materials & Equipment	 Use drip trays Report spills	 Do not create dust Do not drive too fast
	 Store in camp at night Check for leaks Ensure loads don't spill	 Do not wash machinery or tools on site
Waste Management	 Use toilets provided	 Don't burn or bury waste No fires on site Report any other fires
	 Use bins provided for cigarette butts & waste	 Eat in designated area Don't eat at dam or river
Natural Environment	 Save water Use only drinking water provided	 Do not damage trees, flowers or rocks
	 Protect animals and archaeological remains	 Do not swim or wash in the dam or river
Danger & Emergencies	 Know emergency procedures & no's Report accidents	 No smoking near gas or diesel
	 Be careful when working with hazardous substances	 Fines will be issued for non-compliance with environmental specifications

Cape Environmental Assessment Practitioners (Pty) Ltd

Cape EAPrac
Company Profile

Cape Environmental Assessment Practitioners (Pty) Ltd was established in March 2008 by Directors **Doug Jeffery** (EAPASA Reg. No 2019/1746) and **Louise-Mari van Zyl** (EAPASA Reg. No. 2019/1444). The full time professional team includes: **Dale Holder** (Senior Environmental Practitioner (EAPASA Reg.No 2019/301)/GIS/ECO), **Siân Holder** (Practitioner/ECO/Environmental Education), **Paul Buchholz** (Environmental Consultant/Professional GIS Practitioner), **Mariska Nicholson** (Intern Environmental Consultant**), Onke Nandipha** (Junior Consultant/ECO), **Charmaine Mudau** (Environmental Consultant/ECO) and **Carin Naudé** (Business Administrator).

The firm implements legislation under the National Environmental Management Act (NEMA), National Environmental Management: Waste Act (NEM:WA) and the National Environmental Management: Air Quality Act (NEM:AQA).

Our main services include:

- Environmental Impact Assessments (EIA's & Basic Assessments)
- Environmental Management Policies & Plans (EMMP's)
- Environmental Control & Monitoring(ECO)
- Environmental Audits
- Environmental Education & Interpretation
- Environmental Constraints Analysis
- Public Participation & Stakeholder Engagement
- Outeniqua Sensitive Coastal Area Permits (OSCA)
- Forestry Applications (for removal/pruning of protected species)
- GIS & Mapping
- Retrospective Damage Assessment (Section 24G)
- Rehabilitation Plans
- Coastal Water Discharge Permits
- Air Quality Licence Applications (AEL's)
- Waste Management Licence Applications (Waste Licence)

PROJECT EXPERIENCE INCLUDES

Reverse Osmosis Desalination; Sensitive Environmental Management including National Parks/Conservation Areas & World Heritage Sites; Renewable Energy Projects (Solar & Wind); Waste Management License Applications for Waste Disposal Sites, Sewerage Plants & Abattoirs; Waste-to -Energy Projects including Biogas Facilities; Marine Aquaculture; Filling Stations; Air Emission Processes for Sawmills, Brick Works & Processing Plants; ECO responsibilities on Private & State Housing Developments, Provincial & Municipal Roads and Infrastructure, Private, Provincial & Municipal applications for development of infrastructure, housing & commercial components

LIST OF ONGOING ***CAPE EAPRAC*** PROJECTS IS AVAILABLE ON REQUEST. PLEASE VISIT OUR WEBSITE FOR MORE DETAILS

PO Box 2070
6530 George

17 Progress Street
6529 George

www.cape-eaprac.co.za

Tel: +27 44 874 0365
Cell: +27 71 603 4132

The Team

Doug Jeffery - Director

Doug Jeffery obtained a Bsc with majors in Botany and Zoology at the University of Cape Town (UCT) and went on to obtain his MSc in Botany also at UCT. He has worked extensively in the Western-, Southern- and Eastern Cape both as a professional Botanist and co-ordinating EIA processes for over 20 years. He has been registered with the South African Council for Natural Scientific Professions as a Natural Scientist since 1990. He is also registered with the Environmental Assessment Practitioners Association of South Africa.

email: doug@dougjeff.co.za

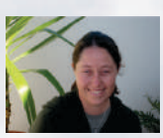
Dale Holder

Senior Practitioner / GIS / ECO

Dale graduated from the Technicon Pretoria in 1999 with a National Diploma in Nature Con-servation. He worked as a Socio-Ecologist for SANParks and as Project Manager for the Department of Marine and Coastal Management. He started working as an environmental practitioner in 2002. His focus is currently on Renewable Energy Infrastructure Assessment, but is also involved with other Assessment, Public Participation & Stakeholder Engagement, GIS & Mapping, Biophysical Inventories, Retrospective Damage Assessment, Air Quality License Applications, Waste Management License Applications, Environmental Impact Assessments, Environmental Management Policies and Plans, Environmental Control, Monitoring and Auditing, Environmental Awareness and Training Programs, Environmental Education and Interpretation and Environmental Feasibility Assessments. Heis registered as and EAP with the Environmental Assessment Practitioners Association of South Africa.

email: dale@cape-eaprac.co.za

Siân Holder - Consultant / ECO



Siân has a National Diploma in Nature Conservation, a BTech Nature Con (NMMU) and a Masters Degree in Environmental Education (Rhodes University). She worked at Tsitsikamma National Park as an Environmental Education Officer on environmental education programmes for Wilderness Foundation SA. She then served as the Experiential Education Manager and wilderness guide for Wilderness Foundation. She joined the environmental consulting vocation in 2008.

email: sian@cape-eaprac.co.za

Onke Nandipha - ECO

Onke obtained a BSc in Environmental Sciences (2017) and a BSc Honours in Geography in 2018. Hw joined Cape EAPrac in July 2019, as an intern, and after gaining experience on various projects, has taken on the responsibility as full time On-Site Environmental Control Officer for a renewable energy development in Kenhardt, Northern Cape. His excellent communication skills in both English and Xhosa, combined with his knowledge and understanding of environmental management makes him a valuable asset on projects where language barriers are a constraint.

email: onke@cape-eaprac.co.za

Louise-Mari van Zyl

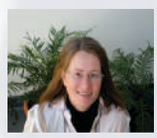
Director / Principal Practitioner

Louise-Mari van Zyl holds a Masters degree in Geography & Environmental Sciences from the University of Stellenbosch. She worked as an Environmental Assessment Practitioner (EAP) since 2002 on projects in the Eastern, Southern, Western & Northern Cape provinces. She is registered as and EAP with the Environmental Assessment Practitioners Association of South Africa.

email: louise@cape-eaprac.co.za

Carin Naudé

Business Administrator



Carin obtained a BBA degree through UNISA. She gained extensive experience in business management and administration since 1988. She joined *Cape EAP*rac in June 2008 and is responsible for the day to day administrative functions of the business. Her acquired knowledge and leadership skills enables the rest of the team to function efficiently in their respective fields.

email: carin@cape-eaprac.co.za

Paul Buchholz

GIS Practitioner / Environmental Consultant

Paul joined Cape EAPrac in September 2022. He holds a MA in Environmental Management from the University Stellenbosch (2009). He is an experienced Geo-informatics and Environmental Specialist who has worked on multidisciplinary environmental and engineering projects in Africa since 2002. Paul is Registered GIS Practitioner with the South African Council for Professional & Technical Surveyors.

email: paul@cape-eaprac.co.za

Mariska Nicholson

Project Assistant / Trainee Environmental Consultant

Mariska joined Cape EAPrac in April 2022 . She completed her BSc in Geology in 2016, BSc Honours in 2017 and holds a MSc in Geology from the University of the Free State (2020). After working a Geologist for two years, she joined our team as Project Assistant and is training to become an Environmental Assessment Practitioner.

email: mariska@cape-eaprac.co.za

Charmaine Mudau - ECO

Charmaine Mudau joined Cape EAPrac in September 2022. She holds a BA in Geography and Environmental Management from the University of the Free State (2014) and a BSc Honours in Geography from UNISA (2020). She joined our team as full time On-Site Environmental Control Officer for a renewable energy development in Kenhardt, Northern Cape.

email: charmaine@cape-eaprac.co.za