MANAGEMENT UNIT CONTROL PLAN FOR CAPE NATURE's WATERVAL CENTRE

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Management Unit Control Plan for CapeNature's Waterval Centre

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Executive Summary

This document sets out a plan for dealing with alien plant invasions on 55 546 ha of land managed by the Waterval Centre of the Western Cape Nature Conservation Board (CapeNature). The Waterval Centre comprises a number of separate mountainous areas including Bokkeriviere (15 236 ha) at the eastern end of the Hex River Mountains, the central Hex River Mountains (13 917 ha) and the Witzenberg (10 231 ha) in the middle, the Waterval Nature Reserve between Nuwekloof in the north and Bainskloof in the south (15 569 ha), and the lone-standing Riebeek-Kasteel Mountain (593 ha) in the west. Some important tributaries of the Breede and Little Berg rivers rise in these mountains.

The plan has been developed with the support of the Working for Water Programme (WfW) of the Department of Environment Affairs because they use clearly defined areas such as water catchments, nature reserves or conservancies as logical units for planning invasive alien plant control measures.

This document describes the rationale and necessity for a plan and the process that was followed in developing it. It provides information on the:

- Current state of the catchment including key aspects of the environment, land-use and land ownership
- A summary of the current state of alien plant invasions
- The goal of invasive alien plant control in the catchment developed with stakeholders
- The criteria used to the prioritise control operations
- The budgets and resources, and the partnerships that will be needed to achieve those goals over a 20 year period
- The last section of the document provides information on a range of useful topics for public entities or private land owners embarking on clearing programmes.

The Waterval Centre has, for the purposes of invasive alien plant control, been delineated into 247 management compartments. Invasive alien plants have been recorded in 228 of these compartments which cover about 51 457 ha. The invasions vary in density from < 1% to as much as 92% of canopy cover, with the 5 to 25% density class occurring most frequently. These 228 compartments have been scheduled for control treatments using the Automated Management Unit Control Plan Generation Tool (MUCP Tool). Since 2001 invasive alien plants in 91 of these compartments, covering an area of 16 705 ha, have been treated at least once and some as many as thirteen times.

Pertinent information for each compartment such as the water flows (run-off), accessibility, slope and the age of the veld is stored in CapeNature's Corporate GIS Database. The information on historical and current invasions, previous control treatments and their costs is stored for each of the treatment units (NBALs) is stored in the same database. There is also a cross-link identifying which NBALs fall within each compartment so this information can be summarised at the compartment

level. The GIS database allows for all this information to be easily retrieved and presented at a compartment level and for this information to be loaded into the MUCP Tool.

A multi-criteria decision making process, the Analytic Hierarchy Process, was followed to develop a goal for invasive alien plant control operations in the management area, to develop the criteria needed to achieve the goal, and to assess the relative importance of these criteria by allocating weights (ranking) to them by means of pair-wise comparisons. The last step in the process was to identify the datasets that enabled objective comparisons to be made between compartments with regard to particular criteria. During this process the stakeholders identified the following goal for the plan:

Reduce invasive alien plants on the Waterval Centre to a maintenance level by 2030 while optimising increases in water flows and reductions in threats to biodiversity

We have developed a set of budget scenarios for this plan using a computerised planning system called the Management Unit Control Plan (MUCP) tool. It schedules treatments of invasions in the catchment over the next 20 years based on the priorities that have been identified by the stakeholders in the plan.

The schedule generated by the MUCP tool takes into account the current state of the invasions, benefits of the clearing, treatments that are required and the resources provided in its budget. The tool allows the stakeholders to vary the resource budgets to evaluate whether the goal is feasible or not and to set a more realistic goal where necessary. The tool does not generate a detailed annual schedule of annual operations but NRM has an Annual Plan of Operations tool which serves that purpose.

The MUCP tool generates treatment schedules for an optimal budget, as if funds were unlimited, and four budget scenarios which are set by the user. We selected two realistic budget scenarios with ceilings of R 3.0 million and R 4.5 million and extracted and summarized the compartment treatments and annual budgets per compartment for the next 15 years. Since it is impossible to eradicate every invading plant, the aim is to achieve a maintenance level of ≤ 1% canopy cover. Large portions of the Waterval Centre have been burnt in a number of recent veldfires and much of the vegetation, with the exception of Riebeek-Kasteel Mountain, is less than two years old. We also prioritized the clearing of the burnt areas and the treatment of low density invasions (between 1 and 5% canopy cover). With an annual budget ceiling of R 3.0 million it would take more than 20 years to reach an overall maintenance level, compared with about 14 years if an annual budget of R 4.5 million was available. In young veld cost can be lower largely because non-sprouting trees are killed by the fire and no longer need felling, sprouting trees only require coppice foliar sprays and herbicide treatment of dense seedling regeneration is relatively inexpensive. However, there are a number of factors which could increase costs and these need to be considered when sourcing funding to ensure that sufficient resources are available to deal with any extensive post-fire regeneration before it will require more expensive treatments.

We believe that it is essential to have a lead agent that drives the implementation of any MUCP. Where Working for Water is the funding agency this should be achievable by themselves or an implementing agent, in this case CapeNature. However if there are multiple funding sources, the

position of the lead agent would need to be negotiated. Lastly this plan is of a long-term strategic nature and should be used to inform the compilation of more detailed annual plans of operation (APOs). The MUCP should be regularly reviewed and revised depending on progress made each year and whether or not an event, such as a wildfire, that changes the treatment options occurs.

Acknowledgements

Derek Malan, the previous technical manager for Working for Water Programme (WfW) in the Western Cape (now retired) and Wessel Wentzel were prime movers within WfW, and together with Nigel Wessel (previously of CapeNature), realized that a focus on a systematic, area and priority based, catchment-level approach to clearing invasive alien plants was needed rather than the current, largely unsystematic approach.

We have worked closely with Anthony Robinson of Handmade Connections to modify the pro-type MUCP tool into a flexible and robust operational planning tool.

The authors wish to acknowledge the following persons and organisations for their valuable contributions:

Andrew Wannenburgh of the Department of Environment Affairs' Chief Directorate: Natural Resources Management (NRM) for providing information on updated costs and the mapping for the invasive alien plants clearing programme.

Aadelia Moerat, and her staff from the regional Working for Water office, for ongoing support and interest during the compilation of the plan.

CapeNature staff especially Tony Marshall who managers CapeNature's Integrated Catchment Monitoring Programme for his support in operationalizing of the MUCP tool. Therese Forsyth CapeNature's GIS technologist: Fire and Aliens for supplying us with the latest information on the alien plant invasions and fire history of the land managed by the Waterval Centre and also for preparing maps.

The participants in a workshop held to formulate the goal for the management plan and identify the criteria that would be used to prioritise the clearing operations for Waterval Centre (See Appendix 3).

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Glossary

APO	Annual Plan of Operations – a plan setting out the work that needs to be done by an organisation over a calendar or financial year
BGCMA	Breede-Gouritz Catchment Management Agency incorporating the Breede-Overberg CMA)
CapeNature	Western Cape Nature Conservation Board
CARA	Conservation of Agricultural Resources Act
CMS	Catchment Management System
Condensed ha	Condensed hectares are the equivalent invaded area of invasion if the density is converted to 100% canopy cover (e.g. if the canopy cover is 50% and the area is 10 ha then the condensed area is 5 ha).
DEA	Department of Environmental Affairs
DWAF	Department of Water Affairs and Forestry
GIS	Geographical Information System
IAP	Invasive Alien Plants – plants that have been introduced from outside an area, generally overseas, and have now spread from where they were planted
IUCN	International Union for Conservation of Nature - Founded in 1948 as the world's first international environmental organization and now the world's largest global conservation network
LandCare	LandCare programme of the Western Cape Department of Agriculture
LUI	Land user incentive scheme of DEA's Natural Resources Management Programme
MTO	Mountain to Ocean Forestry – the private company that manage the state plantation areas and is in the last stages of their exit plan in the Western Cape. It merged with another company to become CapePine in about 2010 and is now known as MTO (Cape).
MUCP	Management Unit Control Plan
NBAL	Natural Biological Alien – the code for the management treatment unit (polygon)
NEM:BA	Natural Environmental Management: Biodiversity Act
NQF	National Qualifications Framework
NRM	Natural Resources Management Programme – a set of programmes within DEA which manage natural resources
PPRI	Plant Protection Research Institute
Safcol	South African Forestry Company Ltd – the state forestry corporation responsible for managing state forest land and managing private company leases
SANBI-ISP	South Africa National Biodiversity Institute which runs an invasive species programme (ISP) specifically aimed at finding and eradicating newly invading species
SAPIA	South African Plant Invaders Atlas
TMS	Table Mountain Sandstone – the dominant rock type forming the mountains managed by Waterval Centre; gives rise to nutrient-poor, sandy soils
WCWSS	Western Cape Water Supply System
WESSA	Wildlife and Environment Society of South Africa
WfW	Working for Water Programme – a programme specifically aimed at managing invasive alien plants to reduce their environmental and social impacts, especially on water resources
WIMS	Working for Water Information Management System which stores information on the location and characteristics of each of the treatment units (NBALs) and the treatments applied to it.

1 INTRODUCTION

This document sets out a plan for dealing with alien plant invasions on 55 546 ha of mostly rugged mountainous land managed by the Waterval Centre of the Western Cape Nature Conservation Board (CapeNature). Some important tributaries of the Breede and Little Berg rivers rise in these mountains.

The Waterval Centre includes a number of separate sections including Bokkeriviere (15 236 ha) at the eastern end of the Hex River Mountains, the Hex River Mountains (13 917 ha) and the Witzenberg (10 231 ha) in the centre, the Waterval Nature Reserve (15 569 ha) between Nuwekloof in the north and Bainskloof in the south, and in the lone standing Riebeek-Kasteel Mountain (593 ha) in the west.

The land managed for controlling invasive alien plants, often referred to as IAPs, includes protected areas administered by Cape Nature, private land proclaimed as mountain catchments in terms of the Mountain Catchment Areas Act (Act No 63 of 1970), land where plantation forestry has been discontinued (Exit Areas) and stewardship sites.

The fynbos vegetation of much of the area is categorized by Mucina and Rutherford (2006) as being least threatened sandstone fynbos but some critically endangered shale renosterveld is found in the vicinity of the Voelvlei Dam. The plan has been developed with the support of the Working for Water programme of the Department of Environment Affairs as they use a water catchment as a logical unit for planning control measures for invasive alien plants.

The plan has been developed with the support of the Working for Water Programme (WfW) of the Department of Environment Affairs because they use clearly defined areas such as water catchments, nature reserves or conservancies as logical units for planning invasive alien plant control measures.

This document describes the rationale and necessity for a plan and the process that was followed in developing it. It provides information on the:

- Current state of Waterval Centre including key aspects of the environment, land-use and land ownership;
- A summary of the current state of alien plant invasions;
- The goal of invasive alien plant control in the catchment developed with stakeholders;
- The criteria used to the prioritise control operations;
- The budgets and resources, and the partnerships that will be needed to achieve those goals;
- A final section providing a range of topics for land owners embarking on invasive alien plant training programmes including links websites containing information on capacity (training) and resources, communications and advocacy, legal requirements and additional sources of information; and
- A list of useful literature is also provided.

The plan is based on spatial management units we have termed compartments (but referred to as mini-compartments by CapeNature managers). The boundaries of these units are clearly locatable on the ground and include water courses, roads and tracks, ridgelines, and boundary fences and other permanent features. This means also that each compartment, or portions of it, can be clearly linked to individual land owners or management authorities. The presence and nature of invasive alien plants has been recorded for each of these compartments. Each compartment has been assigned a priority for treatment and each compartment will be used to monitor and evaluate progress against the plan.

This document does not set out a detailed schedule of treatment operations because that is done by a computerised planning system called the Management Unit Control Plan (MUCP) tool[1] which schedules treatments of invasions in the catchment over the next 20 years (Section 5; Appendices 4 & 5). The schedule generated by the tool takes into account the current state of the invasions, benefits of the clearing, treatments that are required and the resources provided in its budget. The tool allows the stakeholders to vary the resource budgets to evaluate whether the goal is feasible or not and to set a more realistic goal where necessary. This is important because the goal needs to be challenging but achievable to ensure that people are motivated to rise to the challenge. In addition to the control operations, the plan also needs to provide for: (a) the prevention of new invasions by ensuring, as far as possible, that no new invaders are introduced to the area; (b) surveys to identify new invaders; and (c) rapid action to eradicate those invaders wherever possible. The South Africa National biodiversity Institute's Invasive Species Programme (SANBI-ISP) has been dealing with a number of emerging invasive plant species in the Wolseley area that undoubtedly escaped from the Kluitjieskraal nursery or the town.

The overall goal for this plan was developed in 2016 in collaboration with CapeNature, and is based on the information on the state of the catchment presented in this report (see Section 2). The overall goal is that:

Reduce invasive alien plants on the Waterval Centre to a maintenance level by 2030 while optimising increases in water flows and reductions in threats to biodiversity

The participants in this workshop also developed a set of criteria that would be used to prioritise control measures for the Waterval Centre and, with some modifications, this can also be used for other protected areas managed by CapeNature.

1.1 Why manage invasions?

Invasions of alien plant species in South Africa are recognised as a major threat to biodiversity, water resources and land productivity (van Wilgen *et al.* 2008, De Lange and Wilgen 2010). Recent estimates are that some 8 750 taxa have been introduced, 660 of these have become naturalised and about 559 have been listed as invasive (Wilson *et al.* 2013, NRM 2014). The total amount of water that is lost because of invading alien plants is estimated to be at least 2.9% of the volume of

[1] The MUCP tool is being developed on behalf of NRM by a firm of software developers, Handmade Connections and there are plans to make enhancements to it should funding be available.

water that flowed in our rivers prior to European settlement (Le Maitre *et al.* 2013). In volume terms, this is 1 444 million m^3/year - a quantity that is hard to grasp. A typical household of 4 people uses around 1000 litres per day or about 365 m^3/year (1 000 litres = 1 m^3). This means that invading alien plants use enough water to supply about 10 million households for a year. In the Western Cape the Berg and Breede Rivers are the most heavily invaded and the water losses are estimated to be around 6%. If left unchecked the extent and density of the invasions, and thus the impact on water resources, could increase significantly resulting in the loss of much of the available water in certain catchment areas.

1.2 A brief history of alien plant management in the Waterval Centre

It is important to understand the history of alien plant clearing on land managed by the Waterval Centre because, while this plan needs to continue and complete the clearing that has been done, it will involve a wider group of implementers and direct efforts towards clearing the areas that are considered most important for the whole area. Most of the high lying areas managed by CapeNature have only received an initial treatment and some have not been treated at all. One of the aims of this plan is to try to coordinate clearing efforts so that they can be as effective as possible.

The Working for Water Information Management System (WIMS) contains clearing records from the area dating back to November 2001. However, work to clear Black Wattle (*Acacia mearnsii*) from some of the main rivers started in 1996 (Peter Viloen, pers. comm., 2016). The rivers along which work was done were the Klein Berg, running through Nuwekloof, its tributary the Watervalsrivier, the Witte River in Bainskloof in the vicinity of Tweede Tol, and the Dwarsrivier in Mitchells Pass above the confluence with the Witels River. Some work was also done along the Koekedouw River that flows into the Ceres Koekedouw Dam.

In the Hex River Mountains CapeNature has thus far only carried out invasive alien plant clearing in the Ben Evite Nature Reserve. This has either been an initial treatment or a first follow-up treatment. No clearing work has been done far in the Fonteintjiesberg Nature Reserve. Some clearing efforts have been made over the years on the University of Cape Town's Zuurberg property, the source of the Witels River, and on Waaihoekskloof owned by the Mountain Club of South Africa. However, the nature and extent of these efforts has not been recorded.

The South African National Defence Force (SANDF) owns (manages) about 5,300 ha on the flats adjacent to the Bokkeriviere Nature Reserve at the eastern end of the Hex River Mountains. CapeNature has been responsible for some clearing invasions in wetlands feeding the Bok River that flows into Verkeerdervlei Dam. However, there is no information on whether or not the SANDF has embarked on any clearing of invasive alien plants in the vicinity.

1.3 Working for Water

The Department of Water Affairs and Forestry's Working for Water (WfW) programme was initiated in 1995 with two main aims: (i) to control and monitor invasive alien plants to reduce their impacts

on water and other natural resources; and (ii) to provide unemployed or previously disadvantaged people with work for a period and to develop their skills to improve their employment prospects (van Wilgen *et al.* 1998). During 2013 the Working for Water programme was relocated in the Department of Environment Affairs Natural Resource Management programmes (NRM 2014). The environmental and social imperatives of the programme include: (i) augmenting water security; (ii) improving ecological integrity; (iii) restoring the productive potential of land; (iv) promoting the sustainable use of natural resources; and (v) investing in the marginalised communities of South Africa.

The programme has grown during the past 20 years and is now one of the largest environmental programmes in the world. Until recently its activities were confined to supporting actions that helped to control and eradicate invasive alien species. The recently published regulations (DEA 2014) under the National Environmental Management: Biodiversity Act (NEM:BA) (DEA 2004) now enable it to exercise its legal powers to deal with invasive alien species and their management. However, the primary focus of the programme is on educating people about the negative impacts of invasions and enabling them to take action themselves, rather than prosecuting them. One of the requirements of the new legislation is that organs of state must compile plans to deal with all the invasive alien species in a particular area (section 76 of NEM:BA). This plan is aimed at meeting those requirements and providing CapeNature with a logical and systematic approach to controlling invasive species in the areas managed by the Waterval Centre.

The threats posed by invasive alien plants are addressed in section 76 of the NEM:BA Act which requires all organs of state to prepare invasive species monitoring, control and eradication plans for land areas under their control. The wording and the context make it clear that these plans are for specific areas of land, namely area-based, site-based or site-led plans (Downey and Sheppard 2006, NRM 2014). The focus of these plans is on characterising, prioritising and effectively managing the invasions. A good example of regional[2] level prioritisation is the one developed for the Western Cape by Working for Water (Forsyth *et al.* 2012). This plan focuses on one of the high priority catchments identified in that study.

The programme has also developed a number of ways of supporting control measures against invasive alien plants. They provide funds and resources in a number of ways:

- Direct involvement in the management of the clearing teams where they provide all the resources and oversee the operations;
- Indirect involvement through the funding of:
    - Control operations managed by implementing agents such as CapeNature, and for steep areas requiring specialised safety precautions and skills involving rope-work, Working on Fire's High Altitude Teams (HATs).
    - Land-user incentives (LUIs) where groups of land-owners apply for funding to carry out control operations on their land. These initiatives can also include way of using the material (biomass) from the clearing to produce products and rehabilitation of degraded land and river systems.
    - Other inputs such as providing herbicides and advice to land-owners.

[2] The WfW programme has 9 regions corresponding more or less with nine provinces of South Africa.

- Support for the introduction and maintenance of biological control agents for invasive alien plants, and research into agents for those which do not yet have effective agents.

A key aim of this plan is to find ways to use all of these options to optimise the efficacy and efficiency of the management of the invasions. This plan is aligned with the national strategy and the regional priorities of the Working for Water programme. These include ensuring that the benefits of the clearing are maximised, in this case by protecting water and biodiversity resources in the mountain catchments managed by the Waterval Centre.

1.4 Managing invasive alien plant species

Management of invasive species is a complex task, whether it involves managing all the species found in a particular area, as done by Working for Water and other agencies, or managing invasions by single species (DEA 2004, 2014). It is complex because it involves motivating and co-ordinating a range of land owners and land management agencies (each with their own agendas) and dealing with invasions by mixtures of species, each with different treatment requirements, in a range of environments from river banks to mountain tops. The plan also needs to allow for unpredictable events such as wildfires and floods which create opportunities for the spread and regeneration of invading alien plants. The plan also must include monitoring procedures to measure and record progress, and the evaluation of that progress against the objectives, so that the plan can be adapted when progress is not satisfactory.

The Act and regulations require that all state organs, from national departments to local municipalities, must control declared invader species on their land. Everyone who is a land owner must have at least a list of the invaders on their land and a plan to deal with them. The only way to do this effectively is for all the land owners to combine their efforts and resources and become actively involved in controlling invasive alien plants. Treatment operations are labour intensive and many species require herbicides for effective control which makes these operations very resource intensive and expensive, so cost sharing is essential to ensure that the available resources are used to maximum effect. We deliberately followed a participatory approach to developing this MUCP by consulting with CapeNature managers to ensure that they: develop a common understanding of the rationale for controlling invading alien plant species, actively participate in the plan's implementation, and coordinate activities to achieve goals.

2 SITUATIONAL ASSESSMENT

The section provides a description of the protected areas and private mountain catchment areas managed by the Waterval Centre as a background to the plan and to provide the context for it. The area comprises 55 546 ha of mostly rugged mountainous land and includes the Bokkeriviere (15 236 ha) in the east, part of the Hex River Mountains (13 917 ha) and Witzenberg (10 231 ha) in the centre, Waterval Nature Reserve (15 569 ha) between Nuwekloof Pass and Bainskloof Pass, and the Riebeek-Kasteel Mountains (593 ha) in the west.

2.1 Location and elevation

The Waterval Centre is situated between Tulbagh in the north, Worcester in the south, Riebeek-Kasteel in the west and Touws River in the north-east (Figure 1). The centre includes a portion of the Berg River catchment in the west, the Breede River catchment in the centre, and the Gouritz River catchment in the east. The western slopes of the Elandskloof Mountains drain into the Berg as do the eastern slopes from about Wolseley northwards and Riebeek-Kasteel Mountain. The remainder lies in the Breede River catchment, including the Witzenberg, Waaihoek and Hex River mountains. A small section in the east drains into the Touws River catchment. These mountains include some of the highest peaks in the Western Cape, notably the Matroosberg at 2249 m.

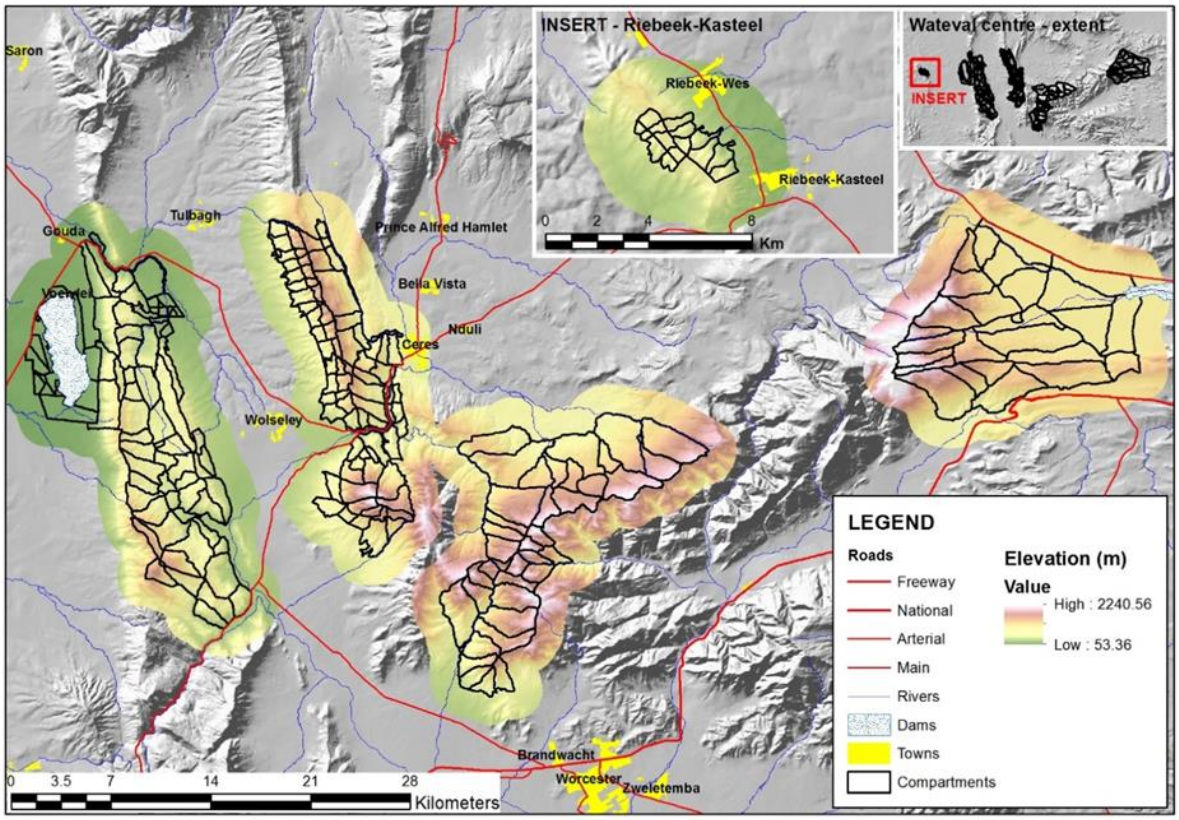


Figure 1: *The location of the protected areas and adjacent mountain catchments managed by the Waterval Centre showing the main topographical features.*

2.2 Mean annual rainfall

Much of the rain falls on the upper slopes and peaks of the Hex River Mountains and the Witzenberg where the mean annual rainfall is estimated to reach 2 000 mm/year (Figure 2). However, in the Bokkerivier area in the east, rainfall drops to as low as 267 mm per annum. Since most of the water is sourced from the mountain areas and relatively little from the valley bottoms it means that invasions in the mountain areas can, potentially, have a much greater impact on water than those in the valley bottoms.

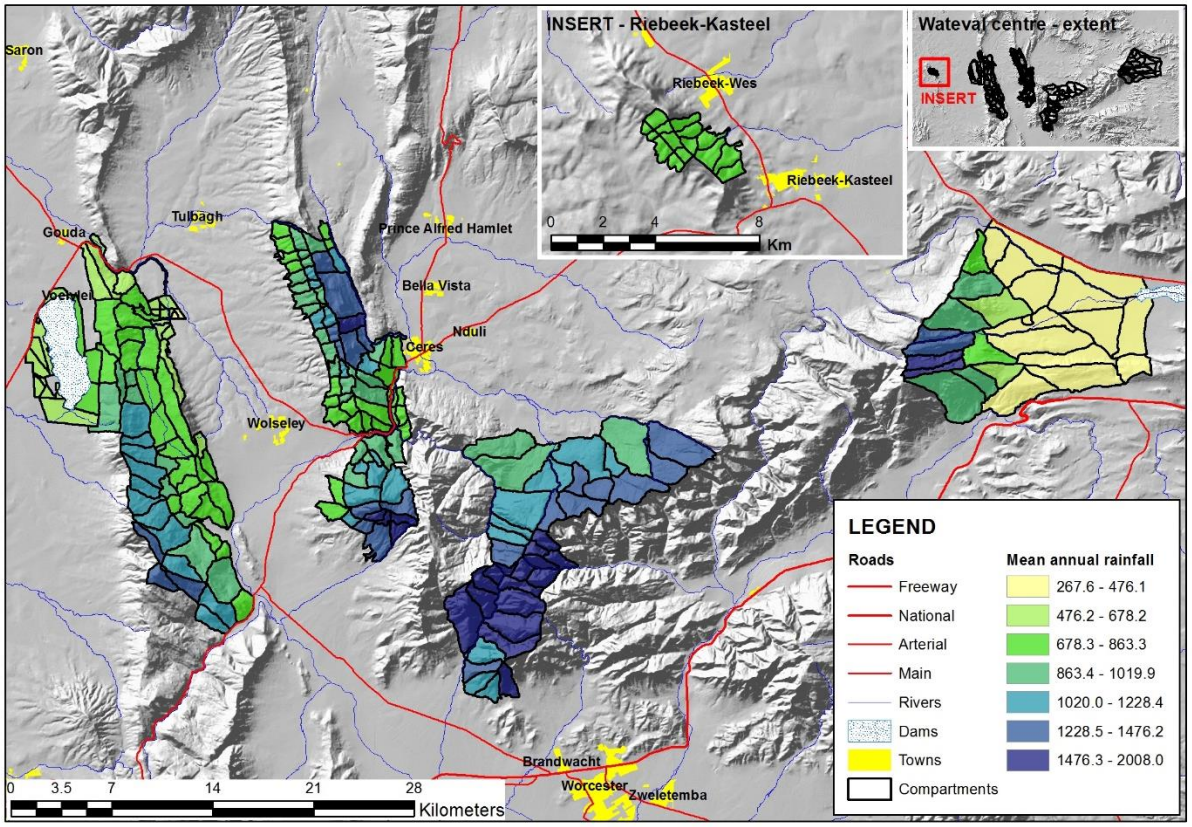


Figure 2: *Mean annual rainfall for the areas managed by the Waterval Centre ranging from ± 265 to 2010 mm per year.*

2.3 Mean annual run-off

The areas managed by the Waterval Centre include portions of quaternary catchments in the Berg River Catchment, H10B, C, D, F and H, and H20a, B and E in the Breede River Catchment and J12 a and B in the Gouritz River Catchment. These catchments had an estimated mean annual river flow (runoff) of 136.5 million m^3/year prior to modern developments (Middleton and Bailey, 2008). The runoff makes a substantial contribution to the flows in the entire Breede River system but the contributions to the Berg and Gouritz River systems are relatively small. Voelvlei Dam, one of the City of Cape Town's important storage dams, is located in this area and the Brandvlei Dam is downstream near Worcester. An estimate of the distribution of the mean annual runoff, based on the rainfall (Nel *et al.* 2013), emphasises that most of the water is sourced from the rugged

mountain areas and relatively little from the valley bottoms (Figure 3). This is important because it means that invasions in the mountain areas can, potentially, have a much greater impact on water resources than those in the valley bottoms, except for riparian invasions.

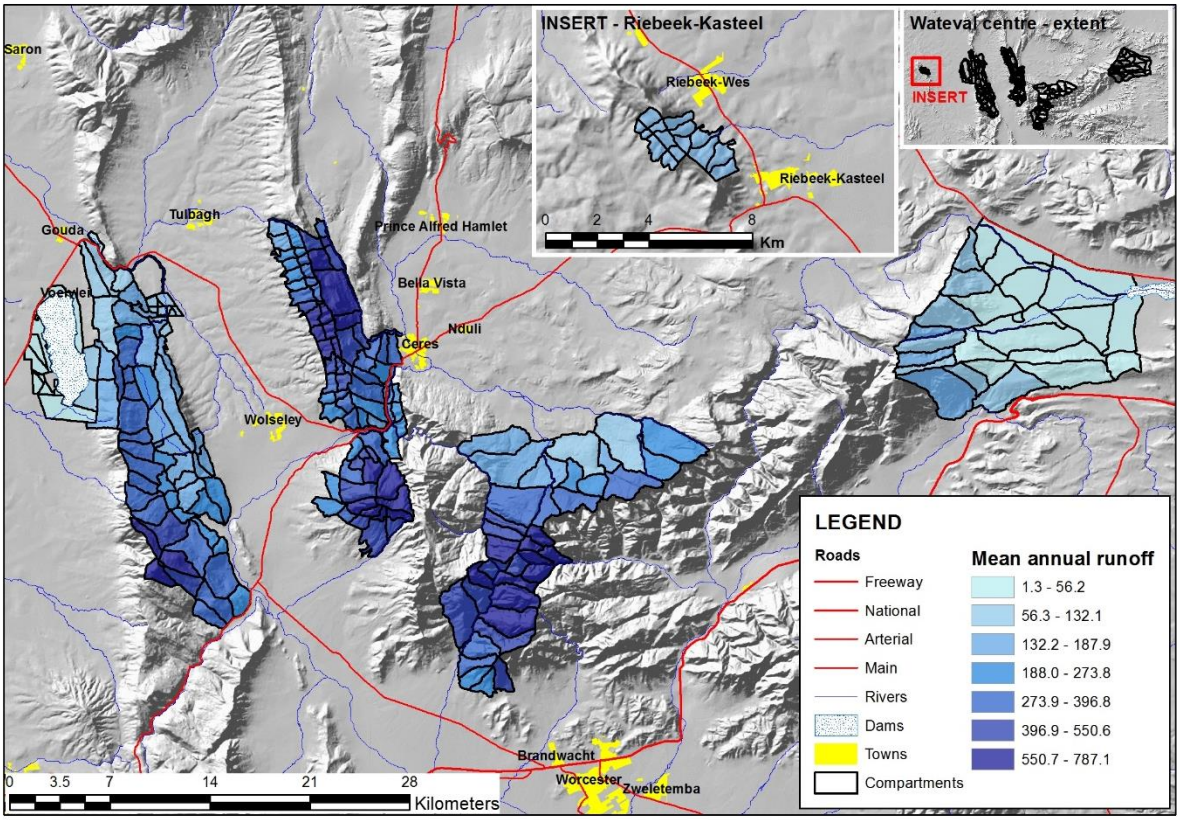


Figure 3: Mean annual run-off ranging from 1 to < 790 mm per year for the areas *managed by the Waterval Centre showing main topographical features.*

2.4 Terrain and slope

Given the rugged nature of the mountains, it is not surprising that a large part of the area is characterised by steep to very steep slopes (Figure 4, Table 1). This is important because steep areas like these are difficult to work in, especially when carrying the equipment needed to deal with large trees such as pines. The WfW programme has identified that slopes ≥ 35° need to be worked by specially trained high altitude teams of the Working on Fire Programme because they need rope skills to ensure their safety. The steep slopes also have significant implications for the cost of clearing because these skilled people rightly cost more per hour and the time required to reach these areas adds significantly to the cost.

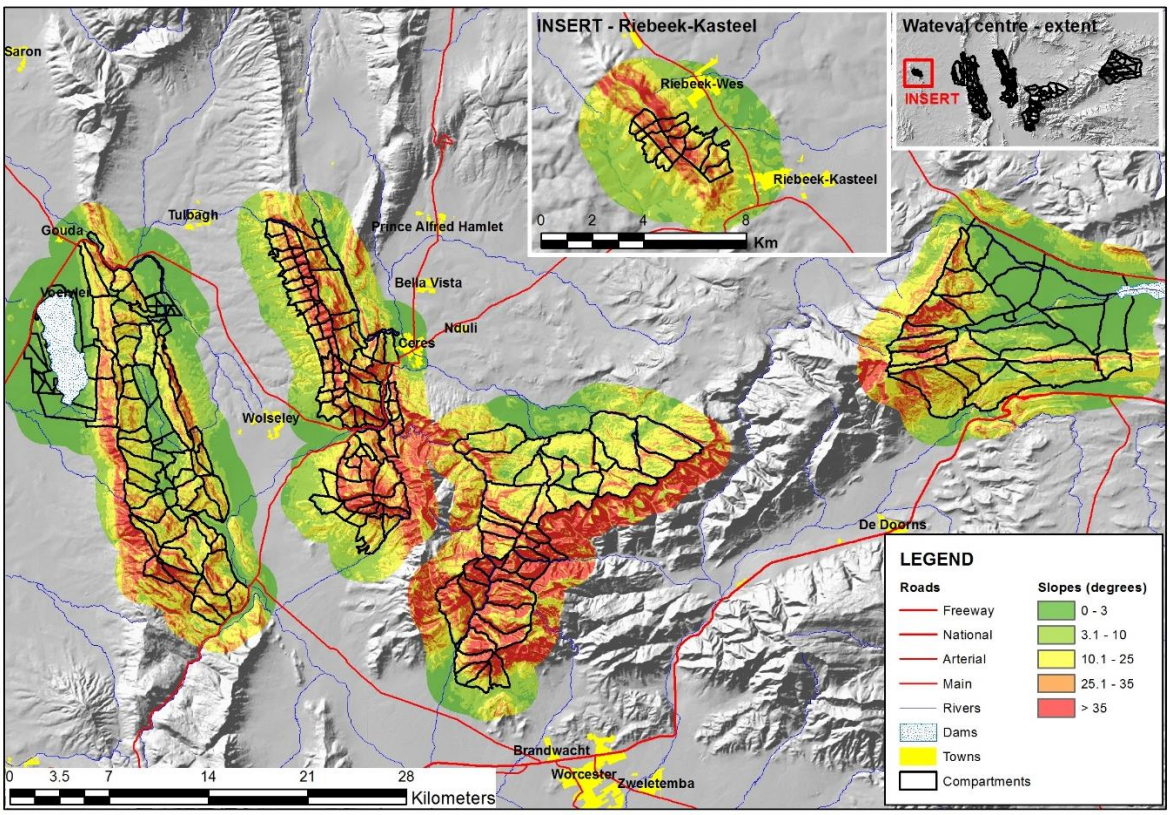


Figure 4: *Distribution of Working for Water slope classes for the areas managed by the Waterval Centre.*

Table 1*: The relative importance of different Working for Water slope classes for the areas managed by the Waterval Centre.*

Slope class (degrees) [1]	Hectares	% of total area
0 – 3	10 885.5	19.6
3.1 – 10	8 449.6	15.2
10.1 – 25	19 440.6	35.0
25.1 – 35	9 833.5	17.7
≥ 35° (high attitude – rope work)	6 936.4	12.5

Notes:

[1] Calculated from the digital elevation model with a resolution of 20 metres in CapeNature's Corporate GIS Database.

2.5 Natural vegetation

The mountain areas of the Waterval Centre have retained most of their natural vegetation because the combination of the rugged terrain and infertile soils has protected most of the sandstone and shale fynbos vegetation units occurring in the area (Figure 5). However, much of the surrounding lowlands have been transformed for agriculture, leaving only limited natural remnants falling within the area managed by the Waterval Centre.

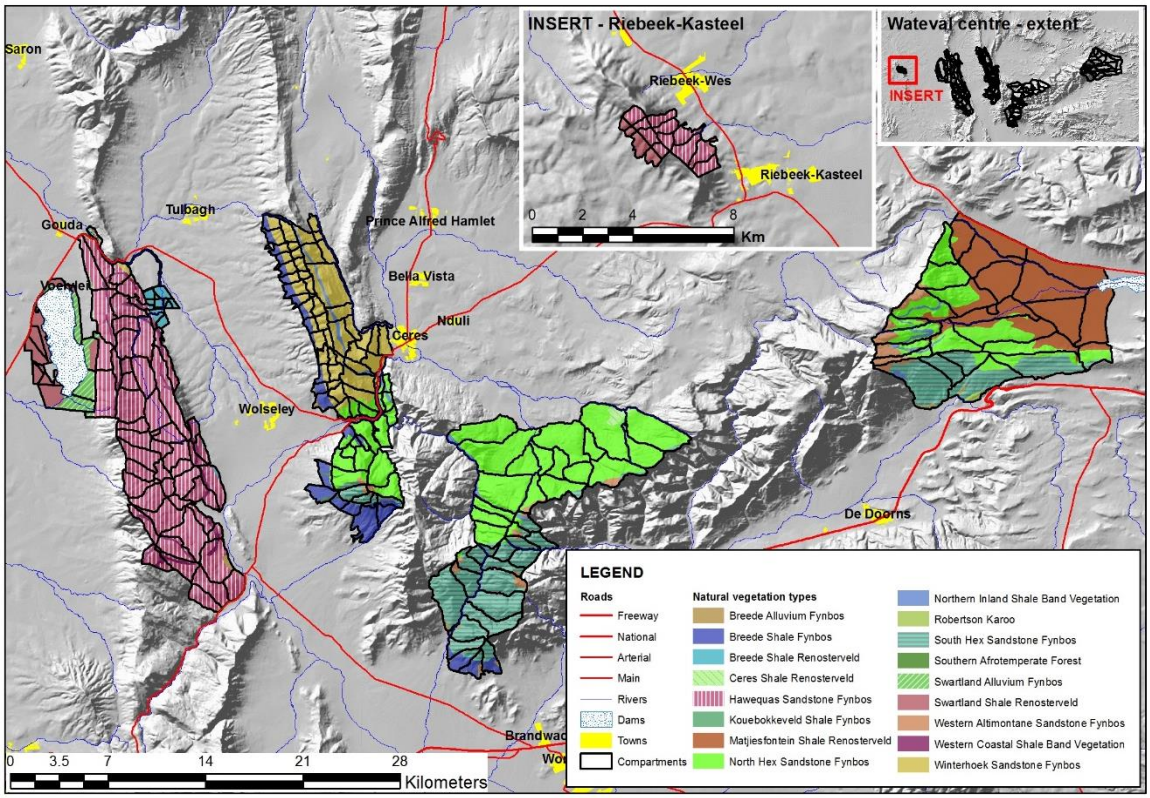


Figure 5: *The natural vegetation types and extent for the areas managed by the Waterval Centre.*

There are 17 vegetation types or units in the area including a Succulent Karoo type, 4 Renosterveld types, 11 fynbos types including shale band vegetation, and a Southern Afrotemperate Forest type (Table 2). Kouebokkeveld Shale Fynbos only covers 10.3 ha whilst Hawequas Sandstone Fynbos covering 12 481.9 ha and North Hex Sandstone fynbos 15 024.6 ha are the most common vegetation types. Most of the natural vegetation (95.3%), whether invaded or not, has the International Union for Conservation of Nature (IUCN) status of least threatened while 0.3% of the area is covered by two vulnerable vegetation types: Ceres Shale Renosterveld and Kouebokkeveld Shale Fynbos (Table 2). Breede Alluvium Fynbos only occurs on 295 ha (0.5 %) of the area and is endangered. It occurs at altitudes mostly between 200 – 350 m in the Upper Breede River flats and extends to the Hex River Valley (Mucina and Rutherford 2006). Swartland Shale Renosterveld and Swartland Alluvium Fynbos are critically endangered and occur in the low lying portions of the Waterval and Riebeek-Kasteel sections. Collectively they cover 3.9% of the area.

Table 2: *Natural vegetation types (units) for the protected areas managed by the Waterval Centre.*

Section / Vegetation unit (type)		Critically endangered (ha)	Endangered (ha)	Least threatened (ha)	Vulnerable (ha)	Total (ha)
Bokkeriviere	Breede Alluvium Fynbos		50.9			50.9
	Ceres Shale Renosterveld				2.3	2.3
	Matjiesfontein Shale Renosterveld			7 187.8		7 187.8
	North Hex Sandstone Fynbos			4 302.5		4 302.5
	Northern Inland Shale Band Vegetation			285.5		285.5
	Robertson Karoo			66.6		66.6
	South Hex Sandstone Fynbos			2 641.5		2 641.5
	Western Altimontane Sandstone Fynbos			698.9		698.9
	Sub-totals		**50.9**	**15 182.7**	**2.3**	**15 235.8**
Hex River	Breede Alluvium Fynbos		112.4			112.4
	Breede Shale Fynbos			354.3		354.3
	Ceres Shale Renosterveld				140.4	140.4
	Kouebokkeveld Shale Fynbos				0.7	0.7
	North Hex Sandstone Fynbos			8 212.9		8 212.9
	Northern Inland Shale Band Vegetation			169.5		169.5
	South Hex Sandstone Fynbos			4 634.8		4 634.8
	Western Altimontane Sandstone Fynbos			291.6		291.6
	Sub-totals		**112.4**	**13 663.1**	**141.1**	**13 916.6**
Riebeek-Kasteel						
	Hawequas Sandstone Fynbos			430.8		430.8
	Swartland Shale Renosterveld	162.1				162.1
	Sub-totals	**162.1**		**430.8**		**593.0**
Waterval	Breede Alluvium Fynbos		75.9			75.9
	Breede Shale Renosterveld			521.1		521.1
	Hawequas Sandstone Fynbos			12 051.1		12 051.1
	Swartland Alluvium Fynbos	903.3				903.3
	Swartland Shale Renosterveld	1 089.8				1 089.8
	Western Coastal Shale Band Vegetation			818.2		818.2
	Winterhoek Sandstone Fynbos			109.7		109.7
	Sub-totals	**1 993.1**	**75.9**	**13 500.1**		**15 569.0**
Witzenberg	Breede Alluvium Fynbos		56.0			56.0
	Breede Shale Fynbos			1 839.3		1 839.3
	Breede Shale Renosterveld			1.4		1.4
	Ceres Shale Renosterveld				16.9	16.9
	Kouebokkeveld Shale Fynbos				9.6	9.6
	North Hex Sandstone Fynbos			2 509.3		2 509.3
	Northern Inland Shale Band Vegetation			340.9		340.9
	South Hex Sandstone Fynbos			401.3		401.3
	Southern Afrotemperate Forest			31.8		31.8
	Western Altimontane Sandstone Fynbos			73.7		73.7
	Winterhoek Sandstone Fynbos			4 951.0		4 951.0
	Sub-totals		**56.0**	**10 148.6**	**26.5**	**10 231.1**
	Totals	**2155.2**	**295.1**	**52 925.3**	**169.9**	**55 545.5**

2.6 Biodiversity

CapeNature maintains an extensive Biodiversity Database, where all species distribution localities are recorded, both on and off reserves. This database also includes IUCN categories for listed species, which indicates the species' international conservation status.

The highest number of threatened species is recorded in the compartments that are found in the critically endangered Swartland Alluvium Fynbos and Swartland Shale Renosterveld which are located near the Voelvlei Dam (Figure 6). This is not surprising as most of this veld type has over the years been transformed into wheat fields both here and elsewhere.

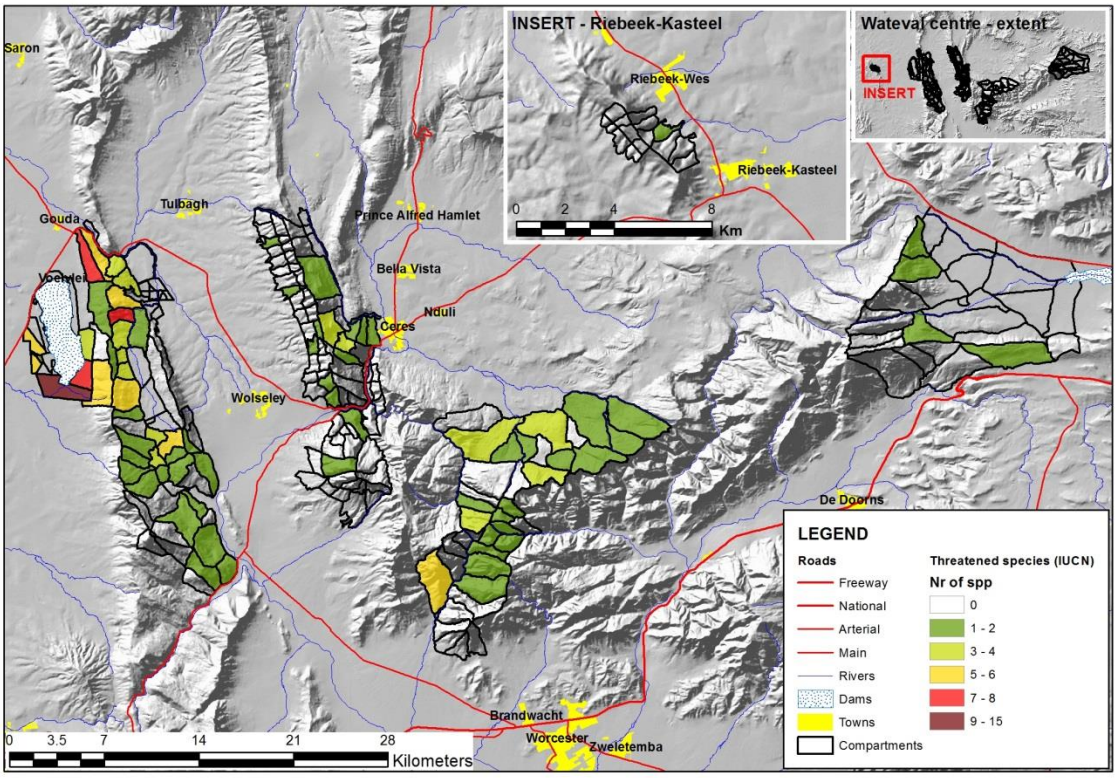


***Figure 6**: The number of threatened species recorded for the compartments in the areas managed by the Waterval Centre.*

2.7 History of clearing and current state of invasion

The first (clearing records) efforts to control alien invasive plants in the protected areas and mountain catchments managed by the Waterval Centre were recorded in the Working for Water Information Management System (WIMS) during November 2001.

Initially clearing was done mainly around the then Waterval Forest Station and in the major rivers of quaternary catchment G10E which is part of the Berg River system. Efforts were then expanded to clear areas around the Voelvlei Dam in quaternary catchment G10F. Many of these areas have now

had more than four follow-up treatments and in some places as many as 10 follow-ups (Figure 7). Clearing activities also included some private land. For example by 2010 five follow-up treatments had been completed on a farm to the west of Ontongskop in the vicinity of the Voelvlei Dam where gum, pine and wattle "woodlots" are present.

In 2001 in these areas the densities recorded for different invasive alien plant species (2001) were: *Pinus* species 78% to 88%, *Acacia* species 38% to 78%, *Acacia saligna* 63%, *Acacia mearnsii* 88% and *Eucalyptus* species ≥ 88%. Nbal analysis records extracted from WIMS indicate that average invasive alien plant densities have been reduced to less than 20% in these areas.

The clearing effort was then expanded to include the Witzenberg, where densities of invasive alien plant species such as *Hakea* species were reduced from 30% to less than 5% by 2014. At the start, many dense stands of *Pinus canariensis* recorded in WIMS but these have now been successfully removed from the area. Many areas have received follow-up treatments, for example, the Wolwekloof area next to the Wittebrug Nature Reserve was initially cleared in 2005 and during 2014 received its 11th and 12th follow-up treatments.

All clearings efforts were focussed in the Waterval and Witzenberg sections from 2001 to 2009. This included work on private land, for example, on the eastern side of Witzenberg, at Wakkerstroom, along the Koekedouw River that feeds the Ceres Koekedouw Dam. Compartments here have received five follow-up treatments.

In 2011 clearing commenced in the Ben Etive Nature Reserve on the northern slopes of the Hex River Mountains in the quaternary catchment H10B of the Breede River. Here *Pinus* species and *Acacia longifolia* occurred at densities of ≤ 5% canopy cover. During the same year, clearing commenced in Riebeek-Kasteel where *Eucalyptus* and *Hakea* species occurred in densities between 5 to 16%. The only recorded clearing in the Bokkeriviere area also took place during 2011 when dense stands (54 to 65%) of a *Eucalyptus* species were cleared from a wetland on the Bokrivier Farm.

Invasive alien plants have been recorded in 228 of the 247 mapped compartments (MUIs) (Table 3). This represents 92.6% (51 457 ha) of the total land managed for invasive alien plans control by the Waterval Centre. The cleared compartments cover 30% (16 705 ha) of the 51 457 ha identified for invasive alien plant control (Table 3).

***Table 3**: Areas (hectares) of the separate sections managed by the Waterval Centre.*

Section	Hectares	Compartments	MIUs [1]	NBALs [2]
Bokkerivier	15 236	27	27	1
Hex River	13 917	39	32	10
Riebeek-Kasteel	593	15	15	9
Waterval	15 569	81	81	42
Witzenberg	10 231	85	73	29
		247	**228**	**91**
Total (ha)		55 546	51 457	16 705
		100%	92.6%	30.1%

Notes:

1. Mapped Invaded unit
2. NBALs = compartments where clearing has taken place

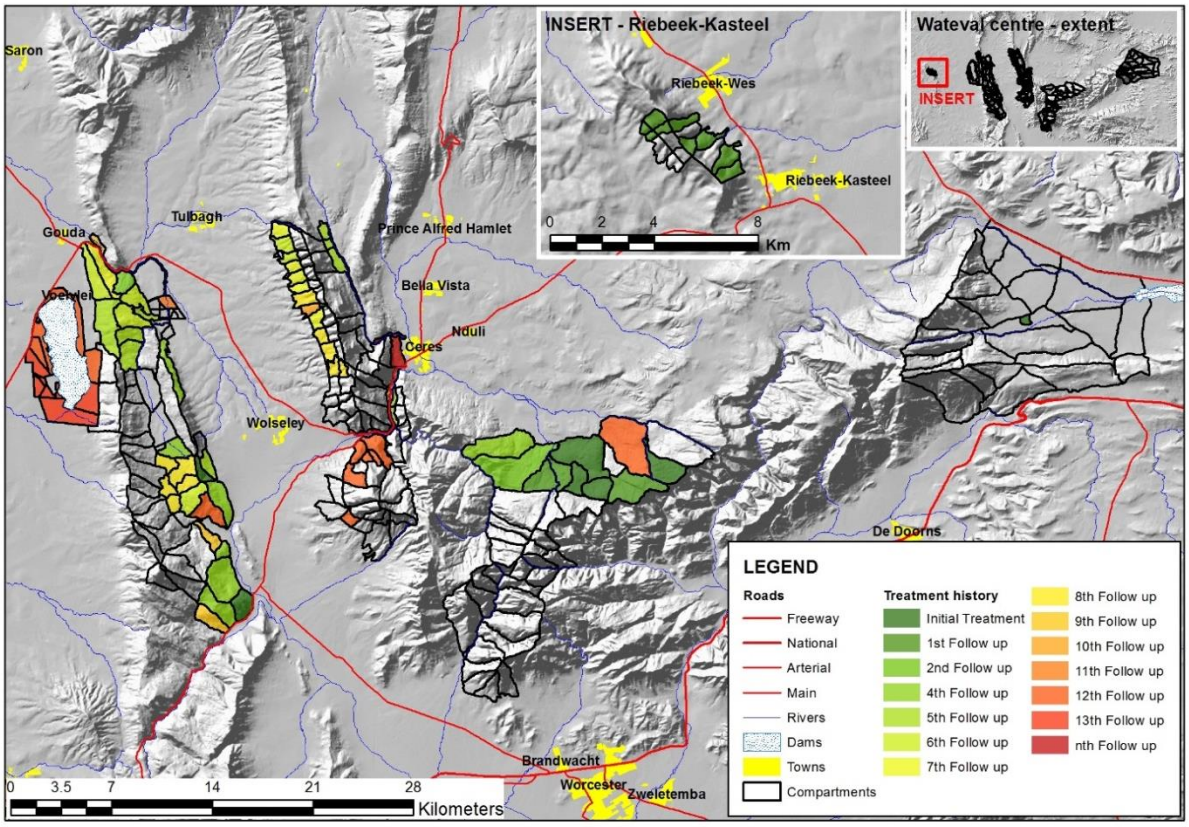


***Figure 7**: The invasive alien plant treatments undertaken in the areas managed by the Waterval Centre.*

If only the dominant five invasive alien plant species per compartment are considered, at least 14 different invading species have been recorded for the Waterval Centre (Table 4; Figure 8).

Table 4: *Attributes of the dominant invasive plant species in areas managed by the Waterval Centre.*

Species	Common name	CARA Category	NEMBA Category	Area invaded (ha) [1]	% of total invaded area [1]	Growth form	Distribution and habitat invaded	Reproductive mode	Age (years) when first seed is produced	Herbicide required [4]	Bio-control agent [5]
Acacia cyclops	Rooikrans	2	1b	64.0	0.7	Tree / shrub	Landscape	Reseeder		No	Yes, effective *Dasineura dielsii, Melanterius servulus*
*Acacia longifolia**	Long-leaved wattle	1	1b	1209.6	12.8	Tree / shrub	Mountain slopes	Reseeder	3	Yes	Yes, effective *Trichilogaster acacialongifoliae*
*Acacia mearnsii**	Black wattle	2	2	1858.9	19.7	Tree	Riparian and landscape	Sprouter	3	Yes	Yes, effective *Ceratocystis albofundus, Cylindrobasidium leave, Dasineura rubiformis, Melanterius maculatus*
*Acacia melanoxylon**	Australian blackwood	2	2	64.7	0.7	Tree	Riparian and Landscape	Sprouter	3	Yes	Yes, effective *Melanterius acaciae*
Acacia pycnantha	Golden wattle	1	1b	75.7	0.8			Reseeder		Yes	Yes, agent available *Trichilogaster signiventris*
*Acacia saligna**	Port Jackson willow	2	1b	108.6	1.1	Tree / shrub	Landscape	Sprouter	3	Yes	Yes, effective *Melanterius compactus,* Gall rust *(Uromycladium tepperianum)*
Eucalyptus globulus	Blue gum	-	-	116.7	4.8	Large tree		Coppices and seeds freely	3	Yes	No
Hakea gibbosa	Rock hakea	1	1b	356.9	3.8	Tree / Shrub		Reseeder		Yes (minor)	Yes, negligible; stem borer and green seed feeder

Species	Common name	CARA Category	NEMBA Category	Area invaded (ha) [1]	% of total invaded area [1]	Growth form	Distribution and habitat invaded	Reproductive mode	Age (years) when first seed is produced	Herbicide required [4]	Bio-control agent [5]
Hakea sericea	Silky hakea	1	1b	1801.4	19.1	Tree / Shrub	Mountain slopes	Reseeder	2	Yes (minor use)	Yes, partly effective *Aphanasium austral, Carposina autologa, Colletotrichum acutatum, Cydmaea binotata, Dicomada rufa, Erytenna consputa*
Pinus pinaster	Cluster pine	2	2 in plantations, 1b elsewhere	2217.0	23.5	Tree	Mountain slopes	Reseeder	5	Yes	No
Pinus radiata	Monterey pine	2	2 in plantations, 1b elsewhere	632.4	6.7	Tree	Mountain slopes	Reseeder	7	Not listed	No
Populus X canescens	Grey poplar	2	2	570.2	6.0	Deciduous Tree	Riparian and seeps	Suckers	No	Yes	No
Rubus fruticosus	European blackberry (Braam)	2	2	2.1	0.0	Thorny herbaceous shrub		Vegetative	2 - 3	Yes	No
Sesbania punicea	Red sesbania	1	1b	33.0	0.3	Small tree	Riparian and seeps	Reseeder	2- 3	No	Yes, effective snout weevils; *Trichapion lativentre, Rhyssomatus marginatus and Neodiplogrammus quadrivittatus*

Notes:

1. *Condensed hectares*
2. **information from http://www.issg.org*
3. ***information from https://florabase.dpaw.wa.gov.au/*
4. *Herbicide information taken from https://sites.google.com/site/wfwplanni*
5. Biocontrol data obtained from (Klein 2011).

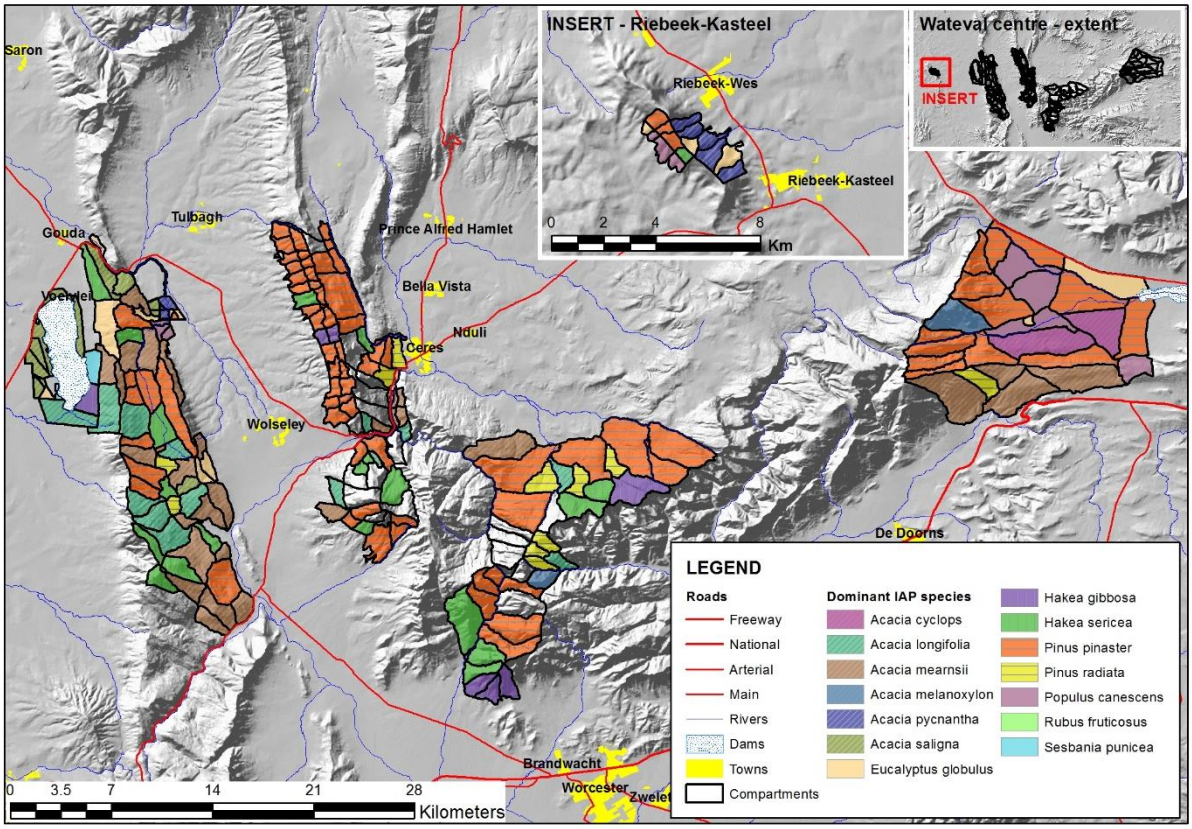


Figure 8: *The dominant invasive alien plants for each mapped compartment in the areas managed by the Waterval Centre.*

At higher attitudes the invading plant species are predominantly Cluster Pine (*Pinus pinaster*), Monterey Pine (*Pinus radiata*) and Silky Hakea (*Hakea sericea*) while on the lower slopes and river courses Long-leaved Wattle (*Acacia longifolia)* and Black Wattle (*Acacia mearnsii*) are most common (Figure 9). The Australian *Acacia* species are probably the most problematic plants as they form extensive and dense stands and require many follow-ups to deal with their ongoing recruitment from long-lived seed banks (Stirton 1978, Campbell 1993).

See http://www.invasives.org.za/plants/plants-a-z for more information on these species and other invaders in the area managed by the Waterval Centre.

Figure 9: *Common invasive alien plant species occurring on the Waterval Centre (A)* Black Wattle *(Acacia mearnsii; (B)* Monterey Pine *(Pinus radiata); (C)* Port Jackson Willow *(Acacia saligna); (D)* Silky Hakea *(Hakea sericea; (E)* Cluster Pine *(Pinus pinaster); and (F)* Long-leaved Wattle *(Acacia longifolia (Photos: G. Forsyth and D. Le Maitre).*

The Waterval Centre has a total invaded area of 51 457 ha. Only about 1% consists of closed canopy stands while dense stands (50-75%) cover 6.6% of the invaded area. Medium density (25-50%) stands occupy about 19% and scattered stands (5-25%) about 39%. Very scattered stands (1-5%) are found in 21.7 % of the area while about 13% is at a maintenance level of ≤ 1% canopy cover (Table 5; Figure 10).

***Table 5**: The invasive alien plant canopy cover density classes for areas managed by the Waterval Centre.*

Density classes for MUI [1]	Hectares	% of total area
0 – 1	6 517.2	12.7
1 – 5	11 144.1	21.7
5 – 25	20 097.9	39.1
25 - 50	9 806.8	19.1
50 – 75	3 415.7	6.6
≥ 75	475.5	0.9
	51 457.2	**100**

Some density classes are not found in some management sections, for example Bokkeriviere and Riebeek-Kasteel have no stands with densities > than 50% (Table 6).

***Table 6**: The invasive alien plant canopy cover density classes for each section of the area managed by the Waterval Centre.*

Hectares	Density classes for MUI [1]	Hectares	% of area
Bokkeriviere	≤ 1	2 683.5	17.6
	1 – 5	4 431.0	29.1
	5 – 25	5 135.9	33.7
	25 – 50	2 985.5	19.6
	50 -75	-	-
	≥ 75	-	-
	Sub-total	**15 235.8**	
Hex River	≤ 1	1 373.9	11.3
	1 – 5	280.8	2.3
	5 – 25	5 718.9	46.9
	25 - 50	2 109.2	17.3
	50 – 75	2 382.4	19.5

Hectares	Density classes for MUI [1]	Hectares	% of area
	≥ 75	325.4	2.7
	Sub-total	**12 190.6**	
Riebeek-Kasteel	≤ 1	26.3	4.4
	1 – 5	102.0	17.2
	5 – 25	412.1	69.5
	25 - 50	52.5	8.9
	50 – 75	-	-
	≥ 75	-	-
	Sub-total	**593.0**	
Waterval	≤ 1	1 034.4	6.6
	1 – 5	5 213.8	33.5
	5 – 25	5 892.8	37.8
	25 - 50	2 394.7	15.4
	50 – 75	1 033.3	6.6
	≥ 75	-	-
	Sub-total	**15 569.0**	
Witzenberg	≤ 1	1 399.0	17.8
	1 – 5	1 087.0	13.8
	5 – 25	2 967.7	37.7
	25 – 50	2 264.9	28.8
	50 – 75	-	-
	≥ 75	150.2	1.9
	Sub-total	**7 868.8**	
	Total	**51 457.2**	

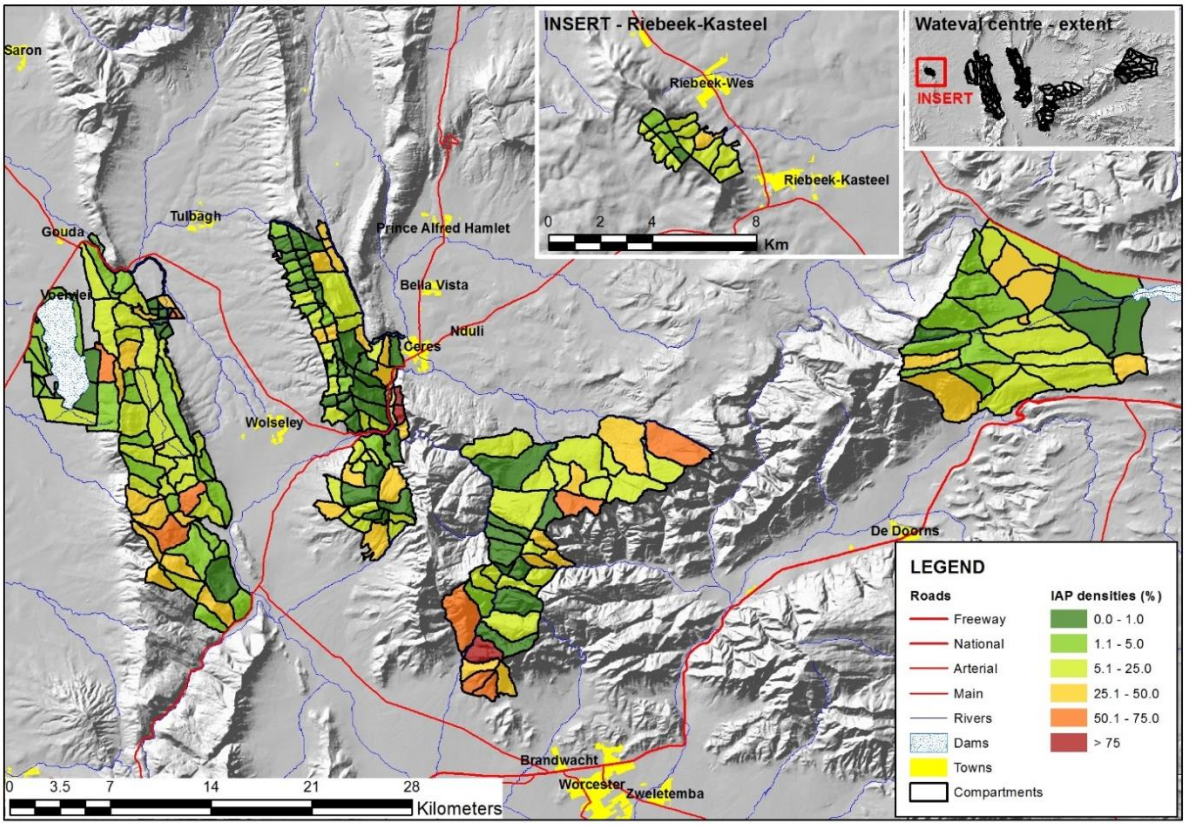


Figure 10: *Current invasive alien plant density classes per management compartment in the areas managed by the Waterval Centre.*

If the area of each invaded compartment (MUI) is multiplied by the sum of the densities of each species present in that compartment, then we can derive the value of condensed hectares for each compartment. Condensed hectares represent the area invaded if all the invasions were converted to their equivalent in hectares with a closed canopy or 100% cover. The total condensed hectares of invasive alien plants in the 55 454 ha managed by the Waterval Centre amounts to 9 450.4 ha. We have used condensed hectares to show the area occupied by problematic species and who owns the problem (Table 7). Cluster pine (*Pinus pinaster*), Black Wattle (*Acacia mearnsii*), Silky Hakea (*Hakea sericea*) and Long-leafed Wattle (*Acacia longifolia*) are the most problematic species with the majority of invasions on CapeNature land. However in the case of Black Wattle most of the invasion occurs on private mountain catchment land.

***Table 7**: Extent of dominant invasive alien plant species, given in condensed hectares, for different ownership classes in the areas managed by the Waterval Centre*

Dominant species	Public	Private		Total (Cond_ha)
	Cape Nature (Cond_ha)	Private mountain catchment area (Cond_ha)	Farm (Cond_ha)	
Acacia baileyana			0.1	0.1
Acacia cyclops	64.0			64.0
Acacia longifolia	819.6	312.9	77.1	1 209.6
Acacia mearnsii	709.2	1 014.0	135.7	1 858.9
Acacia melanoxylon	46.2		18.5	64.7
Acacia pycnantha	37.1		38.6	75.7
Acacia saligna	35.6	22.9	50.1	108.6
Eucalyptus globulus	138.2	50.0	262.7	116.7
Eucalyptus spp.			5.1	5.1
Hakea gibbosa	311.6	44.6	0.7	356.9
Hakea sericea	913.4	794.7	93.3	1 801.4
Pinus pinaster	1 498.1	480.3	238.6	2 217.0
Pinus radiata	442.8	179.8	9.8	632.4
Populus X canescens	339.8		230.3	570.2
Rubus fruticosus		2.1		2.1
Sesbania punicea	29.6		3.4	33.0
Total	**5 385.2**	**2 901.2**	**1 164.0**	**9 450.5**

Once again using condensed hectares we can see which sections of the Waterval Centre has the largest invasions and what species are responsible for this (Table 8). This shows that, for example, the Hex River Mountains have the most extensive invasions and Cluster Pine (*Pinus pinaster*) and Silky Hakea (*Hakea sericea*) contribute the most to these invasions.

***Table 8**: Extent of dominant invasive alien plant species, given in condensed hectares, for different management sections in the areas managed by the Waterval Centre*

Species / Section	Bokkerivier	Hex River	Riebeek-Kasteel	Waterval	Witzenberg	Total (Cond_Ha)
Acacia baileyana				0.1		0.1
Acacia cyclops	64.0					64.0
Acacia longifolia	2.0	153.6	2.6	813.6	237.7	1 209.6
Acacia mearnsii	715.2	133.3	6.7	689.9	313.7	1 858.9
Acacia melanoxylon	6.8	11.2		40.6	6.1	64.7
Acacia pycnantha			36.7	38.8	0.2	75.7
Acacia saligna				102.5	6.1	108.6
Eucalyptus globulus	170.7	44.8	19.3	198.3	17.8	450.9
Eucalyptus spp.				5.1		5.1
Hakea gibbosa		287.4		12.8	56.6	356.9
Hakea sericea		1 139.4	1.3	412.0	248.7	1 801.4
Pinus pinaster	378.1	1 120.6	2.0	188.1	528.1	2 217.0
Pinus radiata	156.6	386.9		41.4	47.5	632.4
Populus X canescens	554.7		7.4	8.1		570.2
Rubus fruticosus					2.1	2.1
Sesbania punicea				28.4	4.7	33.0
Total	**2 048.1**	**3 277.2**	**76.1**	**2 579.7**	**1 469.3**	**9 450.5**

2.8 Fire history

The fire records for the Waterval Centre in CapeNature's Corporate GIS Database date back to 1974. Some localities, often along main roads, have a high fire frequency, with as many as 11 fires burning in certain places since the start of the records. Bainskloof pass, near Steenboksrivier has the shortest fire return interval while the second highest fire recurrence is in Mitchell's Pass. Ignitions are mainly due to the actions of people (± 40%) and only about 9% are attributed to natural causes and about a third (± 32%) are attributed to unknown causes.

There have been a number of recent large veldfires in the area so, in most sections of the Waterval Centre, the majority of veld falls into the 0 to 2 years and 3 to 6 years old categories (Figure 11; Tables 9 & 10). Two very large fires that started in the Hex River Mountains on 31 January (16 494 ha) and 3 February 2016 (21 643 ha) eventually merged resulting in a very large area of equal aged veld.

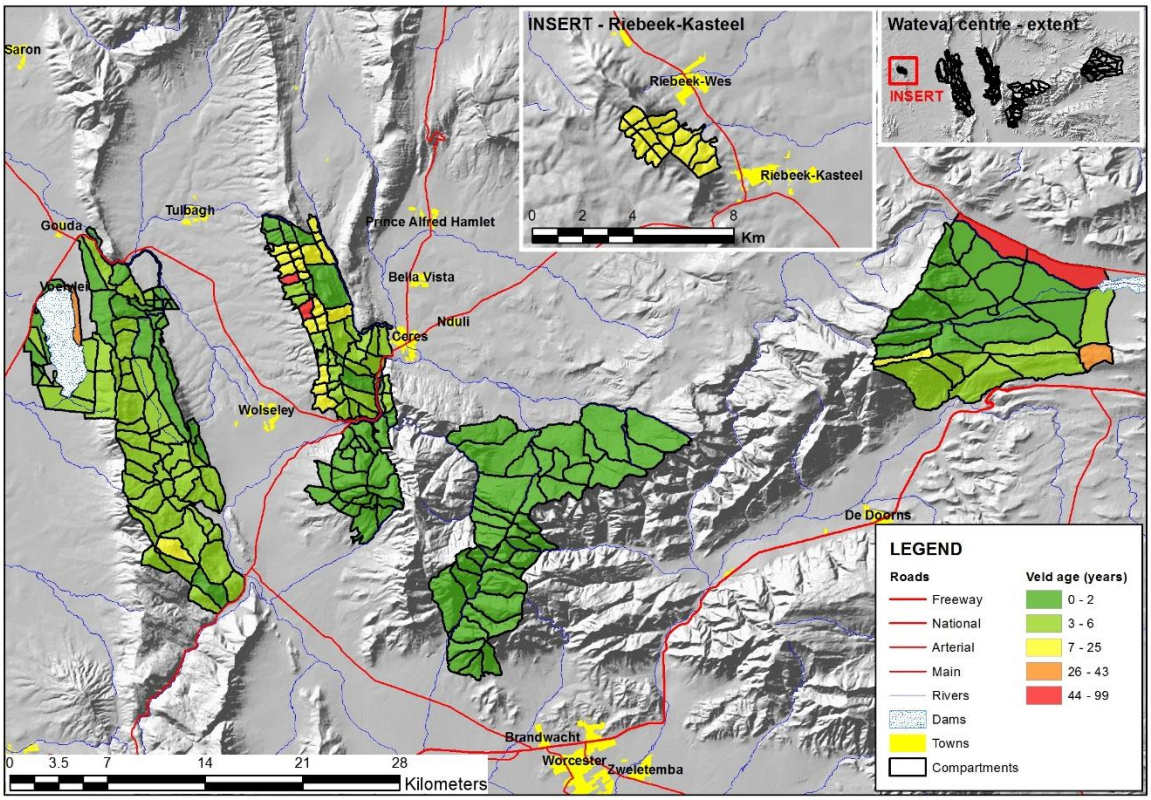


Figure 11: *The distribution of veld ages (March 2016) in the areas managed by the Waterval Centre.*

Young veld does offer the opportunity to treat invasive alien plants before they have matured which can lead to long term cost savings. Unfortunately for the Waterval Centre, because of the large areas of young veld involved and capacity constraints, not all these opportunities will be realised. The veld age categories we have used correspond with the life stages of most of the invasive alien plants that occur in the area (Table 9). Whether the plants are seedlings (< 2 years), juveniles (> 2 to 6 years) or adults (> 6 years) determines the treatment method to be applied to control them. For example, young Cluster Pines can be hand pulled but mature trees have to be felled using chain saws.

Table 9: *Veld age categories (March 2016) for the natural veld (invaded and uninvaded) in the areas managed by the Waterval Centre.*

Post-fire veld age (years)	Ha	% of total area
0 – 2	32 141.8	57.9
3 - 6	18 555.2	33.4
7 - 25	2 854.6	5.1
26 - 43	544.5	1.0
unknown	1 449.5	2.6
	55 545.5	**100**

The same information is presented for each section of the Waterval Centre in Table 10. This shows that 100% of the Hex River section and the majority of the Bokkeriviere and Witzenberg sections are less than 2 years old.

Table 10: *Veld age categories (March 2016) for the natural veld (invaded and uninvaded) for each section managed by the Waterval Centre.*

Section	/ Post-fire veld age (years)	Ha	% of total area
Bokkeriviere	0 – 2	8 657.3	56.8%
	3 – 6	4 794.7	31.5%
	7 – 25	206.2	1.4%
	26 – 43	335.5	2.2%
	Unknown	1 242.2	8.2%
		15 235.8	
Hex River	0 – 2	13 916.6	100%
		13 916.6	
Riebeek-Kasteel	7 – 25	593.0	100%
		593.0	
Waterval	0 – 2	4 217.5	27.1%
	3 – 6	10 856.2	69.7%
	7 – 25	286.3	1.8%
	26 – 43	209.0	1.3%
		15 569.0	
Witzenberg	0 – 2	5 350.4	52.3%
	3 – 6	2 904.3	28.4%
	7 – 25	1 769.1	17.3%
	Unknown	207.3	2.0%
		10 231.1	
		55 545.5	

Overall, fires worsen the invasive alien plant problem by stimulating seed regeneration over large areas and creating large areas of young plants, often in dense stands, that must now be treated. The risk of further fires has been reduced by the young vegetation, but even young fynbos can burn under extreme wildfire conditions (Van Wilgen *et al.* 2010). It is, therefore, important that wild fires are kept out of the area. Special care needs to be taken to prevent fires burning in areas where there are recently cleared plantations where there is slash (i.e. cut branches), and even many logs or whole trees, lying on the surface. Due to the high availability of fuel (i.e. wood), fires in these areas can reach extremely high temperatures and can sterilise the soil (Holmes *et al.* 2000, Holmes and Newton 2004, Le Maitre *et al.* 2014). These areas then require reseeding which is expensive. Fire can still be used as part of the control treatments (e.g. in dense long-leaf acacia stands), but care must be taken to prevent these fires from escaping.

2.9 Land ownership

The area managed by the Waterval Centre has been classed into three ownership categories (Figure 12).

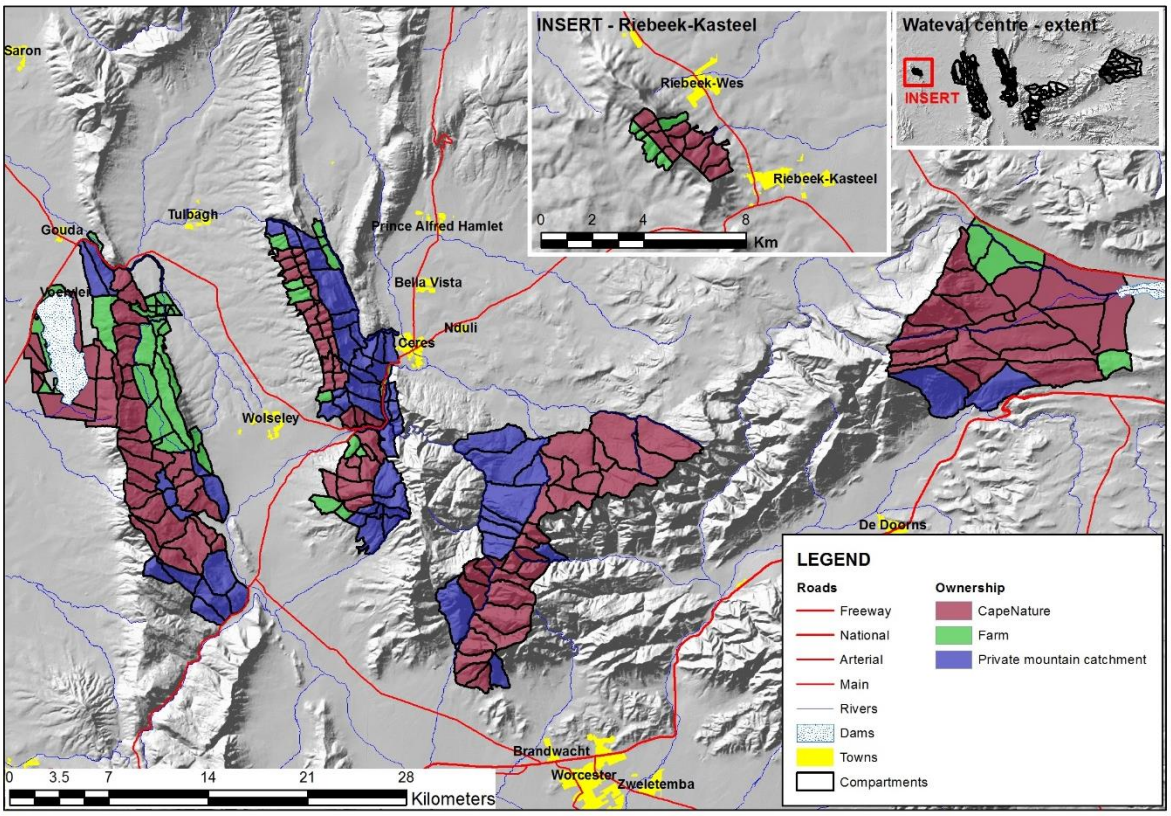


Figure 12: *Land ownership assigned to management compartments in the areas managed by the Waterval Centre.*

CapeNature's land makes up the largest proportion (59.7%) with the remainder including privately owned land subject to the Mountain Catchment Areas Act (Act No 63 of 1970) and a category defined as farm (Table 11). The latter category includes previous plantations, most noticeably at Suurvlak, where the timber has been removed by MTO Forestry as part of their exit strategy. The commercial farm land adjacent to the natural areas managed by the Waterval Centre is not included in this plan.

Table 11: *Land ownership categories for the areas managed by the Waterval Centre.*

Ownership	Area (ha)	% of total
Cape Nature	33 157.6	59.7
Private MCA	15 276.2	27.5
Farm	7 111.8	12.8
Total	**55 545.5**	**100.0**

The "farm" classification is used to identify privately owned land that falls outside proclaimed mountain catchment areas but nevertheless is considered by CapeNature to be integral to their invasive alien plant control efforts and has therefore been included in their management compartments (Table 12).

Table 12: *Land ownership categories listed per management section for the areas managed by the Waterval Centre.*

Section	Ownership	Ha	% of area	Total Ha
Bokkeriviere	CapeNature	11 618.0	76.3%	
	Farm	1 777.5	11.7%	
	Private MCA	1 840.4	12.1%	**15 235.9**
Hex River	CapeNature	9 250.9	66.5%	
	Farm	18.1	0.1%	
	Private MCA	4 647.6	33.4%	**13 916.6**
Riebeek-Kasteel	CapeNature	446.0	75.2%	
	Farm	147.0	24.8%	
	Private MCA	0.0	0.0%	**593.0**
Waterval	CapeNature	8 482.7	54.5%	
	Farm	3 936.4	25.3%	
	Private MCA	3 149.9	20.2%	**15 569.0**
Witzenberg	CapeNature	3 359.9	32.8%	
	Farm	1 232.8	12.0%	
	Private MCA	5 638.4	55.1%	**10 231.1**
				55 545.5

Bokkeriviere

The Bokkeriviere section includes CapeNature's Bokkeriviere Nature Reserve at the eastern end of the Hex River Mountains. The South African Defence Force owns a sizable area at the foot of the mountains adjacent to CapeNature's land. Compartments have been delineated in this area including part of the farm Hartebeeste Kraal 347 (Middelplaas) which borders on the road between Ceres and Touwsrivier (Figure 12).

Hex River

CapeNature land within delineated compartments accounts for two thirds of the area and includes the Ben Etive and Fonteintjiesberg Nature Reserves, with the remainder of the compartments being privately owned proclaimed mountain catchment areas (Table 12). What is surprizing is that no compartments have been delineated for sizable areas of proclaimed mountain catchments in the Hex River Mountains and are thus not included in Table 12. These include portions of the Ceres Mountain Fynbos Nature Reserve, including Skurweberg Peak owned by the Witzenberg Local Municipality, the Matroosberg and Whispering Hills private nature reserves, Waaihoekskloof owned by the Mountain Club of South Africa and the University of Cape Town's Zuurberg property that is also the source of the Witels River. The large area of privately owned proclaimed mountain catchments on the southern side of the Hex River Mountains, between Matroosberg in the east, Buffelhoek Peak in the west, and Audensberg and Brandwachtberg in the south, also has no delineated compartments.

Riebeek-Kasteel

Three quarters of the area falls within CapeNature's Kasteel Nature Reserve and there are no privately owned mountain catchment areas. The remaining 25% consists of private farm land mostly situated on the western slopes of the mountain.

Waterval

More than half of the land is situated in CapeNature's Waterval and Voelvlei Nature Reserves with privately owned mountain catchment areas including Steenboks Park, Steenboksberg (owned by the MCSA) and an area known as Mount Bain Nature Reserve. Areas classified as "farm" include land adjacent to the Voelvlei Dam that is owned either by the state or the City of Cape Town. The farm below and to the west of Ontongskop, also in the vicinity of Voelvlei Dam, is owned by Choice Harvest Pty Ltd. CapeNature has worked on this farm in the past. The area where the Suurvlak plantation was located was managed by MTO Forestry and must still be formally transferred to CapeNature. This land is presently assigned to the Department of Public Works.

Witzenberg

Much of the Witzenberg is privately owned mountain catchment area with the Ceres Mountain Fynbos Reserve owned by the Witzenberg Local Municipality covering a sizable area. CapeNature's Witzenberg and Wittebrug cover just less than 33% of the area. The privately owned Romansrivier Stewardship Site, adjacent to the Wittebrug Nature Reserve in the upper Breede River Valley. Wolwekloof, also adjacent to the Wittebrug Nature Reserve, that is partially privately owned and partially by Winelands District Municipality. Privately owned land near Sagtevleiberg that is part of the Edenhof Stewardship Site. Transnet is responsible for the railway reserve running through Mitchell's Pass.

2.10 Water Users

The main water-users in the areas supplied by the catchments that fall in the Waterval Centre are the commercial farmers in the area from Wolseley to Worcester, and in the southern part of the Ceres basin. They use most of the water to irrigate their orchards, vineyards and pastures and a limited amount for annual crops which may require irrigation. The main source of their water is their farm dams, but some farmers are linked into irrigation schemes in the upper Breede River system (BGCMA 2015) managed by the Breede-Gouritz Catchment Management Agency. The Ceres Municipality receives water from the Ceres Koekedouw Dam on the Koekedouw River in the Witzenberg and boreholes, and the dam also supplies the Ceres-Koekedouw Irrigation Board (BOCMA 2010). Wolseley sources its water from the Tierkloof weir near Tulbagh (Witzenberg 2012) and also has a Water-user Association for the irrigation farmers. Downstream water users on the Breede River include the town of Worcester, which gets most of its water from Stettynskloof, and irrigation boards or water-use associations (BOCMA 2010). The upper Breede River area produces most of the currently unallocated water in the whole catchment (BOCMA 2010) and so is an important water source for maintaining flows in the rest of the main stem down to the estuary. There are indications of water quality problems in the Upper Breede due to the intensive agriculture (BOCMA 2010) so additional flows could help reduce this problem. Little information is available on the upper Touws river and the state of its water resources, but this is a relatively dry area with little runoff and the main agricultural activity is sheep farming with a very limited amount of irrigation. The town of Touwsrivier gets its water from Waterkloof, Donkerkloof and Witklip boreholes, and springs (Breede Valley 2007).

2.11 Stakeholders

All the organisations actively supporting and participating in invasive alien plant control operations within the protected areas and mountain catchments managed by the Waterval Centre are listed in Table 13.

Table 13: *Stakeholder representatives for the areas managed by the Waterval Centre.*

Organisation	Contact	Designation	Telephone	Cell	e-mail
Western Cape – DEADP Development Planning	Jason Mingo	Berg River improvement plan	021 483-0798	084 661-8264	Jason.Mingo@westerncape .gov.za
Western Cape Department of Agriculture: Sustainable Resources	Rudolph Röscher	LandCare Manager : Cape Winelands DC	023-3471003	083 675 1315	rudolphr@elsenburg.com
	Elmo Maree	Landcare officer: Wellington	021 8731135	084 407-9513	elmom@elsenburg.com

Organisation	Contact	Designation	Telephone	Cell	e-mail
Management		district office			
	Francis Steyn	Sustainable Resources Management	021 808-5090	082 907-2813	Franciss@elsenburg.com
Breede-Gouritz Catchment Management Agency	Jeanne Gouws	(CapeNature representative)	021 866-8012	082 552-5811	jgouws@capenature.co.za
CapeNature	Amukelani Nkuna	Catchment Manager: Region West	022 931-2900	072 437-4011	ankuna@capenature.co.za
	Ben van Staden	Natural Resources Manager	021 483-0171	079 503-6424	bvanstaden@capenature.co.za
	Lee Saul	Regional Ecologist	021 866-8021	082 445-4091	lsaul@capenature.co.za
	Morris Floris	Protected Areas Manager: Region West	023 231-1170	082 455-5574	mfloris@capenature.co.za
	Michael Lewis	Waterval Nature Reserve Manager	023 230-0759	079 503-6423	mlewis@capenature.co.za
	Madré Zeeman	AVM Project Manager	023 230-0759	071 605-9366	mzeeman@capenature.co.za
	Natalie Hayward	Ecological co-ordinator: West	021 866-8000		nheyward@capenature.co.za
	Tony Marshall	Integrated Catchment Management		082 740-7787	tmarshall@capenature.co.za
City of Cape Town	Clifford Dorse / Louise Stafford	Biodiversity Management Branch - Voelvlei	021 487-2772		Clifford.dorse@capetown.gov.za
ESKOM					
Greater Cederberg Fire Protection Association	Charl du Plessis	Manager		079 172-4340	charl@cederbergfpa.co.za
MTO Cape (Cape Pine)	Dirk Nortjie	MTO Area Manager	021 867 0184	0828875529	Dirk@mto.co.za

Organisation	Contact	Designation	Telephone	Cell	e-mail
Mountain Club of South Africa	Ian Bradburn	Steenboksberg property convenor		083 651-2962	ian.bradburn@gmail.com
	Aleck McKirdy	Waaihoeksberg property convenor		083 458-5410	aleckmckirdy@gmail.com
Provincial Road Department					
South African National Biodiversity Institute - Invasive Species Programme	Ernita van Wyk	Regional Co-ordinator: Western Cape	021 799-8401 021 799-8837		Er.vanwyk@sanbi.org.za invasivespecies@sanbi.org.za
South African National Defence Force					
Transnet					
UCT		Zuurberg property			
Water Affairs (Department of Water and Sanitation	Derril Daniels	Western Cape Water Supply System	021 941-6000 021 941-6189	082 908-3236	DanielsD@dwa.gov.za
	Melissa Lintnaar-Strauss	Western Cape Water Supply System (Water Quality)	021 941-6000		
Winelands Fire Protection Association	Henrietta Brock	Operations Assistant		071 256 2668	
	Dale Nortje	Manager	021 888 5823		
Witzenberg Municipality	Heloise Truter	Manager: Environment & Amenities	023 316-1854		heloise@witzenberg.gov.za
Working on Fire Programme (DEA –NRM)	Jason de Smidt	Project manager SW region: High altitude teams	021 761-1992	084 548-7140	desmidtjason@gmail.com
	Susan Henn	High altitude teams (HAT)	021 761-1992	082 342-8483	Susan.henn@wofire.co.za

Organisation	Contact	Designation	Telephone	Cell	e-mail
Working for Water Programme (NRM – Environment Affairs	Aadelia Moerat	Regional Programme Leader: Western Cape Environmental Programmes	021 941-6008	076 184-0298	AMoerat@environment.gov.za
	Wessel Wentzel	Implementation Manager: WC Working for Water	021 941-6016	082 888-7766	WWentzel@environment.gov.za
	Nicolette Oliver	WIMS	021 941-6023	074 454-4556	NOliver@environment.gov.za
Working for Wetlands	Heidi Niewoudt	Zuurvlak / Voelvlei site			h.nieuwoudt@sanbi.org.za
WWF- South Africa	Rodney February	Implementation Manager: Water Balance Programme	021 657 6600		rfebruary@wwf.org.za
	Shelly Fuller	Programme Manager: Fruit & Wine Initiatives	021 882 9085	084 555 6068	sfuller@wwf.org.za

3 DELINEATING MANAGEMENT COMPARTMENTS

When the Working for Water programme was launched in 1995, the programme management realised that there was a need for a standardised way of mapping invasions so that records could be kept of the spatial boundaries of invaded areas and so that the costs of treatments could be estimated and monitored. The mapping standards that were developed were based on those developed by the CSIR for the Catchment Management System (CMS) for fynbos (Le Maitre *et al.* 1993) and subsequently revised and modified (Working for Water 2016). The CMS included a series of spatial data layers aimed at providing the managers with the information they needed on the spatial distributions of key species, fires, invasions and land ownership among others. One of the key ones was a management unit known as a "compartment" which was based on the approach developed by the Department of Forestry for the mountain catchment areas they managed (similar units were used in forest plantations). Essentially these were spatial units with clearly defined and identifiable boundaries that were also useful as boundaries for fire management and other operations. They also provided a complete coverage of the area of interest, in this case a catchment. In contrast, the mapping of invasions was based on mapping units with similar invasions (similar species mix and density and location in the landscape), generally with no consideration of compartment boundaries, although rivers and streams often formed natural units. This is because rivers, streams and their floodplains (i.e. riparian areas) often have invasions which differ in species composition, structure and density from adjacent dryland invasions, typically making them separate invaded units.

Invaded areas were then overlaid with compartments to provide information on the characteristics of the invaded areas in each compartment. The key point is that there was only one fixed management unit – the compartment. This choice was deliberate and was intended to ensure that as the different invaded units within each compartment were treated the changes would be documented and form a permanent record of the treatments and the resulting changes in the state of the invasions in every compartment. In this way the boundaries of the treatment unit could change over time depending on what was best suited to the contract requirements regarding workloads and time-frames.

CapeNature has over time delineated all their reserves, and private land demarcated under the Mountain Catchment Areas Act that they manage, into compartments. The boundaries of compartments to a large extent correspond with recognizable physical features that are easily located in the field. In the case of CapeNature, "MIU" and "NBAL" units use the same boundaries as their compartments. Each of these coverages was then combined to create a "wall-to-wall" coverage of 247 compartments for the area managed by the Waterval Centre (Figure 13; Table 3). Although this appears to be a straightforward process, much effort was needed to ensure that the resultant coverage had spatial integrity.

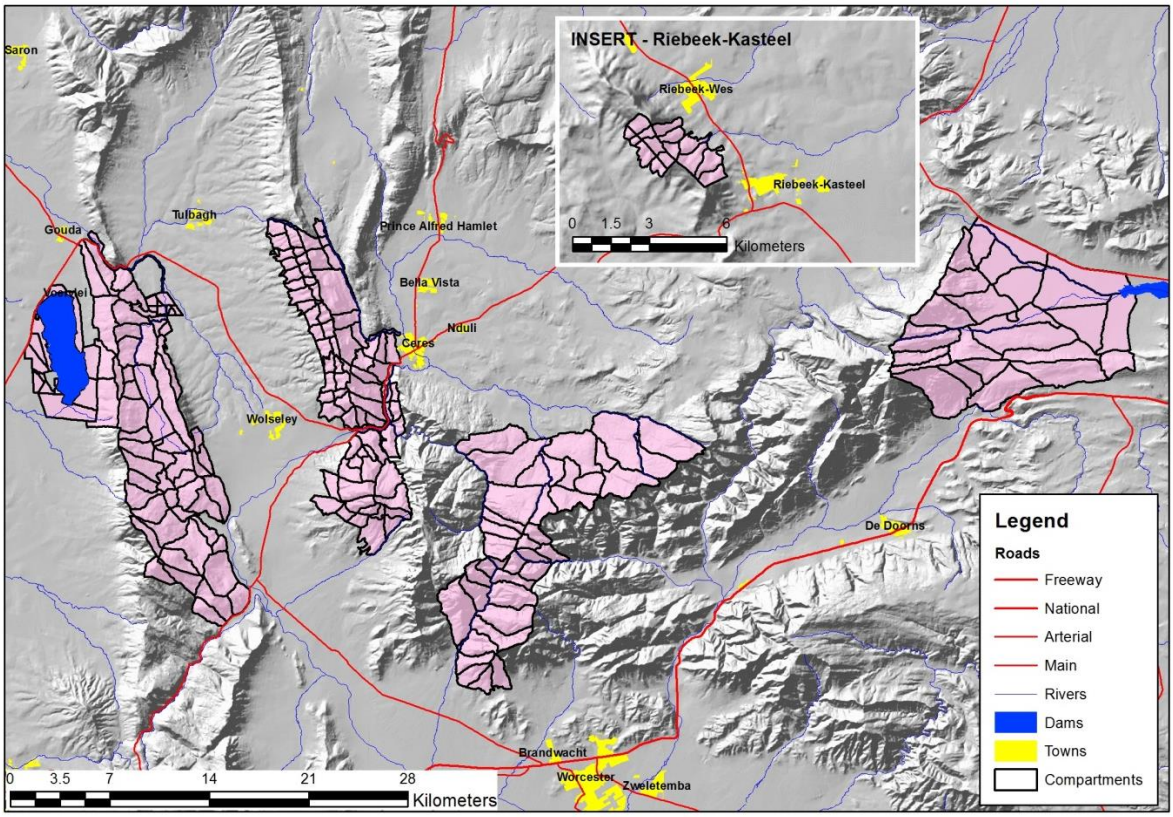


Figure 13: *Delineation of compartments in the areas managed by the Waterval Centre.*

All the pertinent information for each compartment such as the water flows (runoff), accessibility, slope and the age of the veld is stored within a geo-database (Appendix 1). The information on historical and current invasions, previous control treatments and their costs is stored for each of the treatment units (NBALs) in the same geodatabase (Appendix 1). There is also a cross-link which identifies which NBALs or MIUs fall within each compartment so this information can be summarised at the compartment level as well. The geodatabase allows for all this information to be easily retrieved and presented at a compartment level and for such information to be loaded into the Automated Management Unit Control Plan (MUCP) Generation Tool (Appendix 2) (see Section 5). An example of how this data can be used is to depict the average slope for each compartment (Figure 14) or to summarize the information per slope classes used by the WfW programme (Table 14). Almost 23% of the area managed by the Waterval Centre is on fairly steep ground (> 25 degrees), and some cliffs will require rope-work, which greatly increases the cost and the time taken to clear invasions.

Calculations in the MUCP are based on the mean slope of each compartment as derived from a digital elevation model with a 20 m resolution which is stored in CapeNature's Corporate GIS Database.

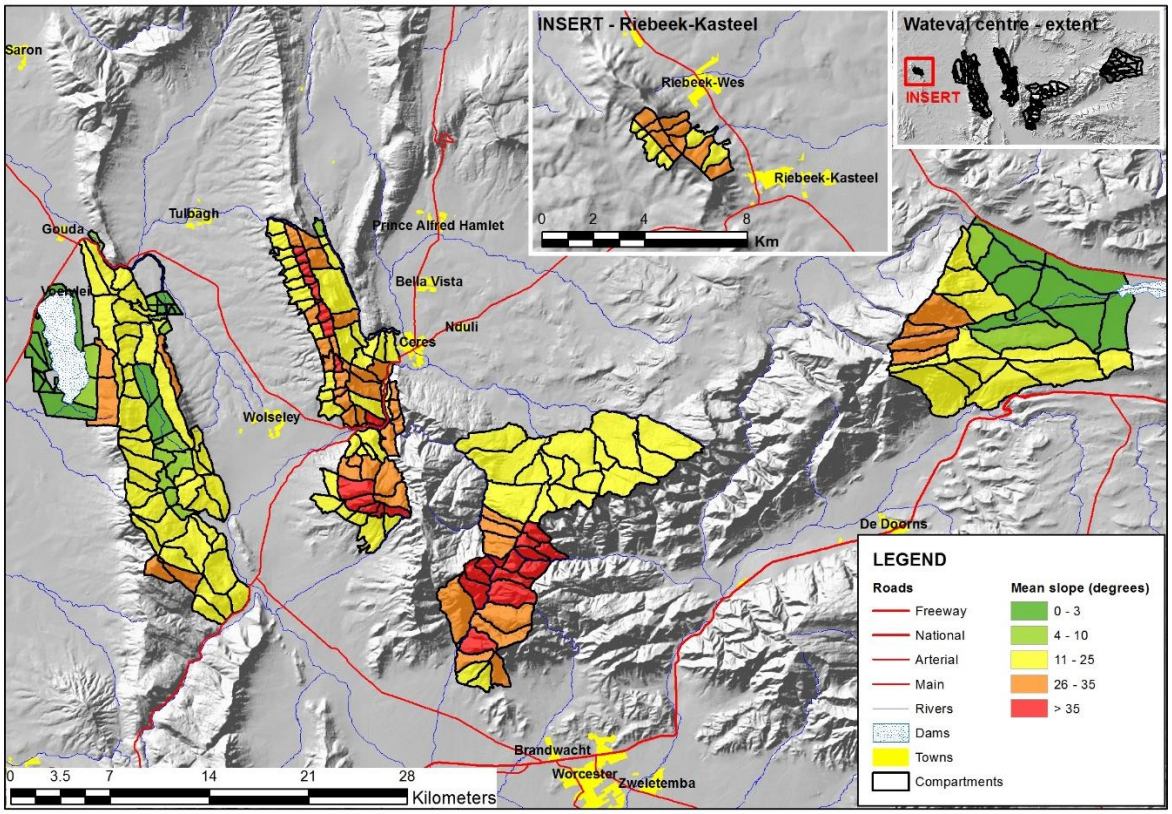


Figure 14: *The average slopes of the management compartments in the areas managed by the Waterval Centre.*

Table 14*: The relative importance of different Working for Water slope classes for the areas managed by the Waterval Centre.*

Slope class (degrees)	Hectares	% of total area
0 – 3	8 529.5	15.4
3.1 – 10	2 693.6	4.8
10.1 – 25	31 720.8	57.1
25.1 – 35	9 528.0	17.2
≥ 35° (high attitude – rope work)	3 073.6	5.5

4 PRIORITISATION (Vision and goals)

Invasive alien plant control requires that managers match the available resources and budget with the work that needs to be accomplished so as to maximise benefits. This means that "trade-offs" often must be made in setting up schedules of which invasions plants will be treated, and where, over time. As described in Section 3 above, the entire catchment has been demarcated into management units known as "compartments", spatial units with clearly identifiable boundaries. The problem is to decide which of these compartments to treat first. This is influenced by the estimated impacts (e.g. on water or biodiversity), the nature and extent of the invasions in each compartment at a given time, its treatment history, and the funds available to deal with the problem in a given budgetary cycle. Prioritisation is, therefore, critical for ensuring that both the individual treatments and the overall programme are as effective as possible.

The general approach to prioritisation is to firstly establish a clear goal that states a desired outcome of what needs to be achieved where and by when. Any such goal should be S.M.A.R.T (Specific, Measurable, Assignable, Realistic and Time-bound). Once the goal has been defined the next step is to develop the criteria (objectives) and sub-criteria (sub-objectives) that have to be realized if the goal is to be achieved.

A multi-criteria decision making process, the Analytic Hierarchy Process (AHP, Saaty 1990), was followed to develop a goal for invasive alien plant control operations in the catchment, to develop the criteria needed to achieve the goal, and to assess the relative importance of these criteria by allocating weights (ranking) to them by means of pair-wise comparisons. This was facilitated by using Expert Choice software (Anon 2009) to construct an AHP model for the catchment. The AHP process is useful for setting priorities when both qualitative and quantitative aspects of a decision need to be considered, and for achieving group consensus. The last step in the process was to identify the datasets that enabled objective comparisons to be made between compartments with regard to particular criteria.

Literature on the application of multi-criteria decision techniques suggests that the difficulties of comparing criteria increase as the number of criteria increases, with the optimal being around seven criteria (Saaty and Ozdemir 2003). The hierarchical structure followed by the AHP method reduces that difficulty somewhat as it groups criteria into clusters that facilitate comparisons. Even so, as the number of criteria increase, it takes more and more time to do the comparisons and participants become fatigued or lose interest and focus. Many of the criteria were also given low weights in the final models so they have little influence on the outcome. The aim is therefore to limit the prioritisation model to as few criteria as possible at each level in the hierarchy, while maintaining the diversity of views among stakeholders.

Participants from CapeNature, WfW and CSIR attended a workshop held during May 2016 to revisit the generic area based prioritisation model developed for CapeNature by the CSIR in 2012 (Appendix 3). Participants established a revised goal and set supporting criteria and this facilitated debate and enabled participants to agree to the final priorities that were identified. The process followed was participatory and transparent so that all the contributors could check the outcomes of their discussions and decisions and alter these dynamically until a consensus was reached.

A goal and timeframe for the control of invasive alien plants for the Waterval Centre and the criteria needed to support this goal was reached (Figure 15). Participants then assessed the relative importance of these criteria by allocating weights to them by means of pairwise comparisons (Figures 15 &16).

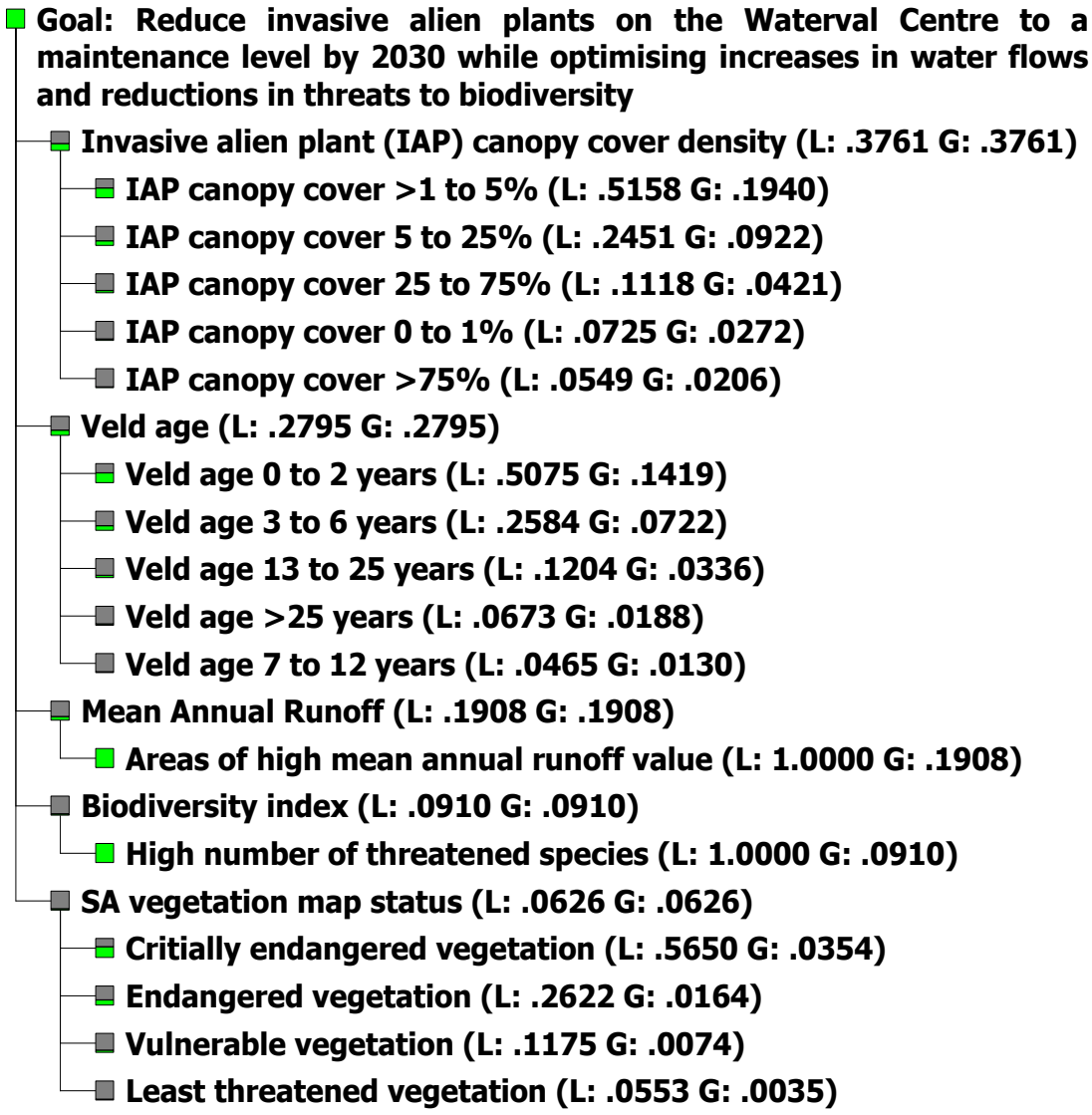


Figure 15: *Prioritisation model for the area managed by the Waterval Centre showing the goal and hierarchy of weighted criteria. G values refer to weights in relation to the goal while L values refer to weights for each covering criterion or sub-criterion.*

During the workshop participants indicated that the areas they particularly wanted to target first are those compartments where the veld is young, less than 6 years, and where the density of invasive alien plants is between 1% and 5%. Thus the decision of where to start and continue working was weighted 37.6% for density and 28% for veld age (Figure 15). These two criteria thus contribute just

less than 66% to the score and, thus, the decision of where to work. Invasions of less than 1% were not seen as a priority as these areas can be considered to be in the maintenance phase and, although they still need attention, the maintenance operations should not necessarily be funded by Working for Water.

Three further criteria were seen as very important in making the decision of where clear alien plant invasions on the Waterval Centre. These were mean annual runoff (MAR), the importance of biodiversity in the form of the number of threatened species present in a compartment and the IUCN treat status of the natural vegetation (Figures 15). Enhancing mean annual run-off (MAR) or river flow scored highest, receiving a weight of 19.08%, and compartments with a high number of threatened species (both plants and animals) was assigned a weight of 9.1%. The IUCN treat status of the natural vegetation was collectively assigned a weight of 6.3% with critically endangered vegetation types making up more than half of this weight (Figure 15). The weights assigned to each individual criterion in the model are shown in Figure 16. The most weight was allocated to those compartments having a canopy cover of 1 – 5% (19.4%), having high MARs (19.1%) and having young vegetation (14.2%) collectively contribute about 53% to any decision of which compartments should be prioritized for clearing.

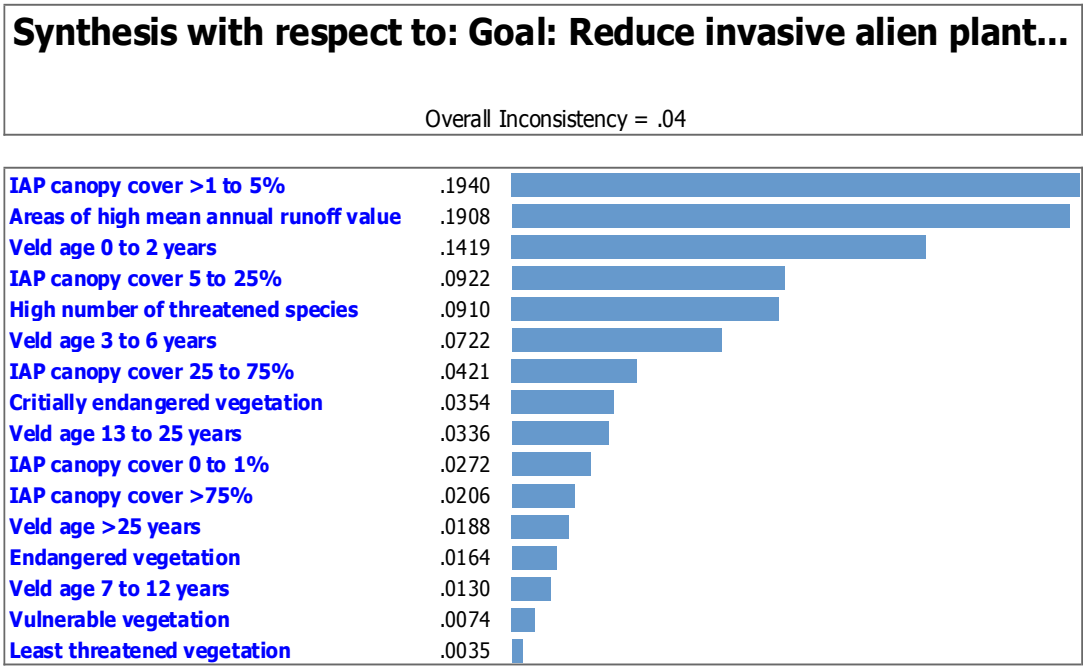


Figure 16: *Ranks assigned to individual criteria in the prioritisation model for the area managed by the Waterval Centre.*

The principle of treating the upper slopes (high elevations) first is also desirable as invasive alien plants established at high elevation have greater potential to spread. Workshop participants felt that CapeNature areas should receive preference over private land but in certain instances stands of invasive alien plants on private land may pose a direct treat to uninvaded portions of CapeNature

land and therefore should be treated sooner rather than later. We have, however, deliberately kept the prioritisation exercise uncomplicated. We believe that by prioritising compartments based on the five criteria: density of invasions, age of veld, contribution to MAR, a measure of biodiversity importance and the IUCN treat status of the vegetation, invasive alien plant clearing operations will be considerably more effective than at present.

Initially the focus in developing the MUCP tool has been on getting the datasets formatted for the tool, implementing WfW's method of using their norms and standards to estimate the treatment cost per Nbal and assessing, together with the implementing agent, whether the estimated costs calculated by the MUCP tool are realistic based on their experience. This information model was used to calibrate the MUCP tool which in turn was used to generate a schedule of treatments, arranged by compartments, for the next 20 years (see Section 5).

We also used the prioritisation model to source supporting datasets (see Appendix 2). The current version of the MUCP tool is not designed to use species characteristics in weighting compartments. This has meant that we have not been able to take species data into account in the tool's prioritization rules. However, we do not believe that this has biased the priorities substantially as the combination of low densities, young vegetation and high runoff has an overriding influence on the priorities assigned to compartments. In any case, the overall costs will remain the same and only the scheduling of compartments would have changed had more criteria been included.

5 ESTIMATING LONG TERM CLEARING COSTS (MUCP Tool outputs)

The MUCP planning tool provides Working for Water and their implementing agents with the ability to set annual targets that are aligned with the overall goal and time frames set for a clearing project.

It also enables them to update the plan based on changes in the status and impacts of invasions, conservation priorities, progress with control operations, the occurrence of events such as fires, and the availability of resources.

5.1 Setting up the data

All the invasions in the catchment have been collated into mapped invaded units (MIUs) based on the characteristics of their invasions (e.g. species and densities). When invaded areas are identified for treatments, the portions of the MIUs in that designated area are included in that treatment unit (Nbal). Thus MIUs include invasions which have yet to be treated while Nbals include invasions which have been treated and, thus, have a treatment history. New Nbals (treatment units) are created during the process of generating clearing contracts.

In the case of CapeNature's data the spatial extent of NBals, MIUs and compartments are identical but the same principles as above apply to each of these spatial datasets.

Our calculations are based on the extent and densities recorded in CapeNature's 2015 "wall to wall" invasive alien plant mapping exercise. This dataset is revised annually by CapeNature in July of each year. Accurate identification of the species and their extent are densities are essential if realistic cost estimates are to be made and ever effort should be made to ensure this. The latest mapping guidelines of Working for Water, "*Standards for Mapping and Management of Alien Vegetation and Operational Data: Version 6 - 2016",* should be adhered to.

Much of the Hex River Mountains burnt during two extensive wildfires in 2016 so the 2015 survey data are only applicable to the unburnt areas. The actual status of the invading species in each burnt compartment still needs to be updated to reflect the new state of these invasions (e.g. resprouting of some species and seedling regeneration of others). This will affect the treatment methods and thus the costs.

Although the most effective approach to controlling invasions is to focus on low densities, in cases whether fires have occurred it is essential to control as much of the seedling regeneration as possible before it reaches reproductive maturity. One would then adjust the priorities to focus on follow-up in areas with a post-fire age of less than two years and where there were dense stands prior to the fire. The plan should also take into consideration the treatments conducted during the 2015/2016 financial year but this information will only become available in July 2016.

However this version of the plan has not incorporated any of these changes but, as it stands, it still gives a good indication of the scale of the problem and the costs and timeframes involved in getting the areas managed by the Waterval Centre to a maintenance level of ≤ 1% canopy cover. The projected invasive alien plant densities for each compartment after the first year of treatment if the annual budget ceiling is set to R4.5 million (Budget 2) are shown in Figure 17.

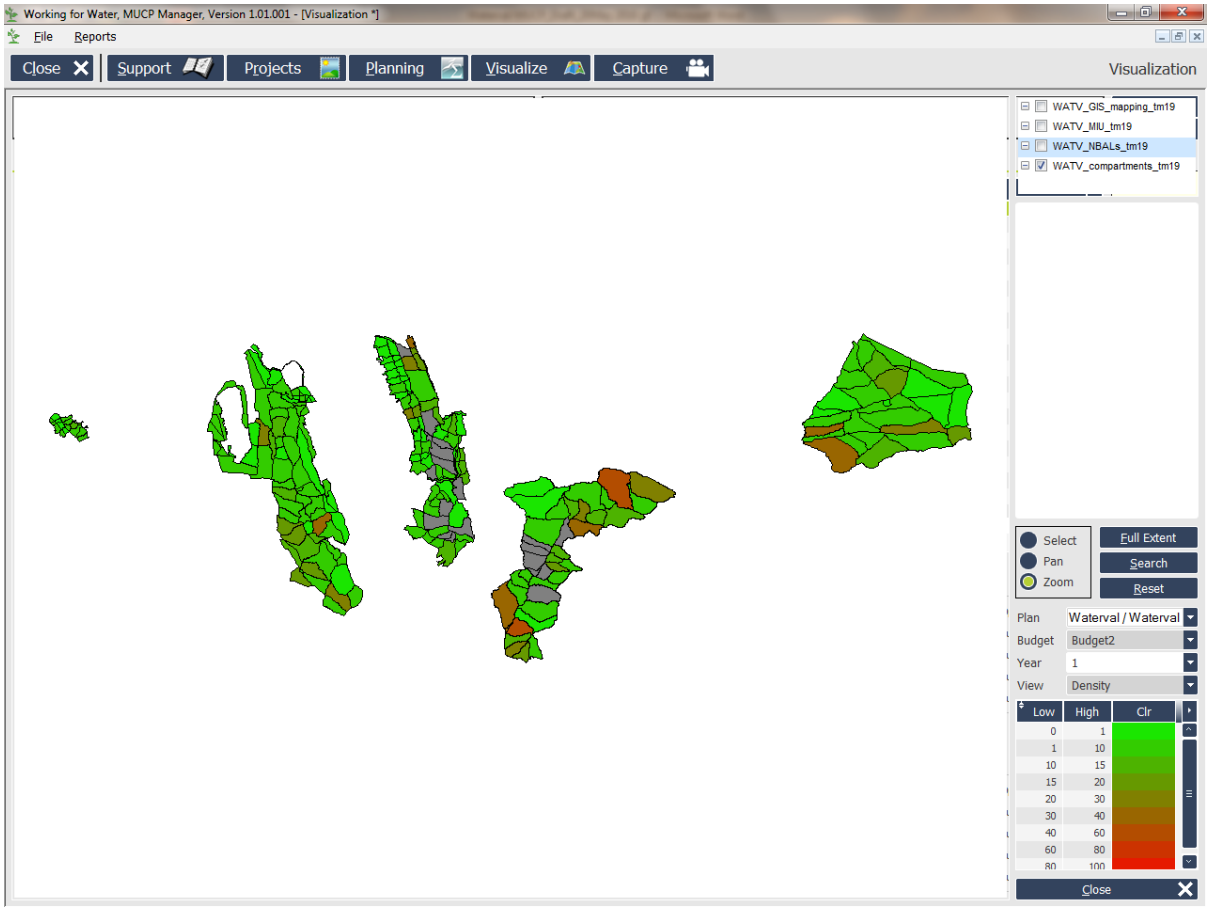


Figure 17: *Compartments managed by the Waterval Centre showing projected IAP densities after the first year of treatment if the annual budget ceiling is set to R4.5 million (Budget 2). Shading corresponds with the density scale in the bottom right corner. Grey shades indicate compartments were no IAPs have been recorded.*

Similarly the projected invasive alien plant densities for each compartment after the seventh year of treatment (half way through the 14 year cycle) if the annual budget ceiling is set to R4.5 million (Budget 2) are shown in Figure 18.

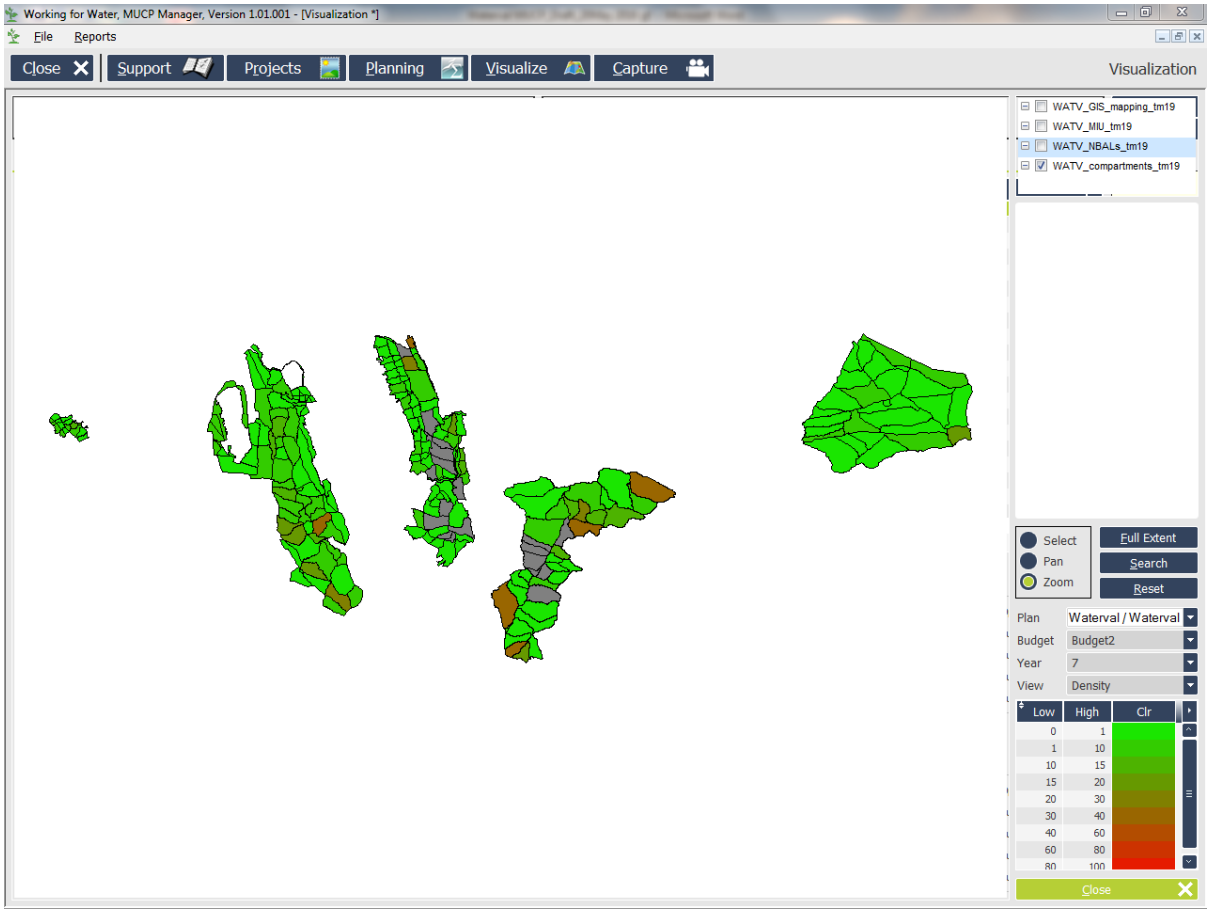


Figure 18: *Compartments managed by the Waterval Centre showing projected IAP densities after the seventh year of treatment (half way through the 14 year cycle) if the annual budget ceiling is set to R4.5 million (Budget 2). Shading corresponds with the density scale in the bottom right corner. Grey shades indicate compartments were no IAPs have been recorded.*

We also strongly recommend that CapeNature ensure that they have the biocontrol agents operating effectively and actively in the unburnt areas and facilitate their recolonization of any untreated regeneration as soon as they reach a suitable reproductive stage for the various agents to attack (see Table 4 for dominant plant species having biocontrol agents).

5.2 Evaluating the budget scenarios

The tool applies different annual budgets over a period of the next 20 years based on the prioritisation of the compartments for clearing. These include an optimal (i.e. unlimited) budget, which is estimated by the system based on the number of treatments each invaded area needs to reach a maintenance level within 2-3 years, and four additional annual budget ceilings which can be set by the user. In this case the annual budgets were set at R3.0 million, R 4.0 million, R 4.5 million, R 5.0 million. The tool calculates an unlimited (optimum) amount (Figure 19).

The duration and total annual cost for each treatment unit, either an Nbal or a MIU, for each species and treatment is displayed in the top panel (Figure 19). In this case it illustrates a budget of R 5.0 million per annum (Budget 1). The bar chart in the middle panel gives total cost per year displayed in a range of colours representing different annual budget ceilings. The line graph in the bottom panel shows how average species densities change in the catchment over time for each of these budgets. Once the levels of invasion have been reduced to ≤ 1% of canopy cover, then the compartment is under maintenance. Although it appears as if the budgets drop to zero after a number of years there is ongoing maintenance for the remaining years, but the maintenance amounts are too small to be apparent at this scale.

The optimal budget is merely for illustrative purposes so although the centre could theoretically be addressed in two years for approximately R 75.4 million, in practice it would be difficult to mobilise and manage sufficient resources efficiently and effectively to achieve this target.

The maintenance level of 1% canopy cover over the entire area can be reached after 12 years with an annual budget of R 5.0 million whereas with an annual budget of R 3.0 million the invasions will only reach ≤ 1% of canopy cover after 20 years. The goal set during the prioritisation exercise was to reach a maintenance level in 2030 which is in 14 years. An annual budget of R 4.5 million is needed over the entire 14 year period to achieve this and the total expenditure amounts to approximately R 55.8 million (Figure 19). The greatest total expenditure over the next 20 years, ignoring the optimum budget, is estimated at R 56.1 million for the R 3.0 million budget ceiling. Compartment schedules showing the annual costs per compartment for two different annual budgets, R 3.0 million and R 4.5 million, for the next 15 years, and sorted by priority, are contained in Annexures 4 and 5.

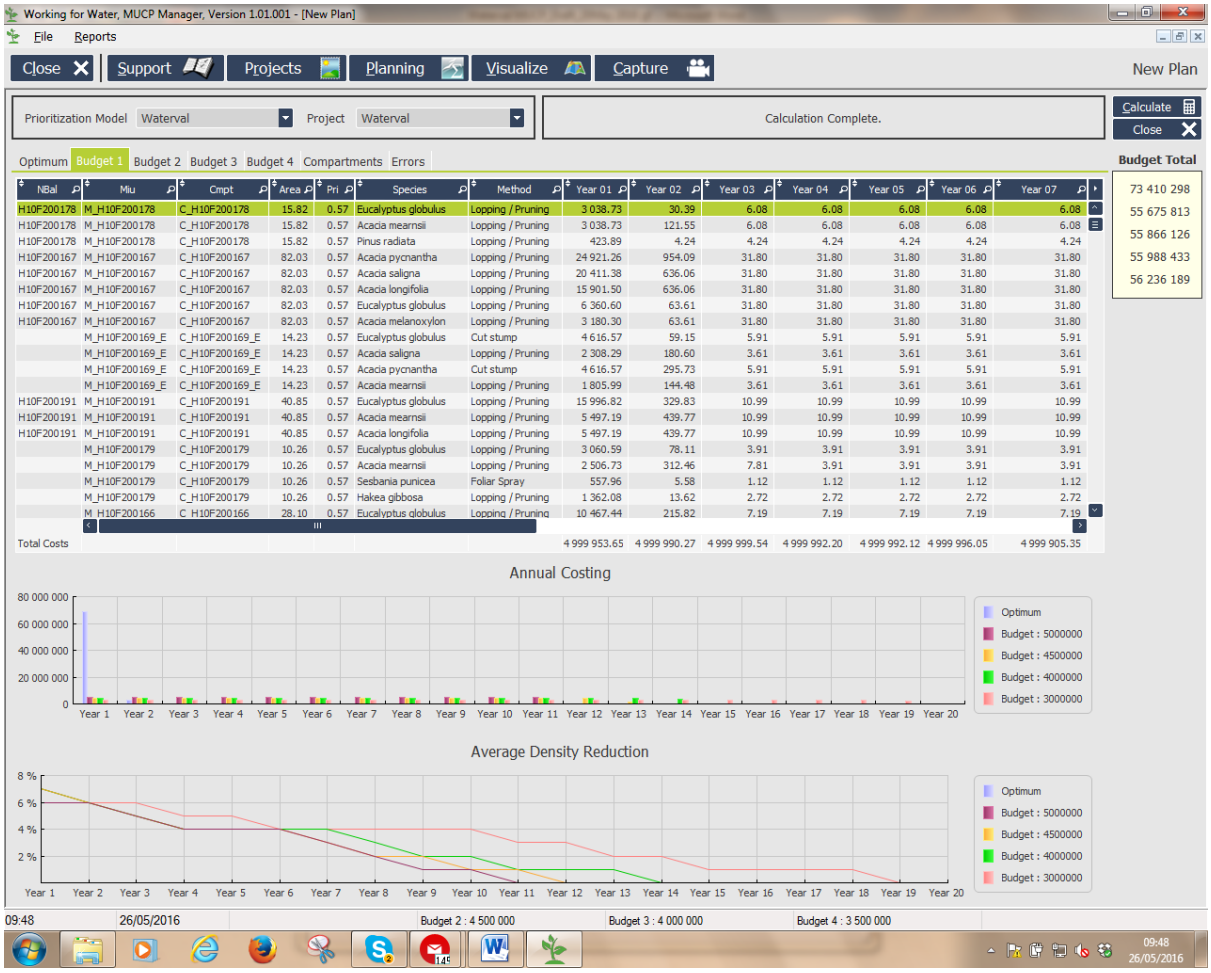


Figure 19: *Summary of the annual budgets allocated per compartment for the next 20 years based on the prioritisation of the compartments for clearing and a range of four annual budget ceilings (for more information see the text).*

The compartments identified for treatment in the first year (year one) of control, if the annual budget is set at R 3.0 million, shows that high levels of expenditure are projected for compartments in the Bokkeriviere, Hex River and Witzenberg (Figure 20).

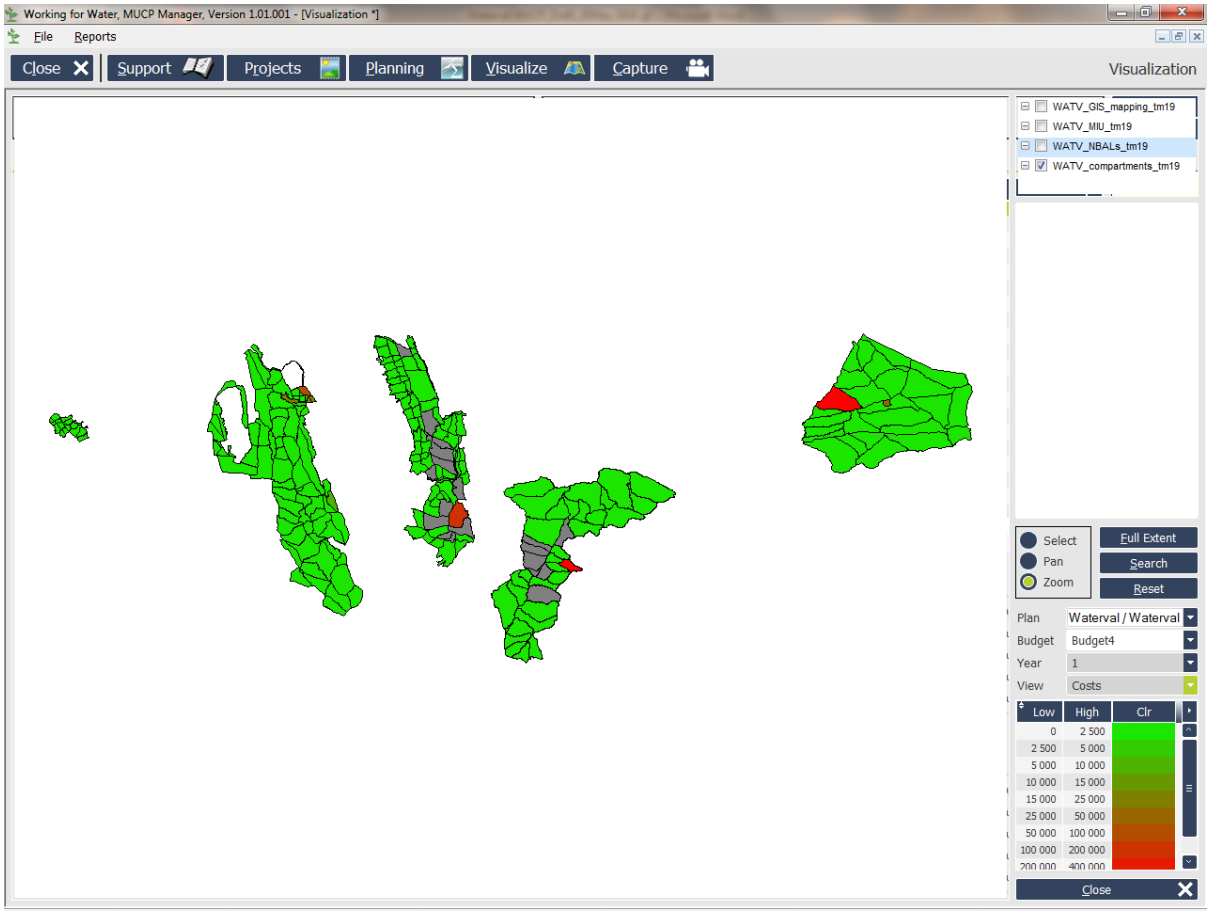


Figure 20: *Compartments scheduled to receive treatments during the first year (2016) if the annual clearing budget is set to R 3.0 million (Budget 2). The shading from green to red indicates the increasing costs of the treatments. Grey shading indicates compartments with no mapped invasions*

With a budget ceiling of R3.0 million per year, it would take about 20 years to reach maintenance and the total expenditure over the 20 years would be R56.2 million.

If the budget is increased to R 4.5 million then more compartments in same sections are treated (Figure 21).

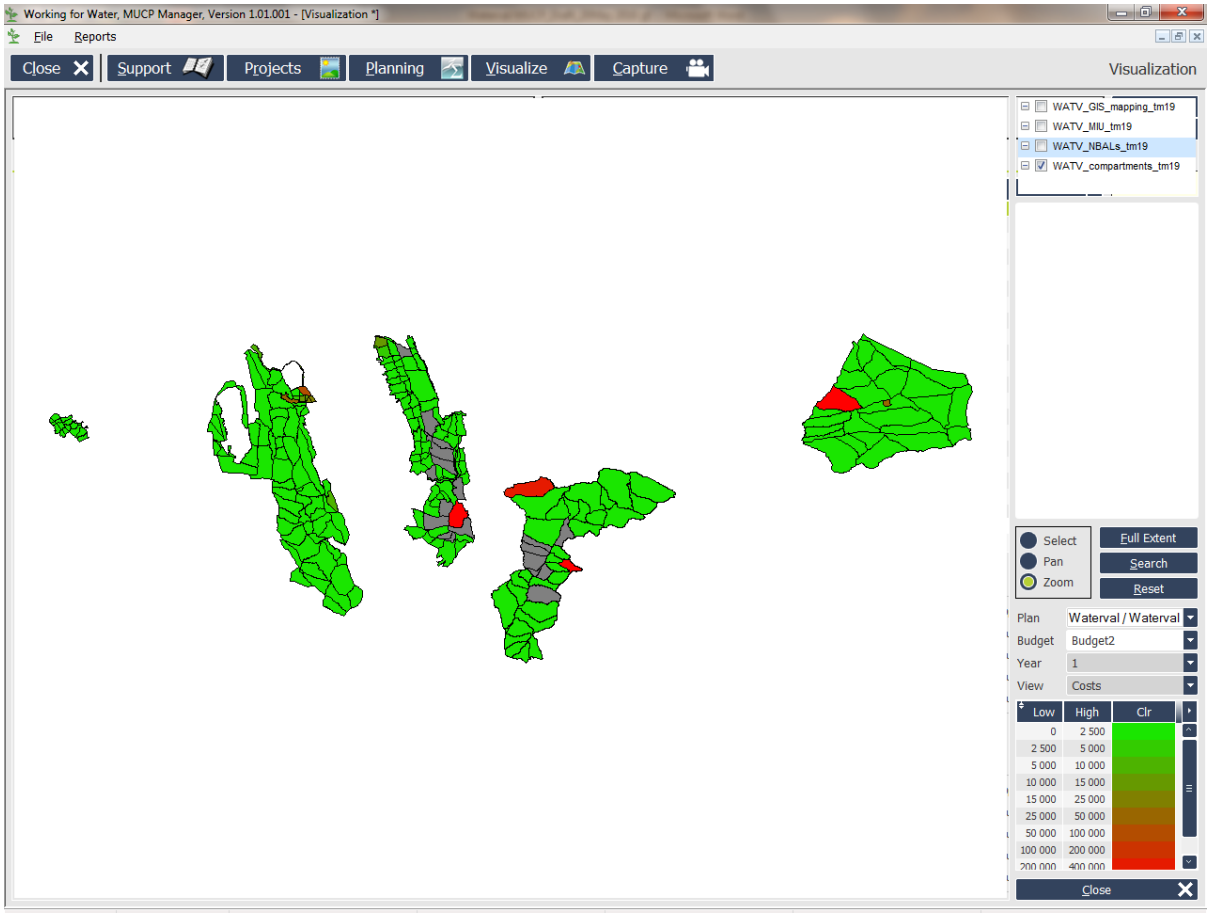
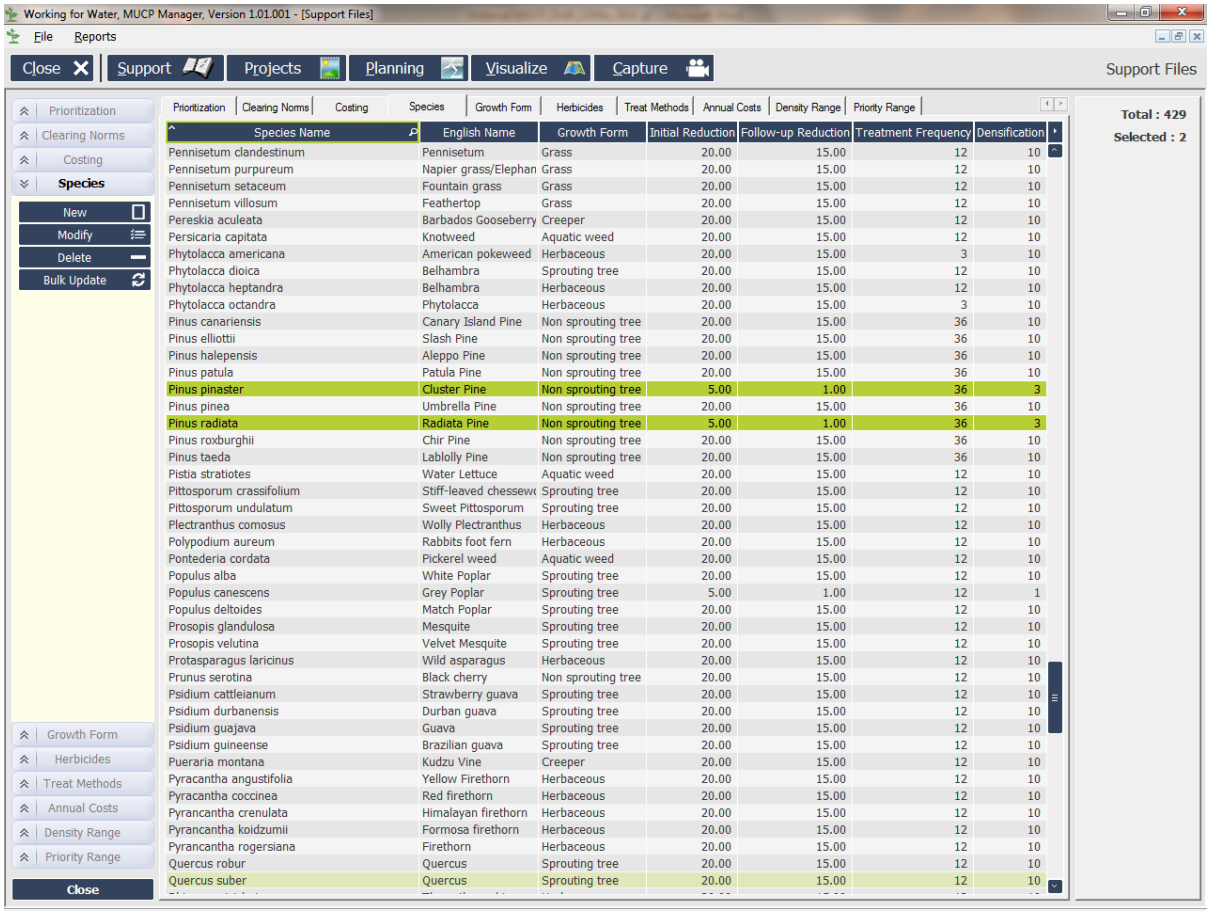


Figure 21: *Compartments that are scheduled to receive treatments during the first year (2016) if the annual clearing budget is set to R 4.5 million (Budget 2). The shading from green to red indicates the increasing costs of the treatments per compartment. (More compartments)*

5.3 Calculation of the resource requirements

A feature of the MUCP tool is that it is preloaded with WfW norms data and formulas for calculating person days, including team sizes, daily rates, and daily workloads for different species-linked treatments (e.g. herbicide on cut stumps, lopping) and densities and adjustments for slope and other factors. All of these setting can be changed by the user to match their own cost structures and team compositions.

The MUCP tool also includes information on the typical reduction in densities after initial and follow-up treatments which can be adjusted by the user either for individual species of for selected groups of species (Figure 22).



Species Name	English Name	Growth Form	Initial Reduction	Follow-up Reduction	Treatment Frequency	Densification
Pennisetum clandestinum	Pennisetum	Grass	20.00	15.00	12	10
Pennisetum purpureum	Napier grass/Elephan	Grass	20.00	15.00	12	10
Pennisetum setaceum	Fountain grass	Grass	20.00	15.00	12	10
Pennisetum villosum	Feathertop	Grass	20.00	15.00	12	10
Pereskia aculeata	Barbados Gooseberry	Creeper	20.00	15.00	12	10
Persicaria capitata	Knotweed	Aquatic weed	20.00	15.00	12	10
Phytolacca americana	American pokeweed	Herbaceous	20.00	15.00	3	10
Phytolacca dioica	Belhambra	Sprouting tree	20.00	15.00	12	10
Phytolacca heptandra	Belhambra	Herbaceous	20.00	15.00	12	10
Phytolacca octandra	Phytolacca	Herbaceous	20.00	15.00	3	10
Pinus canariensis	Canary Island Pine	Non sprouting tree	20.00	15.00	36	10
Pinus elliottii	Slash Pine	Non sprouting tree	20.00	15.00	36	10
Pinus halepensis	Aleppo Pine	Non sprouting tree	20.00	15.00	36	10
Pinus patula	Patula Pine	Non sprouting tree	20.00	15.00	36	10
Pinus pinaster	Cluster Pine	Non sprouting tree	5.00	1.00	36	3
Pinus pinea	Umbrella Pine	Non sprouting tree	20.00	15.00	36	10
Pinus radiata	Radiata Pine	Non sprouting tree	5.00	1.00	36	3
Pinus roxburghii	Chir Pine	Non sprouting tree	20.00	15.00	36	10
Pinus taeda	Lablolly Pine	Non sprouting tree	20.00	15.00	36	10
Pistia stratiotes	Water Lettuce	Aquatic weed	20.00	15.00	12	10
Pittosporum crassifolium	Stiff-leaved chessew	Sprouting tree	20.00	15.00	12	10
Pittosporum undulatum	Sweet Pittosporum	Sprouting tree	20.00	15.00	12	10
Plectranthus comosus	Wolly Plectranthus	Herbaceous	20.00	15.00	12	10
Polypodium aureum	Rabbits foot fern	Herbaceous	20.00	15.00	12	10
Pontederia cordata	Pickerel weed	Aquatic weed	20.00	15.00	12	10
Populus alba	White Poplar	Sprouting tree	20.00	15.00	12	10
Populus canescens	Grey Poplar	Sprouting tree	5.00	1.00	12	1
Populus deltoides	Match Poplar	Sprouting tree	20.00	15.00	12	10
Prosopis glandulosa	Mesquite	Sprouting tree	20.00	15.00	12	10
Prosopis velutina	Velvet Mesquite	Sprouting tree	20.00	15.00	12	10
Protasparagus laricinus	Wild asparagus	Herbaceous	20.00	15.00	12	10
Prunus serotina	Black cherry	Non sprouting tree	20.00	15.00	12	10
Psidium cattleianum	Strawberry guava	Sprouting tree	20.00	15.00	12	10
Psidium durbanensis	Durban guava	Sprouting tree	20.00	15.00	12	10
Psidium guajava	Guava	Sprouting tree	20.00	15.00	12	10
Psidium guineense	Brazilian guava	Sprouting tree	20.00	15.00	12	10
Pueraria montana	Kudzu Vine	Creeper	20.00	15.00	12	10
Pyracantha angustifolia	Yellow Firethorn	Herbaceous	20.00	15.00	12	10
Pyracantha coccinea	Red firethorn	Herbaceous	20.00	15.00	12	10
Pyrancantha crenulata	Himalayan firethorn	Herbaceous	20.00	15.00	12	10
Pyrancantha koidzumii	Formosa firethorn	Herbaceous	20.00	15.00	12	10
Pyrancantha rogersiana	Firethorn	Herbaceous	20.00	15.00	12	10
Quercus robur	Quercus	Sprouting tree	20.00	15.00	12	10
Quercus suber	Quercus	Sprouting tree	20.00	15.00	12	10

Figure 22: *An example of the species information contained in the MUCP tool and used, together with the WfW norms, for calculating compartment treatment workloads and scheduling and projecting them into the future.*

The user can also adjust the treatment frequency and how rapidly invasions by different species become denser if left untreated. Spread into new areas is not accommodated in the system at present. The density reductions, treatment frequencies and densification rates that we used were based on expert input because they need to take into account the limitation that the system has been programmed to continue treating the invasions in each compartment as if they remained in the same state (e.g. adult sprouting trees) when they do not. For example, treatment of stands of adult *Acacia mearnsii* typically results in dense regeneration from seeds as well a low probability that some trees may sprout even if treated with herbicide. The current settings allow for us to include some re-treatment of the adults but not to add in a seedling treatment. This limitation is in place because these transitions are complicated and must still be worked out and expressed as rules so that they can be included in the system. In the interim these adjustments have to be made using expert inputs (Table 15).

The historical data on the treatments and state of the Nbals in the MUCP is extracted from the data stored in WIMS, so it is important that data are captured correctly in the field and entered correctly into WIMS and conform to the standards (NRM 2016). The project managers now have smart phone

based applications which they can use for mapping Nbals and recording the state of invasions which reduces the potential for errors in recording the information on paper and entering the hard cop of the data into WIMS.

***Table 15**: Density reduction, treatment frequencies and densification rates used for each of the major IAPs managed by the Waterval Centre.*

Dominant species	Initial density reduction [1] (%)	Follow-up density reduction (%)	Treatment Frequency [2] (months)	Densification [3] (%)
Acacia baileyana	5.0	1.0	24	1.0
Acacia cyclops	5.0	1.0	24	1.0
Acacia longifolia	7.5	3.0	24	1.0
Acacia mearnsii	7.5	3.0	12	1.0
Acacia melanoxylon	5.0	2.0	12	1.0
Acacia pycnantha	5.0	2.0	24	1.0
Acacia saligna	5.0	2.0	12	1.0
Eucalyptus globulus	1.0	1.0	12	0.5
Hakea gibbosa	1.0	1.0	24	1.0
Hakea sericea	1.0	1.0	24	1.0
Pinus pinaster	2.0	1.0	36	3.0
Pinus radiata	1.0	1.0	36	1.0
Populus X canescens	5.0	1.0	6	1.0
Rubus fruticosus	5.0	1.0	6	1.0
Sesbania punicea	1.0	0.5	24	0.5

Notes:

1. A 5% reduction means that the density has been reduced to 5% of the pre-treatment density (i.e. density reduced by 95%. This is the same for the follow-up treatments
2. Treatment frequency is the minimum interval between treatments to prevention plants maturing and producing seeds
3. In the absence of stimulating seed germination (such as a fire) densification is slow.

6 IMPLEMENTING THE PLAN

When the Working for Water programme was launched in 1995, the general perception was that the programme would be able to control invasive alien plants effectively and reduce invasions to maintenance level. It would do this by accepting responsibility for controlling all invasions on state land and do the initial clearing and two follow-ups on private land. Experience has shown that the programme was not able to achieve effective control and that the only hope for achieving such control was to actively involve everyone who owned or managed land in the clearing effort. This has brought about a shift in the programmes policies and operations of the Chief Directorate of Natural Resource Management programmes (NRM). It is now changing its main funding model to support both government and non-government invasive alien plant management initiatives through what are called Land-User Incentives. In parallel, they have promulgated regulations (DEA 2014) that will enable them to use the provisions of the NEM: Biodiversity Act (DEA 2004) to compel all land owners and organs of state to develop and implement invasive alien species management plans. They have also developed a National Strategy for Biological Invasions which sets out what needs to be done to being invasions by alien species under control (NRM, 2014).

This means that NRM now have three key factors in place to bring invasive alien species under control: (a) an approach that seeks to motivate land owners to take responsibility for clearing, (b) legislation to compel those that do not, and (c) a strategy which sets out what is needed to achieve control. What they are now seeking is for land owners or managers to jointly take on the responsibility of bringing invasive species under control. They could take the lead role themselves, or through their implementing agent, but they really want all land owners to take ownership. This plan shows that invasive alien plants can be brought under control in the areas managed by the Waterval Centre providing there is sufficient funding, the problem is tackled systematically and the treatments are executed efficiently and effectively. It provides a schedule of those treatments that will result in the greatest benefits (e.g. water flows released and biodiversity protected).

Given this, we suggest that CapeNature as the Implementing Agent (IA) for the Waterval Centre engage with representatives of the main stakeholders (Table 13) at regular intervals during the implementation of the plan. CapeNature should also actively engage with owners of private land within proclaimed Mountain Catchment Areas to materially or otherwise contribute to the clearing this land.

The next step is to ensure that the current schedule of operations generated by the MUCP tool is evaluated and that all those involved agree that it will meet their needs and achieve the goal (Figure 15).

Unless the clearing programmes of CapeNature and neighbouring landowners are well co-ordinated, there is a possibility that they will not be working in harmony, leading to slower progress. There are also large portions of private land that are adjacent to or partially enclosed in the Waterval Centre and these should be treated simultaneously to limit the changes of reinvasion taking place from these areas.

This requirement for co-ordinated action means that more resources will be needed to reduce invasive alien plants in the areas managed by the Waterval Centre to maintenance levels within a reasonable timeframe of 14 years. A key factor that will help CapeNature and its neighbouring private land owners to secure the necessary funding from NRM, will be the willingness of all the parties involved to co-fund the clearing operations (e.g. private farmers using their own labour when they have spare capacity). The parties will also have to agree on how the NRM funds will be channelled and used, and on how they will coordinate their operations. What will not work is underfunding. Another challenge will be maintaining stakeholder motivation over this long-time period, and evidence of effective progress will be a key element in sustaining active participation.

No matter what the available budget, implementation of the clearing programme should always start in compartments with the highest priorities and proceed over time to those having lower priorities (Forsyth *et al.*, 2012). In this way available budgets will be applied to achieve the maximum benefits. The Implementing Agent (IA) should begin by working through the top priority compartments listed in Appendix 4 or 5. These compartments need to be assessed and inspected to determine what has been done in the past, and to verify the current state of invasion. If this matches what the tool shows, then the IA needs to agree jointly on who will execute the necessary treatments, the source of the funds and whose resources (e.g. labour, equipment) will be deployed. Should that compartment require more or less funding, then the planned budgets can be adjusted by the IA and fed back into the tool. It is important that areas that are currently uninvaded are kept clear of new invasions. This means that a portion of the overall budget needs to be set aside for surveys of these areas, with some contingency funding and resources to deal with such invasions appropriately.

This prioritisation will need to be re-examined should substantial change, such as wildfires and floods, occur. Much of the Hex River Mountains was burnt during extensive wildfires in February 2016. This change was partially taken into account when considering the criteria in the prioritisation model before running the MUCP tool to calculate clearing costs but then changes in the state of he burnt invasions have not been incorporated yet.

It is essential to report accurately on progress and for the IA to ensure that the progress is evaluated against the goals and the schedule for each year. Typically the control of the quality of the work is done by CapeNature field rangers and it is essential that such staff have a minimum set of skill to do thorough assessments.

Planning should be revised when progress does not match the planned outcomes or meet expectations. Irrespective of the rate of progress, there are always circumstances that change or other unanticipated changes, and the plan should be formally revised every 5 years. Monitoring and evaluation of progress (Levendal *et al.*, 2008), and learning from the past so that things can be done more effectively in future, is central to the adaptive management approach which NRM is attempting to implement in all the work that it is funding (van Wilgen and Wannenburgh 2016).

7 BACKGROUND INFORMATION (WHAT IS INVOLVED?)

7.1 Natural Resource Management: what it does and how it works

The national Department of Environmental Affairs (DEA) has a number of programmes aimed at achieving environmental goals and creating meaningful employment[3]. The Chief Directorate of Natural Resource falls under the Environmental Programmes (EP) branch is one of six branches within the DEA. Its aim is to: "*address the threats to the productive use of land and water, and the functioning of natural systems by invasive alien species, wild fires and land degradation, as well as the opportunities for value added industries (including fibre and furniture production), whilst ensuring meaningful livelihood opportunities are supported for those employed in doing this work*". It has a number of programmes aimed at achieving this, including:

- Working for Water (WfW) was established in 1995 and focuses on controlling alien plant invasions either directly or through a range of implementing agents and a variety of incentives aimed at motivating the private sector to participate in invasive alien plant species management.
- Value-added Industries (previously known as Eco-furniture and Working for Energy) which focuses on using the material generating by the clearing of alien plant invasions to produce products.
- Working for Forests and Working for Ecosystems focus on rehabilitating degraded indigenous forests and rangelands, respectively, to functional ecosystems so ensure that they deliver ecosystem services including forage, fibre and other natural products. Working for Forests also includes the rehabilitation of neglected state plantations and woodlots to productive systems.
- Working for Wetlands which rehabilitates wetlands using engineered structures (e.g. gabions) and natural methods (e.g. planting wetland species) to ensure that they deliver ecosystem services.
- Working on Fire implements an integrated approach to veld and forest fire management to enhance the protection of life, livelihoods and assets and maintain ecologically sound fire regimes in fire-prone ecosystems. Working on Fire also does clearing of invading alien plants in rugged terrain using funding from the WfW budget.

DEA's EP branch has also launched a programme which focuses on Biosecurity whose aim is to: "protect the environment from high-risk invasive alien species through the pre-, at- and post- border management of non-indigenous species." This programme focuses on preventing and minimising the impacts of invasions by high-risk alien species by educating the public about the risks, inspections of goods and baggage entering South Africa, surveys aimed at detecting new invasions, and directing

[3] See https://www.environment.gov.za/projectsprogrammes

teams to eradicate them wherever possible. They work closely with the Invasive Species Programme of SANBI (SANBI-ISP) to ensure that their efforts are well coordinated.

The Working for Water programme has also developed a number of ways of supporting control measures against invasive alien plants. They provide funds and resources in a number of ways:

- Direct involvement in the management of the clearing teams where they provide all the resources and oversee the operations;
- Indirect involvement through the funding of:
    - Control operations managed by implementing agents such as CapeNature, and for steep areas requiring specialised safety precautions and skills involving rope-work, Working on Fire's High Altitude Teams (HATs).
    - Land-user incentives (LUIs) where groups of land-owners apply for funding to carry out control operations on their land. These initiatives can also include way of using the material (biomass) from the clearing to produce products and rehabilitation of degraded land and river systems.
    - Other inputs such as providing herbicides and advice to land-owners.
    - Working with the nursery trade to minimise introduction of invasive species and to stop selling species known to be invaders
- Support for the introduction and maintenance of biological control agents for invasive alien plants, and research into agents for those which do not yet have effective agents.

A key aim of this plan is to find ways to use all of these options to optimise the efficacy and efficiency of the management of the invasions. This plan is aligned with the national strategy and the regional priorities of the Working for Water programme. These include ensuring that the benefits of the clearing are maximised, in this case by protecting water and biodiversity resources in the mountain catchments managed by the Waterval Centre.

The only way to achieve effective control of the alien plant species in this catchment and achieve the goal of reaching a state where only maintenance operations are needed is for every stakeholder to play their part. The failure to develop more effective working relationships, and thus to sustain clearing work already undertaken, is one of the key factors contributing to the overall failure to reduce the extent and impacts of invasions over the past 15 years (van Wilgen *et al.* 2012). This is one of the key reasons why WfW has invested resources in designing and testing various ways of supporting the involvement of other parties in invasive alien plant control as described above. Those responsible for implementing this plan need to ensure that all these options are used to achieve the goal of reaching maintenance levels by 2030.

7.2 Components of Effective Invasive Alien Plant Management

South Africa is one of many countries investing in the management of invasive species and there is a lot that can be learnt from their experiences and ours about what is required for effective management. The recently developed, but still not formally released, National Strategy on Dealing with Biological Invasions (NRM 2014) builds on that experience. This strategy recognises the following things as requirements for its effective implementation:

- An integrated approach based on co-ordination and collaboration across all sectors and levels of government
- Establishment of an effective legislative and regulatory environment
- Management of invasions which entails prevention, eradication where possible and desirable, and optimising the reduction of adverse impacts by reducing the rate of spread and preventing increases in density (asset protection)
- Effective management of information on invasions and the actions being taken and making such information readily available
- Ensuring that there is adequate monitoring and evaluation so that the effectiveness of the implementation can be continuously improved
- Providing adequate resources to carry out all these measures, including capacity development
- Supporting research to provide to evidence needed to support decision making
- Raising awareness of the problem and the need to act

In particular, this plan must make provision for resources to address all the components of effective management of invading species (McNeely *et al.* 2001, Hulme 2006, NRM 2014): prevention, eradication and reducing impacts (i.e. asset protection).

- ***Prevention*****:** actions aimed at ensuring that no new invasive species are introduced to the catchment. Since most invaders are introduced to new areas by people, the primary way of doing this would be through educating the inhabitants about the risk involved in growing or planting alien species. Only a small proportion of all the alien species are invasive but prevention is better than cure. A lot of information on risky and safe species is available on the internet (see sections 7.8 and 7.9). The SANBI-ISP has regional representatives who can be contracted should anyone identify a suspicious species and confirm whether or not it is a new invader (see sections 7.8 and 7.9).
- ***Eradication*****:** involves taking action to ensure that the population of a newly introduced or established species is completely removed or killed and does not re-establish itself. The SANBI-ISP representative, Working for Water manager or the local Plant Protection Research Institute office should be contacted for advice on what to do (see sections 7.8 and 7.9).
- *Containment*: stopping further spread in part or all of the current range of an established invasive species and is another important component of a comprehensive control programme. In the context of this catchment this would involve ensuring that newly established individuals of existing invaders would be removed. The most practical way to do this is through regular surveys of uninvaded areas and removing any invaders that are found to ensure that these areas remain uninvaded.
- *Impact reduction/asset protection*: This involves following a systematic clearing programme in each invaded area: beginning with the initial treatment, then a sequence of follow-up treatments to ensure that all the invading species are reduced to the minimum; and finally ongoing maintenance to deal with any re-establishment. The sequencing of the areas for treatment should be based on the priority assigned to the compartment the invasion occurs in. It is important that these steps are followed but also that they are applied flexibly to ensure that opportunities to make more rapid progress, or avoid going backwards, are

taken. One example of this is fires. Fires will facilitate the spread of most alien plant invaders and will result in increases in their densities. However fires can also offer opportunities by opening up dense invasions or replacing adult plants with seedlings which are much less resource intensive to control. If these opportunities are not grasped timeously, then gains made over many years can be lost.

Another essential component of this plan is to make effective use of biological control (biocontrol) which uses natural enemies of invading species to kill them or reduce their growth or seed production. Biocontrol is particularly important because there aren't enough resources to carry out control operations everywhere but biological agents can be introduced everywhere. They will reduce rates of spread and the invader density and impacts significantly in those areas where there are no control operations yet. The agents are carefully selected, bred, tested for specificity and effectiveness and, once they show promise, are then released to attack the species they were selected to target. This is a very cost-effective method of control for many invading species and limits both their ability to spread and to form dense, single-species stands. The WfW programme has regional biological control managers whose job it is to assess whether the agents are being effective, introduce new agents where necessary and maintain reserves for biocontrol agents among others. Contact details are given under Sources of information (see sections 7.8 and 7.9).

7.3 Capacity and Resources

A core component of WfW is human capacity development of staff and beneficiaries (contract workers) and more information can be found on their website:

https://www.environment.gov.za/projects programmes/wfw/resources/

Working for Water has produced a staff induction manual outlining the operations and procedures within Working for Water. There are clear requirements for employees to undergo a minimum of 48 days of training according to a prescribed training plan. Training is available for both workers and contractors to improve skills and knowledge on biodiversity and environmental practices (Table 16). For example, accredited training programmes developed by the Wildlife and Environment Society of South Africa (WESSA) provide a range of qualifications. A training matrix outlines the required courses on clearing in Terrestrial and Aquatic environments, Health and Safety, Social Development and Contractor Development. This training matrix provides information on the requirements, standards and appropriate training level (Appendix 3).

***Table 16:** Websites and links related to WfW capacity development*

Training topic	Website address
Training matrix	http://workingforwater.org/features/course-information-and-materials
Staff induction manual	https://www.environment.gov.za/sites/default/files/legislations/staffinduction.pdf
WESSA training courses	http://www.wessa.org.za/uploads/documents/projects/Capacity_for_Catchment_%E2%80%93_uMngeni_Ecological_Infrastructure_on_organisations_and_courses.pdf

7.4 Communications and Advocacy

Communication should address:

- Maintaining a contact list (see Section 2.11)and a website
- Regular meetings with stakeholders and the purpose of such meetings
- Updates on legislation which can be found on WfW website and www.invasives.co.za
- Further interventions in the area managed by the Waterval Centre

Advocacy focuses on motivating land owners, other bodies and the general public to become actively involved.

Communications on invasive alien plants and their management are communicated from different platform. These are in the form of pamphlets, factsheets newsletters and information can be accessed from different websites. The planning of invasive alien control program can be viewed online and contains information of the annual plan of operations. Some useful ones are listed in Table 17.

***Table 17:** Websites and links related to communications and advocacy*

Topic	Content	Website address
WfW clearing strategies	It outlines the Working for Water approach, manifesto and research agenda and contains information on clearing strategies, recent research, herbicide registrations and APO plans.	www.wfw.org.za or https://sites.google.com/site/wfwplanning/
WfW training standards	Contains information for trainers and trainees including training and norms and standards needed for workers and contractors, and the levels of qualification that can be obtained.	www.workingforwater.org
WfW overview	Overall view of the working for water programme and how it aligns with governments bodies.	https://www.environment.gov.za/projectsprogrammes/wfw https://www.environment.gov.za/projectsprogrammes/wfw/resources
WfW	This focus is on the planning, operational support and quality assurance terrestrial, invasive alien plant control in South Africa	www.wfw.org.za or https://sites.google.com/site/wfwplanning/
SAPIA and PPRI	Regular newsletters (quarterly?)	http://www.arc.agric.za/arc-ppri/Pages/Newsletters.aspx
National Information on invasive alien species		www.invasives.org.za /

7.5 Legal Background and Requirements

There are two laws and their respective regulations that deal with invasive alien species in South Africa. One is the Conservation of Agricultural Resources Act (CARA), 1983 (Act No 43 of 1983) and its regulations and the other is the National Environmental Management: Biodiversity Act (NEM:BA), 2004 (Act No. 10 of 2004) (DEA 2004) and its regulations.

The CARA was originally intended for use in regulating agricultural weeds but was also used for plant invaders on land not used for agricultural purposes. However there were problems with the scope and implementation of CARA and the NEM:BA was drafted specifically to address environmental invasion problems and enable the Department of Environment Affairs to manage alien species invasions directly. This section deals with the relevant provisions of the NEM:BA and its current regulations (R. 598 of 1 August 2014) (DEA 2014) (see Appendix 1 for relevant extracts from the Act and the regulations).

The NEM:BA contains two sections relating to programmes or plans for the management of invasive alien species (DEA 2004): (1) Section 75 on the *Control and eradication of listed invasive species*, and; (2) Section 76 on the *Invasive species control plans of organs of state*. Section 75 paragraph (4) requires the relevant minister to *ensure the coordination and implementation of programmes for the prevention, control or eradication of invasive species*. Section 76 requires all organs of state, including protected area management authorities, to develop invasive species monitoring, control

and eradication plans for land under their control. The act also stipulates the Minister must provide guidelines for the development of these plans within one year of the regulations coming into effect. These plans are largely aimed at managing extensive, established invasions and, thus, on control through suppression (mitigation) and Asset Protection. There clearly is a role for plans which focus on the key components of prevention, eradication and containment of invasive species, especially given that these components are far more cost-effective than control (NRM 2014). These plans must be incorporated into the authorities overall plans (e.g. management plans for protected areas, integrated development plans, environmental plans). Section 76 does not specifically state whether these plans are intended for particular species or for particular areas but the wording, taken in conjunction with regulation 8 (of R. 598), makes it clear that it deals with plans for specified areas and for all listed species within those areas. The Act defines control as: *…in relation to an alien or invasive species, means - (a) to combat or eradicate an alien or invasive species; or (b) where such eradication is not possible, to prevent, as far as may be practicable, the recurrence, re-establishment, re-growth, multiplication, propagation, regeneration or spreading of an alien or invasive species*. This makes it clear that the word control is to be interpreted as including all aspects of invasive species management.

Section 75 of NEM:BA deals with the control and eradication of listed species and 75(4) requires the Minister to ensure the coordination and implementation of species management programmes for the prevention, control and eradication of invasive species. In the regulations, Regulations 2-4 deal with the categories of invasive species. Within each of the species categories sub-regulation (3) stipulates that if an "*Invasive Species Management Programme*" has been developed for a listed species in terms of section 75(4) of the NEM:BA, then that species must be controlled in accordance with the programme. Neither the act nor the regulations define the content of such a programme but it is clear from the wording that the focus is on a particular species or, possibly, a suite of similar species. The now repealed 2013 draft regulations (R. 506 of 2013) did describe a Species Management Programme under regulation 4, which gives an indication of what such a programme was expected to entail:

4.(1) The competent authority must develop and coordinate species management programmes for Category 1b listed invasive species in order to assist landowners to control or eradicate their listed invasive species.

(2) A species management programme contemplated in sub-regulation (1) must stipulate –
(a) the listed invasive species to which it relates
(b) the measures to eradicate or control the listed invasive species specified in paragraph (a);
(c) the areas in which the measures referred to in paragraph (b) are to be applied; and
(d) the schemes to fund the measures, if applicable.

In addition to the Cara and NEM:BA acts, provincial ordinances can be declared which provide further regulations to control potential invasive alien species. Currently these are available for the Western Cape, Gauteng, Kwazulu-Natal and the Free State provinces.

Websites containing important information on the legal requirements of controlling invasive alien plants are listed in Table 18.

Table 18: *Websites and links related to legal requirements*

Topic	Content	Website address
Legal	Links to legislation and its implementation	https://www.environment.gov.za/legislation/actsregulations
		https://www.environment.gov.za/projectsprogrammes/wfw/
		www.invasives.org.za
		Incorporate a link to the guideline document for an IAS / IAP management plan as required by the Act
Raising awareness of legislation	Wildlife and Environmental Society of SA (WESSA) is facilitating NEM:BA workshops on compliance for landowners	http://www.wessa.org.za/uploads/documents/temporary-docs/WESSA Facilities NEMBA Compliance.pdf

7.6 Occupational Health and Safety

Employment needs to comply with the Occupational Health and Safety Act (1993). WfW is responsible for making sure that the Act is adhered to on projects that they fund. A number of Health and Safety courses are listed in WfW's training matrix (see Appendix 6).

7.7 Working for Water Policies

Working on private land:

A policy exists for work on private land[1]. On the whole, working on private land is being phased out in favour of land owners managing invasive alien plants themselves. This will be determined through land owner incentives or dis-incentives. There is a process to request assistance for clearing on private land.

Working on State land:

Working for Water has undertaken to reduce the density of established, terrestrial, invasive alien plants, through labour intensive, mechanical and chemical control, by 22% per annum. However, only certain areas are worked at a given time. The current process is to prioritise catchments and locations based on defined criteria. These are discussed in the annual plan of operations which are reviewed each year.

***Aquatics*:**

Until recently aquatic weeds were managed by the Department of Water and Sanitation but that responsibility was recently transferred to the Working for Water Programme. The regional office of WfW should be contacted for help in dealing with these species.

***Biological control*:**

Biological control of invasive alien plants refers to the introduction of natural enemies to reduce the vigour or reproductive potential to levels that are comparable to that of natural vegetation. Working for water works in close contact with the Weeds Research division of the Agricultural Research Council's Plant Protection Research Institute (PPRI). The Biological Control Implementation (BCI) programme conducts research on biocontrol agents for invasive alien plants. The current list of biocontrol agents is listed in Klein (2011) and information and links can be found here: http://www.invasives.org.za/resources/biocontrol.

7.8 Sources of additional information

A list of websites containing information on: invasive alien plant species, their biological control, other control methods and training is given in Table 19.

***Table 19:** Websites and links related to additional information*

Topic	Source	Website address
Invasive species	Arc home page for invasive alien species	http://www.arc.agric.za/arc-ppri/Pages/Weeds%20Research/Weeds-Research.aspx
	Arc web page for links to other sites containing information on invasive alien plants.	http://www.arc.agric.za/arc-ppri/Pages/Weeds%20Research/Other-sources-of-information-and-useful-links.aspx
	Information on individual invading plant species that has links via both common and scientific names	http://www.invasives.org.za/plants/plants-a-z
	South African Plant Invaders Atlas (SAPIA)	The SAPIA website is out of date but there are plans to update it and make it accessible via SANBI's website
	South African National Biodiversity Institute	List SANBI website

Topic	Source	Website address
	(SANBI) Alien and Invasive Species List, 2014 – Department of Environment Affairs	*https://www.environment.gov.za/sites/.../nemba10of2004_alienandinvasi.*
Biological control	Fact sheets supplied by the ARC	http://www.arc.agric.za/arc-ppri/Pages/Weeds%20Research/The-Working-for-Water-Programme-and-Biological-Control-Implementation-%28BCI%29.aspx https://www.environment.gov.za/projectsprogrammes/wfw/biocontrol#integration http://www.arc.agric.za/arc-ppri/Pages/Weeds%20Research/Fact-Sheets-on-Invase-Alien-Plants-and-their-Biological-Control-Agents.aspx http://www.invasives.org.za/resources/biocontrol.
Control methods	Control tables outlining procedure for removing alien plants, including herbicide application Outline of clearing techniques Overview of clearing techniques	www.dwaf.gov.za/wfw/Control/docs/controltables.doc https://www.environment.gov.za/projectsprogrammes/wfw/alienplantcontrol_managementplan http://www.invasives.org.za/resources/control-methods/item/392-how-to-remove-invasive-plants.html https://www.dwa.gov.za/wfw/Control/
Academic training institutes	CIB (Post graduate) NMMU (Under post graduate diplomas and degrees) Other training	http://academic.sun.ac.za/cib/ See training matrix in appendix 6 http://www.unep.org/training/programmes/Instructor%20Version/Part_3/readings/WfW_case.pdf

7.9 Clearing support options for private land owners

The Working for Water (WfW) programme no longer solely manages the clearing of invasive alien plants on private land. Instead a new policy was adopted whereby working for water would enter in contracts with private land owners and offer incentives to facilitate the clearing of invasive alien plants. This approach aims to get private land owners to both manage and be accountable for invasive alien plants on their own land.

The contract would outline roles, responsibilities and obligations of the land owner, clearing team and working for water. For this approach the clearing team is contracted to the land owner who is responsible for the clearing operation.

The working for water programme provides incentives which include training of clearing teams, support of labour costs (up to 100% for initial clearing, 75% for 1st follow-up, 50% for the 2nd follow up), branded clothing, planning and mapping support, biological control, herbicides and monitoring and evaluations. The private land owner will be responsible for the provision of the following to clearing teams: equipment, protective clothing, food, transport, or facilities for suitable working conditions (e.g. ablutions).

It is important to note that where Emerging species are present on private land then the Working for Water programme may provide the full labour, herbicide and other costs for species listed as "emerging species" in a particular area as part of its prioritization of early detection of and rapid response to emerging invasive alien plant species.

The Working for Water programme reserves the right to issue disincentives which may extend to charges for seed pollution, or a general charge for the control of invasive alien plants, as determined by WfW's parent Departments through its Executive Committee.

Resources:

Full private land policy	https://www.environment.gov.za/sites/default/files/legislations/approachtoworkon_privateland.pdf
WfW incentive application form:	https://www.environment.gov.za/sites/default/files/docs/forms/clearing_assisstance_application.pdf

The following applications processes are available to private land owners:

Herbicide assistance:

The Working for Water programme provides assistance for herbicides where necessary to control invasive alien plants. This will be provided for the initial and up to three follow-up clearing applications. This assistance does not require that an incentive contract (as mentioned above) be entered into. Herbicide assistance can be applied for to contain invasive alien species prior to incentive contracts.

Herbicide application form:	https://www.environment.gov.za/sites/default/files/docs/forms/herbicide_assistance.pdf

Biocontrol assistance:

The Working for Water programme may provide biological control agents to the land-owner, who will be responsible to report back to WfW on the impact of these agents against key performance indicators.

Biocontrol application form:	https://www.environment.gov.za/sites/default/files/docs/forms/dermacationof_biologicalcontrol_reservesite_forteristerailplants.pdf
Biological control observation forms	https://www.environment.gov.za/projectsprogrammes/wfw/resources

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***Appendix 1**: Spatial datasets*

Data file name	Description	Methods used as a basis of comparison	Type	Source
WaTR_ compartments_TM19	Management compartments units with clearly defined and permanent boundaries	*Shapefile fields (attributes):* Compartment layer for use in MUCP system; Compt ID, Slope, Walk time, Drive time, and riparian or landscape code	Shapefile (Vector)	CapeNature
WaTR_mini_compt_TM19	Management compartments for establishing priorities, scheduling treatments and recording progress	*The fields (attributes) added for use in prioritization table:* Compt ID, AREA HA, OWNERSHIP, VEG STATUS, VELD AGE, Ave MAR, Erosion (elevation), Siltation (IAP aggressiveness), Soil prop (No IAP spp), Rain, IAP dom (dominant species), IAP dens (density of dominant species), Total dens (total densities of all IAPs), Fire (Biodiversity index). *Method*: Each variable i.e. was assigned to a compartment based on the unique compartment ID. How these were derived is listed below.	Shapefile (Vector)	CapeNature
Watv_prioritisation_table	Prioritisation table to input into the MUCP Tool	Derived from contents of the WaTR_mini_compt_TM19 shapefile	Excel CSV	CapeNature
GIS mapping	Union of three input shapefiles required by the MUCP Tool	Union WaTR_compartments_TM19; MIU; Treatment units NBALS. Field required are Compt_ID, MUI_ID and NBAL_ID and Area	Shapefile (Vector)	CapeNature
IAP aggressiveness	IAP aggressive score per compartment	Attribute: Sum of aggressive score per dominant IAP for each compartment. Data entered in the "Siltation" field in the prioritisation CSV file.	Attribute field	CSIR
IAP species	Number of IAP species per compartment	Attribute field containing the number of IAPs recorded per compartment. Derived from CapeNature's annual "IAP Wall-to-Wall map" data compiled by staff on CapeNature reserves. Data entered in the "Soil_prop" field in the prioritisation CSV file.	Attribute field	CapeNature
MIU	Mapped invaded units (boundaries correspond with those of compartments)	A layer containing variables: MIU_ID, Area, Riparian code	Shapefile (Vector)	CapeNature
MIU linked species list	All IAP species and densities	Variables include: MIU-ID, Species name, Density, Age class	Excel	CapeNature

Data file name	Description	Methods used as a basis of comparison	Type	Source
Treatment units NBALS	All IAP species which have a treatment history	Variables include: NBAL_ID, Area, Treatment stage and Treatment date, Contract number	Shapefile (Vector)	CapeNature and WIMS
NBAL linked species list	All IAP species	Variables include: NBAL ID, Species name, Density, Age class	Excel	CapeNature
Ownership	The ownership of each compartment	Attribute table showing ownership per compartment in three categories; CapeNature, Private Mountain Catchment and Farms. Ownership derived from farm cadastres, Cape Nature protected areas coverage. CapeNature's Corporate GIS database, based on the location of the compartment centroid.	Shapefile (Vector)	CapeNature
Veld age	Age of veld after 2015/16 fire season	Intersect with the CapeNature veld age map. Categorised ages into five classes: 1-2 years; 3-6 years; 7-25 years and >26 =43 years and no age = 99. Dissolved by compartment number and selected youngest age class.	Shapefile (Vector)	CapeNature
Invasions by ownership	To show type and extent of invasions by ownership	Attribute table based on IAP data. IAP data was combined with ownership shapefile to show invasions by ownership. Condensed areas of invasions were derived from density field statistics.	Excel table	CapeNature
Rainfall	Mean annual precipitation in millimetres per compartment	Layer created as input for compartment prioritization. Indicate mean annual rainfall calculated from the an_precip_20 grid, extracted from the Agrohydro-Climatology Atlas of South Africa, using zonal statistics.	Raster	Agrohydro-Climatology Atlas of South Africa
Ecosystem status	Ecosystem status derived by CapeNature using updated landcover and agricultural fields layers. The statuses derived were linked to the SA Vegetation Map (Mucina & Rutherford 2006)	Layer created as input for compartment prioritization. Derived from ecosystem to indicate UICN conservation status: 1 – LT (Least threatened); 2 – VU (Vulnerable); 3 – EN (Endangered) and 4 – CE (Critically Endangered).	Raster	SANBI
Slopes (degrees)	Mean slope in degrees per compartment	Layer created as input for compartment prioritization. Derived from 20 metre digital elevation model (DEM).	Raster	CapeNature
MAR	Mean annual runoff	Layer created as input for compartment prioritization. Mean annual run-off grid at scale of 1 min X 1 min resampled using "Raster resampling / Bilinear interpolation" to fine grid size of 100 m. Zonal statistics used to extract the mean run-off value per compartment.	Raster	CSIR

Data file name	Description	Methods used as a basis of comparison	Type	Source
Vegetation types and status	Vegetation types and status as per National Vegetation Map, with status derived by CapeNature using updated landcover and agricultural fields layers.	Compartments intersected with the SA vegetation types 2009 and CapeNature 2014 status map (Mucina and Rutherford, 2006). Dissolved the results by compartment and selected the highest status recorded within the compartment.	Shapefile (Vector)	SANBI
Roads / Towns / Rivers / Dams	Base data: Infrastructure; Major Roads, Major Rivers, Towns and villages 2011, Major Dams	Method: Clip to study area. The major roads, rivers and dams were extracted from the 1:50,000 topo maps vector data. The towns and villages layer is a layer compiled and maintained by CapeNature.	Shapefiles (Vectors)	CapeNature
Biodiversity	Biodiversity index	Number of threatened species (IUCN categories) present per compartment as extracted from CapeNature's Biodiversity Database. Data entered in the "Fire intensity" field in the prioritisation CSV file.		CapeNature
Elevation	Base data: Elevation	Used 20 m DEM (source) and used zonal statistics to extract the Mean height above sea level for each compartment. Data entered in the "Erosion" field in the prioritisation CSV file.	Raster	CapeNature

Appendix 2: *Management compartment input data for MUCP*

Compartment	Area (Ha)	Ownership	Elevation (m)	Slope (degree)	Rain (mm)	MAR (mm)	Veld age (year)	Vegetation Status	Biodiversity Index	Density %	IAP species (number)	IAP aggressive score	Drive time (minutes)	Walk time (minutes)
C_H10F200001	113.1	Private MCA	773	22.2	946.2	322.7	6	LT	1	9.5	4	423	2	10
C_H10F200002	40.7	Farm	409	17.4	774.0	235.6	6	LT	0	30	3	270	2	7
C_H10F200003	14.3	Farm	327	16.1	777.5	199.7	6	LT	0	15	3	324	3	10
C_H10F200004	17.0	Farm	357	12.2	808.3	202.9	2	LT	0	17	3	324	3	8
C_H10F200005	668.1	Private MCA	1058	24.5	1347.9	569.8	2	LT	2	20	2	297	4	132
C_H10F200006	179.4	Private MCA	994	27.2	1573.7	694.5	25	LT	0	15	1	81	3	56
C_H10F200007	111.7	Private MCA	712	20.1	1325.7	410.6	6	LT	0	38	3	378	3	11
C_H10F200008	364.4	Private MCA	1036	30.9	1126.9	606.4	2	LT	0	41	2	162	5	120
C_H10F200009	160.0	CapeNature	1428	43.3	1298.2	598.8	2	LT	0	6	1	81	8	71
C_H10F200010	106.2	Private MCA	1399	37.8	1769.5	586.9	2	LT	0	14	2	162	8	103
C_H10F200011	117.7	Private MCA	1002	22.4	1554.0	520.3	2	LT	0	17	3	234	8	75
C_H10F200012	53.2	Private MCA	1381	40.2	1609.6	682.4	2	LT	0	0	0	0	8	68
C_H10F200013	361.6	Private MCA	766	20.0	1302.2	423.4	2	LT	0	40	3	216	8	19
C_H10F200014	81.2	Private MCA	1444	42.0	1518.0	705.0	2	LT	0	0	0	0	8	57
C_H10F200015	318.4	CapeNature	1387	37.7	1097.0	522.2	2	LT	1	0	0	0	8	113
C_H10F200016	160.9	CapeNature	636	18.0	803.2	216.2	2	LT	0	7	3	270	4	56
C_H10F200017	249.1	Private MCA	1368	31.0	1464.0	666.6	2	LT	0	0	0	0	8	125
C_H10F200018	189.4	Farm	594	11.8	812.5	199.9	2	LT	0	26	5	432	4	56
C_H10F200019	179.5	CapeNature	466	17.7	752.0	223.9	6	LT	7	7	3	216	6	71
C_H10F200020	174.6	CapeNature	369	21.4	676.6	123.0	2	LT	4	2.2	4	369	4	31
C_H10F200021	614.0	Farm	587	17.7	711.6	169.6	2	LT	0	2	2	162	6	25

Compartment	Area (Ha)	Ownership	Elevation (m)	Slope (degree)	Rain (mm)	MAR (mm)	Veld age (year)	Vegetation Status	Biodiversity Index	Density %	IAP species (number)	IAP aggressive score	Drive time (minutes)	Walk time (minutes)
C_H10F200022	237.6	Private MCA	413	21.8	768.6	246.1	6	LT	1	2	2	270	10	28
C_H10F200023	26.5	Farm	103	15.9	669.6	122.1	2	LT	0	5	3	288	4	5
C_H10F200024	282.7	Private MCA	316	18.8	669.2	103.0	6	LT	6	1.1	3	342	3	15
C_H10F200025	330.9	Private MCA	269	17.7	667.9	77.2	2	LT	7	15	2	153	3	47
C_H10F200026	284.7	CapeNature	492	16.8	744.3	164.1	2	LT	6	9	5	459	6	65
C_H10F200027	369.2	Farm	357	11.9	717.8	187.3	2	LT	2	22	4	432	7	28
C_H10F200028	345.9	Farm	423	2.9	808.5	217.9	6	LT	0	10	2	162	7	25
C_H10F200029	363.4	Farm	454	2.3	858.3	186.8	6	LT	0	15	2	162	5	29
C_H10F200030	265.0	CapeNature	459	15.4	830.6	297.2	6	LT	4	31	3	351	8	47
C_H10F200031	85.6	CapeNature	516	14.8	962.1	338.0	6	LT	3	1.5	1	81	8	16
C_H10F200032	131.1	CapeNature	550	16.0	982.4	313.5	6	LT	4	2	2	162	7	21
C_H10F200033	453.0	CapeNature	714	18.7	1070.3	313.2	6	LT	5	16	3	216	6	43
C_H10F200034	107.4	Private MCA	377	6.5	861.7	231.8	6	LT	2	3	3	216	6	110
C_H10F200035	97.6	Private MCA	311	8.3	933.8	223.3	6	LT	0	45	3	270	6	68
C_H10F200036	279.9	CapeNature	468	19.0	863.3	222.4	6	LT	0	17	5	531	6	26
C_H10F200037	300.7	Private MCA	402	19.7	707.9	200.9	6	LT	1	2.5	4	351	4	22
C_H10F200038	105.6	Private MCA	529	19.5	741.4	174.2	6	LT	1	3	3	270	4	23
C_H10F200039	115.9	Private MCA	407	3.5	945.9	256.1	6	LT	4	11	3	216	6	85
C_H10F200040	147.1	CapeNature	383	20.8	844.6	216.6	6	LT	1	2.5	2	153	7	38
C_H10F200041	93.3	CapeNature	426	22.8	737.3	230.4	6	LT	0	3	2	270	7	30
C_H10F200042	537.4	Private MCA	499	21.1	878.3	385.9	6	LT	2	0.3	3	351	9	67
C_H10F200043	545.7	CapeNature	602	16.6	949.6	360.6	6	LT	2	1.51	2	297	7	83
C_H10F200044	130.9	CapeNature	506	11.4	766.8	174.8	6	LT	2	15	2	153	5	73
C_H10F200045	262.0	CapeNature	542	18.7	810.2	186.3	6	LT	2	70	2	270	6	78
C_H10F200046	250.0	CapeNature	509	8.7	780.4	163.4	6	LT	5	15	2	297	5	35
C_H10F200047	335.1	Private MCA	603	22.7	1087.6	354.3	2	LT	1	30	1	216	11	66

Compartment	Area (Ha)	Ownership	Elevation (m)	Slope (degree)	Rain (mm)	MAR (mm)	Veld age (year)	Vegetation Status	Biodiversity Index	Density %	IAP species (number)	IAP aggressive score	Drive time (minutes)	Walk time (minutes)
C_H10F200048	286.3	CapeNature	1053	24.1	1207.1	597.8	25	LT	0	47	3	135	7	141
C_H10F200049	227.4	Private MCA	413	20.4	1105.6	283.7	6	LT	0	5	1	216	11	60
C_H10F200050	258.8	Private MCA	801	32.2	1318.2	494.1	6	LT	0	20	3	378	7	160
C_H10F200051	161.2	CapeNature	669	14.0	1168.5	319.1	6	LT	1	2	1	81	6	36
C_H10F200052	196.3	CapeNature	610	13.9	1120.2	320.0	6	LT	1	10	1	81	6	102
C_H10F200053	318.3	CapeNature	642	11.7	1112.5	314.3	6	LT	2	5	1	81	6	62
C_H10F200054	268.1	CapeNature	759	20.4	1089.9	286.6	6	LT	2	35	2	135	6	143
C_H10F200055	312.8	CapeNature	739	21.6	1203.1	393.1	6	LT	1	40	2	135	6	152
C_H10F200056	423.1	CapeNature	702	19.7	1072.7	427.2	6	LT	0	56	4	432	6	114
C_H10F200057	212.7	Private MCA	1134	34.7	1407.9	597.4	6	LT	0	50	3	216	9	160
C_H10F200058	187.2	CapeNature	1185	23.3	1408.8	588.4	6	LT	0	45	3	216	9	137
C_H10F200059	41.4	CapeNature	523	28.8	782.2	93.0	25	LT	0	16	3	405	1	51
C_H10F200060	31.5	CapeNature	646	32.3	791.4	102.6	25	LT	0	20	2	108	3	60
C_H10F200061	52.5	CapeNature	384	20.6	779.7	92.5	25	LT	1	30	2	162	2	48
C_H10F200062	72.4	CapeNature	530	28.3	797.0	104.0	25	LT	0	15	2	108	3	52
C_H10F200063	50.3	CapeNature	467	25.2	789.2	93.5	25	LT	0	20	3	324	1	33
C_H10F200064	69.5	CapeNature	383	22.6	784.1	95.6	25	LT	0	15	2	108	2	31
C_H10F200065	404.1	CapeNature	1550	18.2	1300.4	252.1	2	LT	1	10	1	81	13	98
C_H10F200066	161.9	CapeNature	1594	39.0	1724.7	534.9	2	LT	2	0	0	0	6	345
C_H10F200067	223.2	CapeNature	1351	42.7	1738.9	687.8	2	LT	1	8	4	459	6	314
C_H10F200068	122.2	CapeNature	1390	45.0	1608.2	508.8	2	LT	0	11	2	297	9	316
C_H10F200069	210.1	CapeNature	1429	39.7	1693.0	596.1	2	LT	2	16	2	297	6	306
C_H10F200070	280.8	CapeNature	1221	39.0	2008.0	546.7	2	LT	0	2	1	81	9	238
C_H10F200071	498.7	CapeNature	1399	35.5	1674.8	697.2	2	LT	1	0	0	0	6	262
C_H10F200072	595.4	CapeNature	1303	31.7	1641.0	708.2	2	LT	1	10	2	162	6	211
C_H10F200073	417.9	CapeNature	1211	34.9	1597.1	519.9	2	LT	0	1	1	81	7	153

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C_H10F200074	974.2	CapeNature	907	13.5	927.8	92.8	2	LT	1	40	1	81	12	53
C_H10F200075	846.4	CapeNature	1304	17.2	1302.3	208.6	2	LT	2	50.1	2	297	13	57
C_H10F200076	195.7	CapeNature	1442	41.4	1844.6	571.1	2	LT	0	6	1	81	9	286
C_H10F200077	63.0	CapeNature	1425	43.5	1625.2	503.7	2	LT	0	0	0	0	9	340
C_H10F200078	325.0	Private MCA	1429	28.4	1276.4	601.9	2	LT	4	0	0	0	8	374
C_H10F200079	232.5	Private MCA	1189	31.6	1102.2	550.6	2	LT	1	0	0	0	5	333
C_H10F200080	183.2	Private MCA	1150	27.5	1152.9	446.3	2	LT	0	0	0	0	6	306
C_H10F200081	217.9	CapeNature	975	17.9	1138.2	155.5	2	LT	1	15	1	54	8	120
C_H10F200082	398.6	CapeNature	1507	18.3	1430.8	370.9	2	LT	3	70	2	162	8	209
C_H10F200083	222.4	CapeNature	1155	12.4	1272.9	208.5	2	LT	0	45	2	162	8	144
C_H10F200084	772.0	CapeNature	815	13.7	1073.6	112.9	2	LT	3	7.5	3	351	8	89
C_H10F200085	576.8	CapeNature	1606	21.5	1440.9	301.4	2	LT	1	23	2	135	12	147
C_H10F200086	190.1	CapeNature	970	15.6	1097.9	140.5	2	LT	0	10	1	81	12	117
C_H10F200087	222.9	Private MCA	842	29.4	1645.0	422.6	2	LT	0	27	3	351	7	55
C_H10F200088	203.2	CapeNature	595	22.3	1131.0	206.2	2	LT	0	56	2	135	9	55
C_H10F200089	180.0	CapeNature	625	21.5	1198.3	250.2	2	LT	0	51	3	351	7	51
C_H10F200090	259.2	CapeNature	1350	13.9	1334.3	271.7	2	LT	1	21	2	162	8	189
C_H10F200091	653.3	Private MCA	829	17.5	948.4	134.4	2	LT	0	7	2	297	5	84
C_H10F200092	956.0	Private MCA	877	18.5	945.0	163.6	2	LT	3	1	1	81	6	141
C_H10F200093	261.7	CapeNature	1611	24.1	1476.2	394.8	2	LT	0	0	0	0	8	231
C_H10F200094	329.6	Private MCA	1000	14.3	1084.7	170.4	2	LT	2	20	2	135	8	150
C_H10F200095	851.9	Private MCA	1279	23.5	1172.0	332.2	2	LT	0	15	3	297	8	246
C_H10F200096	170.0	CapeNature	1586	40.2	1851.5	599.5	2	LT	2	26	2	135	8	311
C_H10F200097	117.5	CapeNature	1692	35.2	1613.1	663.6	2	LT	1	22	2	135	8	341
C_H10F200098	157.2	Private MCA	1062	41.8	1513.8	787.1	2	LT	0	31	2	135	6	346
C_H10F200099	142.2	CapeNature	1415	41.5	1676.7	647.4	2	LT	1	31	2	135	6	356

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C_H10F200100	507.3	Farm	845	1.0	319.9	1.7	99	LT	0	7.01	2	81	11	22
C_H10F200101	734.9	CapeNature	827	1.3	322.0	2.0	99	LT	0	1.51	1	0	8	12
C_H10F200102	335.5	Farm	992	14.5	338.3	5.2	43	LT	0	31	2	93	4	33
C_H10F200103	668.3	CapeNature	855	1.2	290.0	2.9	2	LT	0	36.1	2	93	9	6
C_H10F200104	683.4	CapeNature	1054	11.7	556.6	21.8	2	LT	0	1.5	1	81	8	93
C_H10F200105	760.0	CapeNature	822	0.9	287.0	2.4	6	LT	0	0.2	2	135	4	77
C_H10F200106	786.5	CapeNature	825	1.3	286.7	1.7	2	LT	0	0.6	2	135	6	37
C_H10F200107	909.7	CapeNature	827	0.9	267.6	1.3	2	LT	0	0.1	1	81	8	16
C_H10F200108	647.9	CapeNature	942	13.5	409.7	5.2	6	LT	0	20	1	81	7	74
C_H10F200109	463.3	CapeNature	1486	25.6	1247.6	114.6	2	LT	0	5	1	81	4	217
C_H10F200110	483.7	CapeNature	1169	17.8	747.5	34.6	2	LT	1	2.3	3	135	3	157
C_H10F200111	1057.8	CapeNature	921	4.8	385.0	11.2	2	LT	0	5.8	3	135	8	80
C_H10F200112	227.3	CapeNature	1536	28.6	1263.0	136.2	2	LT	0	0.1	1	81	6	216
C_H10F200113	680.9	CapeNature	1462	27.7	996.3	76.0	2	LT	0	2.6	3	459	8	210
C_H10F200114	206.2	CapeNature	1796	24.8	1671.7	124.8	25	LT	0	1.1	1	81	4	168
C_H10F200115	322.2	CapeNature	1651	25.5	1634.2	140.0	2	LT	0	30	1	81	5	194
C_H10F200116	363.9	Farm	891	4.0	461.0	11.9	2	LT	0	5.1	1	81	9	6
C_H10F200117	551.3	CapeNature	1298	19.5	977.6	64.3	2	LT	1	1.1	1	81	10	112
C_H10F200118	570.9	Farm	856	1.6	317.9	4.2	2	LT	0	45	3	93	10	10
C_H10F200119	1047.8	Private MCA	1172	23.3	922.9	187.9	6	LT	0	40	1	216	4	84
C_H10F200120	309.5	CapeNature	1238	20.1	928.0	132.1	6	LT	0	5	1	81	3	85
C_H10F200121	343.3	CapeNature	1161	13.8	668.7	48.5	6	LT	0	15	2	297	3	106
C_H10F200122	792.6	Private MCA	921	15.6	432.6	64.5	6	LT	0	25	2	297	3	40
C_H10F200123	893.6	CapeNature	1082	11.3	436.2	10.3	6	LT	1	20	2	297	4	57
C_H10F200124	317.7	CapeNature	1162	22.7	770.6	68.2	2	LT	2	1.1	1	81	9	60
C_H10F200125	67.5	Farm	98	5.9	600.8	56.2	2	LT	0	3	4	342	3	9

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C_H10F200126	28.6	Private MCA	752	27.5	1019.9	186.1	2	LT	0	3	2	234	4	79
C_H10F200127	125.1	Private MCA	1124	33.0	916.7	217.7	2	LT	0	0.5	1	81	6	97
C_H10F200128	116.0	Private MCA	617	22.9	846.2	169.3	2	LT	0	2	2	297	4	73
C_H10F200129	139.1	Farm	656	24.4	811.4	186.0	2	LT	0	1	1	81	5	66
C_H10F200130	140.0	Private MCA	1183	25.3	878.6	438.6	2	LT	0	0	0	0	6	64
C_H10F200131	40.9	Farm	828	10.7	828.8	610.6	25	LT	0	35	2	243	6	23
C_H10F200132	196.0	Private MCA	1144	27.9	1243.7	582.0	25	LT	0	45.5	2	297	6	68
C_H10F200133	121.5	Farm	803	11.4	1168.3	540.3	25	LT	0	36	2	297	6	53
C_H10F200134	29.6	Farm	450	17.5	782.8	110.1	25	CR	0	5.01	2	93	3	25
C_H10F200135	11.9	Farm	473	20.6	793.8	116.1	25	CR	0	6.5	2	93	3	30
C_H10F200136	15.0	Farm	478	20.3	795.2	118.7	25	CR	0	10.21	2	81	3	23
C_H10F200137	47.5	Farm	453	18.2	782.0	110.0	25	CR	0	11.11	2	93	3	32
C_H10F200138	36.4	CapeNature	668	31.4	792.6	107.8	25	LT	0	2	2	162	3	50
C_H10F200139	22.1	CapeNature	744	31.2	805.1	112.1	25	LT	0	2	2	162	3	50
C_H10F200140	43.5	CapeNature	716	29.2	805.4	113.8	25	LT	0	2	2	162	3	44
C_H10F200141	111.6	CapeNature	766	30.1	1066.4	666.5	99	LT	0	7	2	135	5	77
C_H10F200142	101.6	CapeNature	1209	41.3	1228.4	751.6	25	LT	0	5	1	81	4	109
C_H10F200143	91.8	CapeNature	1147	40.6	1256.6	773.2	25	LT	0	40	2	135	4	93
C_H10F200144	89.5	CapeNature	700	23.7	985.1	778.9	25	LT	0	50	2	135	4	61
C_H10F200145	60.1	CapeNature	1080	40.0	1101.5	511.7	6	LT	0	0.5	1	81	3	81
C_H10F200146	105.1	CapeNature	1082	31.8	1018.4	426.1	6	LT	0	2	1	81	3	71
C_H10F200147	156.4	Private MCA	456	18.9	730.9	254.2	25	LT	0	10	1	81	3	28
C_H10F200148	108.6	Private MCA	902	30.2	842.2	368.9	6	LT	1	0.5	1	81	3	65
C_H10F200149	80.0	Farm	525	18.7	764.6	209.0	25	LT	0	1	1	81	3	30
C_H10F200150	49.3	Private MCA	909	32.2	902.6	347.9	6	LT	0	0.5	1	81	3	64
C_H10F200151	104.2	CapeNature	626	23.0	857.0	314.7	25	LT	0	11	3	378	3	35

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C_H10F200152	90.8	CapeNature	758	28.6	970.6	511.4	6	LT	2	1.5	2	162	3	60
C_H10F200153	125.1	CapeNature	758	27.1	972.5	700.7	6	LT	0	6	2	162	4	75
C_H10F200154	132.8	Private MCA	926	31.9	915.7	290.5	6	LT	1	0	0	0	2	59
C_H10F200155	152.2	Private MCA	745	32.9	823.8	239.7	6	LT	0	31	4	513	2	25
C_H10F200156	234.2	Private MCA	839	24.6	785.7	217.3	6	LT	0	0	0	0	3	43
C_H10F200157	331.4	Private MCA	899	25.2	883.2	285.0	2	LT	0	0	0	0	2	63
C_H10F200158	85.0	CapeNature	679	34.8	771.1	245.6	6	LT	0	20	3	351	5	36
C_H10F200159	86.4	CapeNature	565	36.0	790.4	175.7	6	LT	0	20	3	351	5	21
C_H10F200160	117.5	CapeNature	594	29.8	760.8	318.9	6	LT	1	0	0	0	4	30
C_H10F200161	37.7	Farm	390	18.6	791.1	197.4	2	LT	0	2.6	5	459	3	5
C_H10F200162	41.8	CapeNature	344	20.9	789.6	213.7	6	LT	0	2.2	4	351	5	8
C_H10F200163	527.8	CapeNature	548	27.5	919.4	182.7	6	LT	5	5	1	54	7	65
C_H10F200164	4.4	Farm	164	3.1	646.0	116.5	6	LT	0	65	1	0	5	20
C_H10F200165	20.5	Farm	139	1.1	476.1	91.2	2	LT	0	75	2	81	5	4
C_H10F200166	28.1	Farm	143	1.2	465.8	79.4	2	LT	0	60	3	189	5	11
C_H10F200167	82.0	Farm	130	1.9	529.7	93.2	2	LT	0	33	5	396	5	15
C_H10F200168	5.4	Farm	135	0.6	578.7	116.9	2	LT	0	70	2	54	6	4
C_H10F200169_A	11.7	Farm	137	1.4	581.3	108.3	2	LT	0	0	4	396	5	5
C_H10F200169_B	39.2	Farm	135	0.8	567.3	110.4	2	LT	0	0	5	315	5	15
C_H10F200169_C	52.6	Farm	160	3.9	645.9	120.9	6	LT	0	0	2	180	5	16
C_H10F200169_D	26.1	Farm	155	3.6	648.3	127.7	2	LT	0	0	2	180	5	12
C_H10F200169_E	14.2	Farm	133	0.9	507.8	96.1	2	LT	0	0	4	396	5	8
C_H10F200170	80.4	Farm	245	13.1	708.9	147.3	2	LT	0	38	5	531	6	23
C_H10F200171_A	54.4	Farm	156	3.2	540.5	129.2	2	LT	0	0	3	282	6	12
C_H10F200171_B	64.3	Farm	184	10.9	612.6	136.6	2	LT	0	0	3	282	6	10
C_H10F200171_C	43.3	Farm	148	5.2	625.2	130.6	2	LT	0	0	3	282	6	8

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C_H10F200172	215.4	CapeNature	399	17.6	698.3	138.2	6	LT	3	10.5	5	531	4	61
C_H10F200173	223.6	Farm	483	25.2	610.0	159.1	2	LT	0	8	4	450	7	40
C_H10F200174	477.1	CapeNature	90	1.6	671.5	49.0	6	LT	15	21	4	378	6	16
C_H10F200175	522.3	Farm	415	21.3	730.0	120.0	2	LT	2	15.22	4	378	5	50
C_H10F200176	250.6	CapeNature	455	26.1	800.5	152.8	6	LT	0	55	2	270	8	73
C_H10F200177	142.6	CapeNature	747	22.1	968.7	311.0	6	LT	2	45	3	378	8	44
C_H10F200178	15.8	Farm	102	3.5	580.1	83.2	2	LT	0	11	3	297	4	14
C_H10F200179	10.3	Farm	119	0.7	533.0	79.9	2	LT	0	35	4	324	4	13
C_H10F200180	12.2	Farm	116	1.0	517.5	62.3	2	LT	0	37.5	5	351	3	12
C_H10F200181	23.9	Farm	479	2.0	1016.6	210.4	6	LT	0	26	3	378	6	16
C_H10F200182	217.7	Farm	493	3.6	821.2	180.4	6	LT	0	8	4	351	5	21
C_H10F200183	243.2	CapeNature	708	14.9	1172.0	329.0	6	LT	0	25	2	216	6	44
C_H10F200184	137.0	CapeNature	486	3.6	955.0	209.2	6	LT	4	15	3	378	6	19
C_H10F200185	94.2	Farm	484	23.6	678.2	168.1	2	LT	0	20	3	270	4	12
C_H10F200186	127.2	Farm	398	17.7	713.4	163.2	2	LT	0	3	2	216	4	4
C_H10F200187	736.1	Private MCA	933	33.0	1511.7	505.5	2	LT	5	74	2	162	9	175
C_H10F200188	325.4	CapeNature	803	35.2	1216.6	301.7	2	LT	0	92	2	162	9	123
C_H10F200189	18.1	Farm	369	5.9	873.9	263.2	2	LT	0	75	2	297	9	90
C_H10F200190	529.6	CapeNature	895	1.6	362.7	11.6	2	LT	0	25	2	12	8	34
C_H10F200191	40.8	CapeNature	894	1.6	339.5	9.5	2	LT	0	40	3	270	8	20
C_H10F200192	122.9	Private MCA	757	24.3	813.2	297.0	6	LT	1	40	3	351	2	34
C_H10F200193	169.0	Private MCA	524	11.9	699.0	282.8	6	LT	2	0.5	1	81	1	20
C_H10F200194	47.1	Private MCA	539	16.3	787.6	309.9	2	LT	1	3	3	351	2	11
C_H10F200195	42.4	Private MCA	726	15.0	1175.5	517.6	25	LT	0	5.5	2	297	6	81
C_H10F200196	71.8	Farm	824	7.5	810.7	396.8	25	LT	0	30	1	81	6	22
C_H10F200197	237.8	CapeNature	480	24.5	916.5	279.4	2	LT	1	1.6	4	423	5	25

Compartment	Area (Ha)	Ownership	Elevation (m)	Slope (degree)	Rain (mm)	MAR (mm)	Veld age (year)	Vegetation Status	Biodiversity Index	Density %	IAP species (number)	IAP aggressive score	Drive time (minutes)	Walk time (minutes)
C_H10F200198	49.8	CapeNature	562	20.2	1038.5	468.6	2	LT	0	16	3	351	5	25
C_H10F200199	40.8	Farm	520	21.3	1005.4	417.9	2	LT	0	15	3	351	5	20
C_H10F200200	201.6	CapeNature	1032	33.2	1195.8	688.9	2	LT	0	0	0	0	5	69
C_H10F200201	74.2	CapeNature	819	28.9	1055.7	439.5	2	LT	0	15	3	351	5	49
C_H10F200202	118.4	Farm	504	24.3	876.5	247.7	2	LT	0	15	3	351	4	23
C_H10F200203	178.3	CapeNature	1090	29.9	1014.0	387.5	2	LT	0	31	2	162	5	81
C_H10F200204	83.6	Farm	798	19.1	1127.1	359.9	2	LT	0	16	4	432	8	68
C_H10F200205	100.6	Private MCA	885	20.0	1327.6	499.5	2	LT	0	16	4	432	8	27
C_H10F200206	87.3	Private MCA	480	30.1	855.7	201.5	2	LT	0	45	3	351	4	34
C_H10F200207	38.0	Private MCA	365	11.8	819.7	213.0	2	LT	0	5.6	3	351	3	12
C_H10F200208	43.9	Private MCA	358	18.7	775.1	207.8	6	LT	0	6.6	3	351	3	13
C_H10F200209	60.9	Private MCA	532	32.7	839.3	227.3	6	LT	0	100	3	351	3	27
C_H10F200210	89.2	Private MCA	536	26.7	779.2	224.5	6	LT	0	115	3	351	4	30
C_H10F200211	201.3	Private MCA	538	29.2	948.2	214.0	2	LT	0	0	0	0	4	42
C_H10F200212	45.0	CapeNature	306	10.5	811.0	186.1	2	LT	0	40	4	405	5	5
C_H10F200213	64.8	CapeNature	1189	34.9	1276.2	580.2	6	LT	2	1	2	162	3	74
C_H10F200214	301.6	Private MCA	1071	24.4	1473.7	457.7	6	LT	3	0	0	0	3	40
C_H10F200215	43.0	Farm	571	29.1	782.8	93.7	25	LT	0	11	3	405	1	46
C_H10F200216	220.4	CapeNature	742	32.0	1358.1	291.2	2	LT	0	30	2	297	9	85
C_H10F200217	26.3	CapeNature	641	31.4	792.5	109.1	25	LT	0	1	1	81	3	42
C_H10F200218	16.9	Private MCA	370	19.7	923.0	225.7	2	LT	0	20	2	270	4	30
C_H10F200219	42.1	CapeNature	1143	40.3	880.1	273.8	25	LT	0	0.2	2	162	5	99
C_H10F200220	89.6	CapeNature	650	23.2	820.1	201.2	25	LT	2	1	2	162	5	56
C_H10F200221	52.4	CapeNature	1192	41.6	987.3	344.2	25	LT	0	1	1	81	6	99
C_H10F200222	88.5	CapeNature	692	23.7	851.0	220.6	25	LT	0	2.5	3	378	5	70
C_H10F200223	71.4	CapeNature	1164	39.8	1106.6	386.1	25	LT	0	0.1	1	81	6	86

Compartment	Area (Ha)	Ownership	Elevation (m)	Slope (degree)	Rain (mm)	MAR (mm)	Veld age (year)	Vegetation Status	Biodiversity Index	Density %	IAP species (number)	IAP aggressive score	Drive time (minutes)	Walk time (minutes)
C_H10F200224	103.3	CapeNature	676	23.7	885.9	239.2	25	LT	0	1.5	3	216	6	52
C_H10F200225	46.3	CapeNature	1154	37.6	1040.4	338.0	25	LT	0	0.5	1	81	6	79
C_H10F200226	84.2	Farm	652	22.7	897.2	240.8	99	LT	0	0.5	1	81	6	39
C_H10F200227	64.6	CapeNature	1259	40.7	946.1	310.4	2	LT	0	1	2	162	6	91
C_H10F200228	153.6	Farm	705	23.9	900.5	288.8	6	LT	0	15	2	162	6	51
C_H10F200229	11.5	CapeNature	1216	43.2	1010.0	472.3	99	LT	0	1	1	81	6	103
C_H10F200230	88.8	CapeNature	693	23.6	960.4	457.1	6	LT	1	1.5	3	216	5	71
C_H10F200231	140.9	Private MCA	947	23.0	1053.3	345.3	6	LT	3	1	1	81	3	37
C_H10F200232	57.6	Farm	79	0.5	590.2	43.8	6	CR	0	5	2	72	6	22
C_H10F200233	30.9	Farm	80	0.2	647.7	42.4	6	CR	0	1	2	270	6	7
C_H10F200234	287.8	Farm	82	2.2	586.4	23.8	2	CR	0	2.1	2	72	4	10
C_H10F200235	209.0	CapeNature	82	1.3	726.1	45.3	43	CR	0	2.5	2	72	4	21
C_H10F200236	224.7	CapeNature	116	7.4	757.1	71.3	6	LT	3	1	2	270	8	62
C_H10F200237	241.4	CapeNature	109	5.5	796.9	69.1	6	LT	8	1	2	270	7	9
C_H10F200238	78.2	CapeNature	75	0.8	586.6	38.4	2	CR	5	2	1	72	6	42
C_H10F200239	23.0	CapeNature	72	1.0	584.3	32.2	2	CR	1	2	1	72	6	27
C_H10F200240	151.0	CapeNature	71	1.1	556.7	22.8	2	CR	5	2.5	2	288	6	14
C_H10F200241	126.1	CapeNature	79	1.3	556.1	21.5	6	CR	0	2.5	2	72	6	13

***Appendix 3**: Participants in the expert workshop*

Participants in the workshop held at the CSIR in Stellenbosch on 17th May 2016 to determine criteria and rank these to use in prioritising the clearing of invasive alien plants in the protected areas and mountain catchments managed by the Waterval Centre.

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Appendix 4: *Summary of annual budget of R 3.0 million*

Summary of the annual budget in Rand per compartment for the next 15 years based on the prioritisation of the compartments for clearing and a total annual budget ceiling of R3.0 million. Using this budget the objective of reducing all compartments to a maintenance level of ≤ 1% canopy cover (e.g. year 2 onwards for the first compartment listed below) in 15 years will not be achieved. The scheduled costs are not exactly in the priority sequence because they take species treatment requirements and budget ceilings into account.

Compartment	Priority	Year 01	Year 02	Year 03	Year 04	Year 05	Year 06	Year 07	Year 08	Year 09	Year 10	Year 11	Year 12	Year 13	Year 14	Year 15
C_H10F200165	0.57	16150	504	9	9	9	9	9	9	9	9	9	9	9	9	9
C_H10F200166	0.57	19325	679	19	19	19	19	19	19	19	19	19	19	19	19	19
C_H10F200167	0.57	70775	2353	159	159	159	159	159	159	159	159	159	159	159	159	159
C_H10F200169_E	0.57	13347	680	19	19	19	19	19	19	19	19	19	19	19	19	19
C_H10F200178	0.57	6501	156	16	16	16	16	16	16	16	16	16	16	16	16	16
C_H10F200179	0.57	7487	410	16	12	12	12	12	12	12	12	12	12	12	12	12
C_H10F200191	0.57	26991	1209	33	33	33	33	33	33	33	33	33	33	33	33	33
C_H10F200008	0.95	127331	393438	6272	369	369	369	369	369	369	369	369	369	369	369	369
C_H10F200098	0.95	2069950	1092495	19055	2497	2497	2497	2497	2497	2497	2497	2497	2497	2497	2497	2497
C_H10F200113	0.95	600673	34531	6629	6629	6629	6629	6629	6629	6629	6629	6629	6629	6629	6629	6629
C_H10F200180	0.95	10542	1167	45	22	22	22	22	22	22	22	22	22	22	22	22
C_H10F200009	1.33	0	0	0	28309	519	52	52	52	52	52	52	52	52	52	52
C_H10F200010	1.33	0	0	0	50940	1018	122	122	122	122	122	122	122	122	122	122
C_H10F200011	1.33	0	0	49158	37812	503	215	215	215	215	215	215	215	215	215	215
C_H10F200018	1.33	0	9871	175798	8975	492	393	393	393	393	393	393	393	393	393	393
C_H10F200021	1.33	0	23155	347	232	232	232	232	232	232	232	232	232	232	232	232
C_H10F200023	1.33	0	5844	312	29	29	29	29	29	29	29	29	29	29	29	29
C_H10F200068	1.33	0	0	0	794462	43923	1536	1536	1536	1536	1536	1536	1536	1536	1536	1536
C_H10F200070	1.33	0	0	268330	5367	1342	1342	1342	1342	1342	1342	1342	1342	1342	1342	1342
C_H10F200073	1.33	0	27456	549	275	275	275	275	275	275	275	275	275	275	275	275
C_H10F200076	1.33	0	0	509790	9350	935	935	935	935	935	935	935	935	935	935	935

Compartment	Priority	Year 01	Year 02	Year 03	Year 04	Year 05	Year 06	Year 07	Year 08	Year 09	Year 10	Year 11	Year 12	Year 13	Year 14	Year 15
C_H10F200086	1.33	0	0	86786	1110	111	111	111	111	111	111	111	111	111	111	111
C_H10F200091	1.33	0	235493	7879	625	625	625	625	625	625	625	625	625	625	625	625
C_H10F200103	1.33	0	31086	474155	50830	662	409	409	409	409	409	409	409	409	409	409
C_H10F200109	1.33	0	0	579848	11597	1160	1160	1160	1160	1160	1160	1160	1160	1160	1160	1160
C_H10F200111	1.33	0	521728	30771	2300	2300	2300	2300	2300	2300	2300	2300	2300	2300	2300	2300
C_H10F200112	1.33	0	629	629	629	629	629	629	629	629	629	629	629	629	629	629
C_H10F200115	1.33	0	0	751640	24189	403	403	403	403	403	403	403	403	403	403	403
C_H10F200116	1.33	0	42312	846	85	85	85	85	85	85	85	85	85	85	85	85
C_H10F200125	1.33	0	8262	158	83	83	83	83	83	83	83	83	83	83	83	83
C_H10F200126	1.33	0	2437	40	20	20	20	20	20	20	20	20	20	20	20	20
C_H10F200128	1.33	0	10323	236	103	103	103	103	103	103	103	103	103	103	103	103
C_H10F200129	1.33	0	3239	32	32	32	32	32	32	32	32	32	32	32	32	32
C_H10F200161	1.33	992	2820	71	44	44	44	44	44	44	44	44	44	44	44	44
C_H10F200168	1.33	0	11409	238	5	4	4	4	4	4	4	4	4	4	4	4
C_H10F200169_A	1.33	0	6587	467	15	12	12	12	12	12	12	12	12	12	12	12
C_H10F200169_B	1.33	0	47845	3843	112	67	67	67	67	67	67	67	67	67	67	67
C_H10F200169_D	1.33	0	4052	236	14	14	14	14	14	14	14	14	14	14	14	14
C_H10F200170	1.33	20266	28445	762	102	102	102	102	102	102	102	102	102	102	102	102
C_H10F200171_A	1.33	0	15522	917	42	42	42	42	42	42	42	42	42	42	42	42
C_H10F200171_B	1.33	0	26916	1591	73	73	73	73	73	73	73	73	73	73	73	73
C_H10F200171_C	1.33	0	17887	1057	49	49	49	49	49	49	49	49	49	49	49	49
C_H10F200173	1.33	0	53104	1660	266	266	266	266	266	266	266	266	266	266	266	266
C_H10F200185	1.33	0	58909	4485	144	108	108	108	108	108	108	108	108	108	108	108
C_H10F200186	1.33	9435	220	63	63	63	63	63	63	63	63	63	63	63	63	63
C_H10F200190	1.33	0	228034	7981	456	456	456	456	456	456	456	456	456	456	456	456
C_H10F200212	1.33	0	34365	3921	133	50	50	50	50	50	50	50	50	50	50	50
C_H10F200122	1.52	0	0	0	419736	53566	1944	579	579	579	579	579	579	579	579	579
C_H10F200153	1.52	0	5004	50	20346	253	91	91	91	91	91	91	91	91	91	91
C_H10F200013	1.71	0	0	0	449993	40834	1438	489	489	489	489	489	489	489	489	489
C_H10F200059	1.71	0	0	862	14305	1138	34	34	34	34	34	34	34	34	34	34

Compartment	Priority	Year 01	Year 02	Year 03	Year 04	Year 05	Year 06	Year 07	Year 08	Year 09	Year 10	Year 11	Year 12	Year 13	Year 14	Year 15
C_H10F200063	1.71	0	0	0	23060	633	42	42	42	42	42	42	42	42	42	42
C_H10F200064	1.71	0	0	0	21936	385	39	39	39	39	39	39	39	39	39	39
C_H10F200087	1.71	0	0	0	156880	3225	265	265	265	265	265	265	265	265	265	265
C_H10F200198	1.71	0	0	939	15566	692	37	37	37	37	37	37	37	37	37	37
C_H10F200199	1.71	0	9191	255	5465	236	29	29	29	29	29	29	29	29	29	29
C_H10F200201	1.71	0	0	0	43232	2554	86	86	86	86	86	86	86	86	86	86
C_H10F200205	1.71	0	0	0	64435	3894	149	149	149	149	149	149	149	149	149	149
C_H10F200215	1.71	0	0	878	12785	392	34	34	34	34	34	34	34	34	34	34
C_H10F200074	1.83	0	0	0	0	776369	11704	293	293	293	293	293	293	293	293	293
C_H10F200025	1.85	0	0	0	93858	1684	168	168	168	168	168	168	168	168	168	168
C_H10F200003	1.9	0	0	0	3443	2900	221	12	12	12	12	12	12	12	12	12
C_H10F200029	1.9	0	0	0	52704	68521	1159	211	211	211	211	211	211	211	211	211
C_H10F200057	1.9	0	0	0	0	134249	494944	7656	561	561	561	561	561	561	561	561
C_H10F200058	1.9	0	0	0	173717	172355	17985	832	373	373	373	373	373	373	373	373
C_H10F200105	1.9	0	0	0	960	960	960	960	960	960	960	960	960	960	960	960
C_H10F200119	1.9	0	0	0	0	1605519	193787	5814	646	646	646	646	646	646	646	646
C_H10F200120	1.9	0	0	0	40321	403	81	81	81	81	81	81	81	81	81	81
C_H10F200145	1.9	0	0	0	2026	20	20	20	20	20	20	20	20	20	20	20
C_H10F200159	1.9	0	0	0	41684	3446	100	77	77	77	77	77	77	77	77	77
C_H10F200164	1.9	0	0	0	1665	34	1	1	1	1	1	1	1	1	1	1
C_H10F200169_C	1.9	0	0	0	9614	549	27	27	27	27	27	27	27	27	27	27
C_H10F200176	1.9	0	0	0	226597	40605	1263	180	180	180	180	180	180	180	180	180
C_H10F200182	1.9	0	0	0	66473	2133	319	319	319	319	319	319	319	319	319	319
C_H10F200006	2.09	0	0	0	0	0	49335	1555	52	52	52	52	52	52	52	52
C_H10F200095	2.09	0	0	0	0	0	0	0	1865684	37314	3731	3731	3731	3731	3731	3731
C_H10F200118	2.09	0	0	0	0	0	1047533	45100	865	865	865	865	865	865	865	865
C_H10F200131	2.09	0	0	0	0	0	43172	1121	37	37	37	37	37	37	37	37
C_H10F200142	2.09	0	0	0	0	0	20851	417	42	42	42	42	42	42	42	42
C_H10F200143	2.09	0	0	0	0	0	104244	1923	75	75	75	75	75	75	75	75
C_H10F200144	2.09	0	0	0	0	0	100686	1790	60	60	60	60	60	60	60	60

Compartment	Priority	Year 01	Year 02	Year 03	Year 04	Year 05	Year 06	Year 07	Year 08	Year 09	Year 10	Year 11	Year 12	Year 13	Year 14	Year 15
C_H10F200188	2.09	0	0	0	0	0	31669	2655679	29441	451	451	451	451	451	451	451
C_H10F200203	2.09	0	0	0	0	0	33975	504	92	92	92	92	92	92	92	92
C_H10F200204	2.09	0	0	0	0	13309	51181	1970	155	155	155	155	155	155	155	155
C_H10F200227	2.09	0	0	0	0	2359	2955	53	53	53	53	53	53	53	53	53
C_H10F200067	2.21	0	0	0	0	0	88913	129256	129642	12362	640828	41682	4713	4713	4713	4713
C_H10F200072	2.21	0	0	0	0	0	0	0	0	0	1857780	25098	3716	3716	3716	3716
C_H10F200097	2.21	0	0	0	0	0	531839	6344	773193	74507	2481	1558	1558	1558	1558	1558
C_H10F200099	2.21	0	0	0	0	0	0	0	0	2362550	125493	3598	2260	2260	2260	2260
C_H10F200117	2.21	0	0	0	0	0	48295	966	241	241	241	241	241	241	241	241
C_H10F200124	2.21	0	0	0	0	0	19305	386	97	97	97	97	97	97	97	97
C_H10F200026	2.23	0	0	0	0	0	71323	26389	619	523	523	523	523	523	523	523
C_H10F200237	2.24	0	0	0	0	0	4267	6250	229	105	105	105	105	105	105	105
C_H10F200007	2.28	0	0	0	0	0	0	0	0	0	0	111316	7390	305	137	137
C_H10F200050	2.28	0	0	0	0	0	0	0	69251	128743	16255	69792	1032	478	478	478
C_H10F200056	2.28	0	0	0	0	0	0	13963	140	140	295648	343503	35936	1544	731	731
C_H10F200108	2.28	0	0	0	0	0	0	0	0	340815	12770	213	213	213	213	213
C_H10F200121	2.28	0	0	0	0	0	0	51885	96978	12179	406	255	255	255	255	255
C_H10F200146	2.28	0	0	0	0	0	0	6619	132	33	33	33	33	33	33	33
C_H10F200232	2.4	0	0	0	0	0	0	4670	4717	109	31	31	31	31	31	31
C_H10F200233	2.4	165	3	3	3	3	780	27	11	11	11	11	11	11	11	11
C_H10F200020	2.41	0	82	82	82	82	82	82	82	82	9848	327	180	180	180	180
C_H10F200187	2.41	0	0	0	0	0	0	0	0	0	0	271488	5430	679	679	679
C_H10F200174	2.46	0	0	0	0	0	0	0	0	0	0	231480	9516	557	557	557
C_H10F200004	2.47	0	0	0	0	0	0	0	0	0	0	0	5816	396	14	14
C_H10F200016	2.47	0	0	0	0	0	0	0	0	0	0	0	55739	4099	220	220
C_H10F200048	2.47	0	0	0	0	0	0	0	0	0	0	0	730234	33004	1248	667
C_H10F200060	2.47	0	0	0	0	0	0	0	0	0	0	5102	8041	214	20	20
C_H10F200062	2.47	0	0	0	0	0	0	0	0	0	0	14246	12260	134	45	45
C_H10F200083	2.47	0	0	0	0	0	0	0	0	0	0	172258	313573	5019	324	324
C_H10F200088	2.47	0	0	0	0	0	0	0	0	0	0	380848	5068	135	135	135

Compartment	Priority	Year 01	Year 02	Year 03	Year 04	Year 05	Year 06	Year 07	Year 08	Year 09	Year 10	Year 11	Year 12	Year 13	Year 14	Year 15
C_H10F200089	2.47	0	0	0	0	0	0	0	0	0	0	202177	4036	172	172	172
C_H10F200104	2.47	0	0	0	0	0	0	0	0	0	0	51310	1026	257	257	257
C_H10F200114	2.47	0	0	0	0	0	0	0	0	0	0	31873	637	159	159	159
C_H10F200127	2.47	0	0	0	0	0	0	0	0	0	0	3617	72	36	36	36
C_H10F200132	2.47	0	0	0	0	0	0	0	0	0	0	251037	11772	285	173	173
C_H10F200133	2.47	0	0	0	0	0	0	0	0	0	0	151181	4228	129	129	129
C_H10F200138	2.47	0	0	0	0	0	0	0	0	0	0	2272	33	23	23	23
C_H10F200139	2.47	0	0	0	0	0	0	618	6	6	768	14	14	14	14	14
C_H10F200140	2.47	0	0	0	0	0	0	0	0	0	0	2620	26	26	26	26
C_H10F200189	2.47	0	0	0	0	0	0	0	0	0	0	136662	10109	371	30	30
C_H10F200195	2.47	0	0	0	0	0	0	0	0	0	0	13534	967	40	40	40
C_H10F200202	2.47	0	0	0	0	0	0	0	0	0	0	42827	1384	86	86	86
C_H10F200206	2.47	0	0	0	0	0	0	0	0	0	0	162450	18659	630	144	144
C_H10F200207	2.47	0	10	10	10	10	10	1446	53	24	24	7202	311	39	39	39
C_H10F200216	2.47	0	0	0	0	0	0	0	0	0	0	228821	8570	239	239	239
C_H10F200217	2.47	0	0	0	0	0	0	0	0	0	0	874	9	9	9	9
C_H10F200218	2.47	0	0	0	0	0	0	0	0	0	3005	3381	386	14	9	9
C_H10F200134	2.59	6	6	6	6	0	6	6	6	6	0	6	4022	247	14	14
C_H10F200135	2.59	0	0	0	226	2	2	2	2	2	2	2	2995	35	8	8
C_H10F200136	2.59	37	4	4	4	0	4	4	4	4	0	4	5120	69	10	10
C_H10F200137	2.59	0	12	12	12	0	12	12	12	12	12	12	18193	1316	34	34
C_H10F200234	2.59	0	73	0	73	73	73	73	0	73	0	73	14678	365	146	146
C_H10F200005	2.59	0	0	0	0	0	0	0	0	0	0	0	0	0	944320	78523
C_H10F200027	2.59	0	0	0	0	0	0	0	0	0	0	0	21421	197918	218045	20954
C_H10F200069	2.59	0	0	0	0	0	0	0	0	0	0	0	0	1168007	62737	1937
C_H10F200081	2.59	0	0	0	0	0	0	0	0	0	0	0	0	129456	8260	330
C_H10F200084	2.59	0	0	0	0	0	0	0	0	0	0	0	91864	215302	7338	1239
C_H10F200092	2.59	0	0	0	0	0	0	0	0	0	0	0	60776	608	608	608
C_H10F200094	2.59	0	0	0	0	0	0	0	0	0	0	0	374775	12734	585	585
C_H10F200096	2.59	0	0	0	0	0	0	0	0	0	0	0	976860	1136524	107837	3591

Compartment	Priority	Year 01	Year 02	Year 03	Year 04	Year 05	Year 06	Year 07	Year 08	Year 09	Year 10	Year 11	Year 12	Year 13	Year 14	Year 15
C_H10F200175	2.59	0	0	0	111	0	265	111	0	111	0	487	126346	3722	649	649
C_H10F200150	2.66	0	0	0	0	0	0	0	0	0	0	0	1488	30	15	15
C_H10F200183	2.66	0	0	0	0	0	0	0	0	0	0	0	0	0	103923	11733
C_H10F200236	2.78	0	0	0	0	0	0	0	0	0	0	0	0	10787	259	108
C_H10F200024	2.8	0	0	0	0	0	73	0	0	0	0	73	73	14745	440	220
C_H10F200061	2.97	0	0	0	0	0	0	0	0	0	0	0	0	0	36905	1648
C_H10F200046	2.98	0	0	0	0	0	0	0	0	0	0	0	0	0	106096	3587
C_H10F200163	2.98	0	0	0	0	0	0	0	0	0	0	0	0	0	133780	10702
C_H10F200002	3.04	0	0	0	0	0	0	0	0	0	0	0	0	0	28790	2093
C_H10F200028	3.04	0	0	0	0	0	0	0	0	0	0	0	0	0	98910	1484
C_H10F200035	3.04	0	0	0	0	0	0	0	0	0	0	0	0	0	78596	10269
C_H10F200036	3.04	0	0	0	0	0	0	0	0	0	0	0	0	0	109114	3386
C_H10F200041	3.04	0	0	0	0	0	0	0	0	0	0	0	0	0	10533	316
C_H10F200049	3.04	0	0	0	0	0	0	0	0	0	0	0	0	0	38527	1541
C_H10F200155	3.04	0	0	0	0	0	0	0	0	0	0	0	0	0	71820	6891
C_H10F200158	3.04	0	0	0	0	0	0	0	0	0	0	0	0	0	36132	3008
C_H10F200162	3.04	0	7	7	7	0	0	7	0	7	0	7	1058	2119	81	39
C_H10F200181	3.04	0	0	0	0	0	0	0	0	0	0	0	433	4	7409	638
C_H10F200208	3.04	0	12	12	12	0	0	12	0	12	0	12	12	8413	3708	129
C_H10F200209	3.04	0	0	0	0	0	0	0	0	0	0	0	0	0	66859	6330
C_H10F200210	3.04	0	0	0	0	0	0	0	0	0	0	0	0	0	68465	7116
C_H10F200228	3.04	0	0	0	0	0	0	0	0	0	0	0	0	0	64569	764
C_H10F200241	3.16	0	0	0	0	0	0	0	0	0	0	0	0	0	9774	163
C_H10F200038	3.16	0	0	0	0	0	0	0	0	0	0	0	0	0	8529	483
C_H10F200044	3.16	0	0	0	0	0	0	0	0	0	0	0	0	0	45466	1084
C_H10F200045	3.16	0	0	0	0	0	0	0	0	0	0	0	0	0	358615	23214
C_H10F200152	3.16	0	0	0	0	0	0	0	0	0	0	0	0	0	6021	60
C_H10F200172	3.16	0	0	0	0	0	0	0	0	0	0	0	0	0	80653	2366
C_H10F200213	3.16	0	0	0	0	0	0	0	0	0	0	0	0	0	3128	47
C_H10F200106	3.23	0	0	0	0	0	0	0	0	0	0	0	0	209	209	34244

Compartment	Priority	Year 01	Year 02	Year 03	Year 04	Year 05	Year 06	Year 07	Year 08	Year 09	Year 10	Year 11	Year 12	Year 13	Year 14	Year 15
C_H10F200107	3.23	0	0	0	0	0	0	0	0	0	0	0	0	221	221	221
C_H10F200151	3.23	0	0	0	0	0	0	0	0	0	0	0	0	0	13494	19864
C_H10F200196	3.23	0	0	0	0	0	0	0	0	0	0	0	0	0	0	46999
C_H10F200221	3.23	0	0	0	0	0	0	0	0	0	0	0	0	0	2041	41
C_H10F200223	3.23	0	0	0	0	0	0	0	0	0	0	25	25	25	25	25
C_H10F200225	3.23	0	0	0	0	0	0	0	0	0	0	0	0	0	1569	31
C_H10F200238	3.29	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4667
C_H10F200047	3.35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	365853
C_H10F200082	3.35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C_H10F200085	3.35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1200328
C_H10F200110	3.35	0	0	0	0	0	0	0	0	0	0	0	0	0	853	235040
C_H10F200194	3.35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4797
C_H10F200102	3.42	0	0	0	0	0	0	0	0	0	0	0	0	0	0	306382
C_H10F200239	3.47	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1273
C_H10F200230	3.54	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7359
C_H10F200235	3.54	0	0	0	0	0	0	0	0	0	0	0	0	0	0	16719
C_H10F200147	3.61	0	0	0	0	0	0	0	0	0	0	0	0	0	0	28415
C_H10F200149	3.61	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2013
C_H10F200219	3.61	0	12	12	0	0	0	12	0	24	0	0	0	24	24	24
C_H10F200222	3.61	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7297
C_H10F200224	3.61	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7720
C_H10F200240	3.67	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11859
C_H10F200065	3.73	0	0	0	0	0	0	0	0	0	0	0	0	0	0	118608
C_H10F200075	3.73	0	0	0	0	0	0	0	0	0	0	0	0	0	0	427
C_H10F200090	3.73	0	0	0	0	0	0	0	0	0	0	0	0	0	0	38170
C_H10F200197	3.73	0	0	0	0	0	0	0	0	0	0	0	0	65	65	19059
C_H10F200032	3.74	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4897
C_H10F200033	3.74	0	0	0	0	0	0	0	0	0	0	0	0	0	0	142901
C_H10F200141	3.8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	19581
C_H10F200001	3.92	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Compartment	Priority	Year 01	Year 02	Year 03	Year 04	Year 05	Year 06	Year 07	Year 08	Year 09	Year 10	Year 11	Year 12	Year 13	Year 14	Year 15
C_H10F200031	3.92	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4128
C_H10F200042	3.92	0	0	0	0	0	0	0	0	0	0	0	0	317	0	504
C_H10F200043	3.92	0	0	0	0	0	0	0	0	0	0	0	0	0	0	143
C_H10F200051	3.92	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8513
C_H10F200052	3.92	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C_H10F200053	3.92	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C_H10F200055	3.92	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C_H10F200148	3.92	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3279
C_H10F200177	3.92	0	0	0	0	0	0	0	0	0	0	0	0	0	0	73700
C_H10F200231	3.92	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3684
C_H10F200019	3.94	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C_H10F200030	4.12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C_H10F200039	4.12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C_H10F200184	4.12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C_H10F200101	4.18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C_H10F200022	4.3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C_H10F200034	4.3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C_H10F200037	4.3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C_H10F200040	4.3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C_H10F200054	4.3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C_H10F200192	4.3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C_H10F200193	4.3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C_H10F200229	4.56	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C_H10F200220	4.87	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C_H10F200123	5.06	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C_H10F200226	5.32	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C_H10F200100	6.08	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		2999976	**2999991**	**3000000**	**2999999**	**2999999**	**3000000**	**2999999**	**2999994**	**2999999**	**2999999**	**2999996**	**2999992**	**2999928**	**2999959**	**2999992**

Appendix 5: *Summary of annual budget of R 4.5 million*

Summary of the annual budget in Rand per compartment for the next 15 years based on the prioritisation of the compartments for clearing and a total annual budget ceiling of R4.5 million. Using this budget it will take approximately 14 years for the densities in all compartments to be reduced to a maintenance level of ≤ 1% canopy cover (e.g. year 2 onwards for the first compartment listed below). The scheduled costs are not exactly in the priority sequence because they take species treatment requirements and budget ceilings into account.

Compartment	Priority	Year 01	Year 02	Year 03	Year 04	Year 05	Year 06	Year 07	Year 08	Year 09	Year 10	Year 11	Year 12	Year 13	Year 14	Year 15
C_H10F200165	0.57	16 150	504	9	9	9	9	9	9	9	9	9	9	9	9	9
C_H10F200166	0.57	19 325	679	19	19	19	19	19	19	19	19	19	19	19	19	19
C_H10F200167	0.57	70 775	2 353	159	159	159	159	159	159	159	159	159	159	159	159	159
C_H10F200169_E	0.57	13 347	680	19	19	19	19	19	19	19	19	19	19	19	19	19
C_H10F200178	0.57	6 501	156	16	16	16	16	16	16	16	16	16	16	16	16	16
C_H10F200179	0.57	7 487	410	16	12	12	12	12	12	12	12	12	12	12	12	12
C_H10F200191	0.57	26 991	1 209	33	33	33	33	33	33	33	33	33	33	33	33	33
C_H10F200008	0.95	517 467	9 408	369	369	369	369	369	369	369	369	369	369	369	369	369
C_H10F200098	0.95	2 866 738	305 891	9 890	2 497	2 497	2 497	2 497	2 497	2 497	2 497	2 497	2 497	2 497	2 497	2 497
C_H10F200113	0.95	600 673	34 531	6 629	6 629	6 629	6 629	6 629	6 629	6 629	6 629	6 629	6 629	6 629	6 629	6 629
C_H10F200180	0.95	10 542	1 167	45	22	22	22	22	22	22	22	22	22	22	22	22
C_H10F200009	1.33	0	0	28 309	519	52	52	52	52	52	52	52	52	52	52	52
C_H10F200010	1.33	0	0	50 940	1 018	122	122	122	122	122	122	122	122	122	122	122
C_H10F200011	1.33	0	0	85 147	2 183	215	215	215	215	215	215	215	215	215	215	215
C_H10F200018	1.33	0	33 909	151 310	9 395	492	393	393	393	393	393	393	393	393	393	393
C_H10F200021	1.33	0	23 155	347	232	232	232	232	232	232	232	232	232	232	232	232
C_H10F200023	1.33	4 870	292	29	29	29	29	29	29	29	29	29	29	29	29	29
C_H10F200068	1.33	0	318 425	481 878	38 667	1 536	1 536	1 536	1 536	1 536	1 536	1 536	1 536	1 536	1 536	1 536
C_H10F200070	1.33	0	268 330	5 367	1 342	1 342	1 342	1 342	1 342	1 342	1 342	1 342	1 342	1 342	1 342	1 342
C_H10F200073	1.33	0	27 456	549	275	275	275	275	275	275	275	275	275	275	275	275

Compartment	Priority	Year 01	Year 02	Year 03	Year 04	Year 05	Year 06	Year 07	Year 08	Year 09	Year 10	Year 11	Year 12	Year 13	Year 14	Year 15
C_H10F200076	1.33	0	509 790	9 350	935	935	935	935	935	935	935	935	935	935	935	935
C_H10F200086	1.33	0	86 786	1 110	111	111	111	111	111	111	111	111	111	111	111	111
C_H10F200091	1.33	235 493	7 879	625	625	625	625	625	625	625	625	625	625	625	625	625
C_H10F200103	1.33	0	504 619	51 297	662	409	409	409	409	409	409	409	409	409	409	409
C_H10F200109	1.33	0	579 848	11 597	1 160	1 160	1 160	1 160	1 160	1 160	1 160	1 160	1 160	1 160	1 160	1 160
C_H10F200111	1.33	0	521 728	30 771	2 300	2 300	2 300	2 300	2 300	2 300	2 300	2 300	2 300	2 300	2 300	2 300
C_H10F200112	1.33	0	629	629	629	629	629	629	629	629	629	629	629	629	629	629
C_H10F200115	1.33	0	725 131	24 189	403	403	403	403	403	403	403	403	403	403	403	403
C_H10F200116	1.33	0	42 312	846	85	85	85	85	85	85	85	85	85	85	85	85
C_H10F200125	1.33	6 646	133	83	83	83	83	83	83	83	83	83	83	83	83	83
C_H10F200126	1.33	2 437	40	20	20	20	20	20	20	20	20	20	20	20	20	20
C_H10F200128	1.33	10 323	236	103	103	103	103	103	103	103	103	103	103	103	103	103
C_H10F200129	1.33	3 239	32	32	32	32	32	32	32	32	32	32	32	32	32	32
C_H10F200161	1.33	2 385	71	44	44	44	44	44	44	44	44	44	44	44	44	44
C_H10F200168	1.33	855	10 662	134	4	4	4	4	4	4	4	4	4	4	4	4
C_H10F200169_A	1.33	438	6 032	412	15	12	12	12	12	12	12	12	12	12	12	12
C_H10F200169_B	1.33	11 563	35 259	3 088	112	67	67	67	67	67	67	67	67	67	67	67
C_H10F200169_D	1.33	3 714	223	14	14	14	14	14	14	14	14	14	14	14	14	14
C_H10F200170	1.33	47 118	1 198	102	102	102	102	102	102	102	102	102	102	102	102	102
C_H10F200171_A	1.33	1 411	14 182	861	42	42	42	42	42	42	42	42	42	42	42	42
C_H10F200171_B	1.33	2 447	24 592	1 493	73	73	73	73	73	73	73	73	73	73	73	73
C_H10F200171_C	1.33	1 626	16 342	992	49	49	49	49	49	49	49	49	49	49	49	49
C_H10F200173	1.33	0	53 104	1 660	266	266	266	266	266	266	266	266	266	266	266	266
C_H10F200185	1.33	0	58 909	4 485	144	108	108	108	108	108	108	108	108	108	108	108
C_H10F200186	1.33	9 435	220	63	63	63	63	63	63	63	63	63	63	63	63	63
C_H10F200190	1.33	0	228 034	7 981	456	456	456	456	456	456	456	456	456	456	456	456
C_H10F200212	1.33	0	34 365	3 921	133	50	50	50	50	50	50	50	50	50	50	50
C_H10F200122	1.52	0	0	419 736	53 566	1 944	579	579	579	579	579	579	579	579	579	579
C_H10F200153	1.52	0	5 004	20 346	253	91	91	91	91	91	91	91	91	91	91	91
C_H10F200013	1.71	0	0	445 998	39 950	1 438	489	489	489	489	489	489	489	489	489	489

Compartment	Priority	Year 01	Year 02	Year 03	Year 04	Year 05	Year 06	Year 07	Year 08	Year 09	Year 10	Year 11	Year 12	Year 13	Year 14	Year 15
C_H10F200059	1.71	0	0	15 150	1 146	34	34	34	34	34	34	34	34	34	34	34
C_H10F200063	1.71	0	0	23 060	633	42	42	42	42	42	42	42	42	42	42	42
C_H10F200064	1.71	0	0	21 936	385	39	39	39	39	39	39	39	39	39	39	39
C_H10F200087	1.71	0	0	156 880	3 225	265	265	265	265	265	265	265	265	265	265	265
C_H10F200198	1.71	0	0	16 495	692	37	37	37	37	37	37	37	37	37	37	37
C_H10F200199	1.71	0	3 744	10 930	443	29	29	29	29	29	29	29	29	29	29	29
C_H10F200201	1.71	0	0	43 232	2 554	86	86	86	86	86	86	86	86	86	86	86
C_H10F200205	1.71	0	0	64 435	3 894	149	149	149	149	149	149	149	149	149	149	149
C_H10F200215	1.71	0	0	13 655	392	34	34	34	34	34	34	34	34	34	34	34
C_H10F200074	1.83	0	0	737 891	11 704	293	293	293	293	293	293	293	293	293	293	293
C_H10F200025	1.85	0	0	93 858	1 684	168	168	168	168	168	168	168	168	168	168	168
C_H10F200003	1.90	0	0	6 121	436	12	12	12	12	12	12	12	12	12	12	12
C_H10F200029	1.90	0	0	67 467	53 758	1 159	211	211	211	211	211	211	211	211	211	211
C_H10F200057	1.90	0	0	603 314	32 673	1 251	561	561	561	561	561	561	561	561	561	561
C_H10F200058	1.90	0	0	343 491	20 437	832	373	373	373	373	373	373	373	373	373	373
C_H10F200105	1.90	0	286	960	960	960	960	960	960	960	960	960	960	960	960	960
C_H10F200119	1.90	0	0	0	1 605 519	193 787	5 814	646	646	646	646	646	646	646	646	646
C_H10F200120	1.90	0	0	40 321	403	81	81	81	81	81	81	81	81	81	81	81
C_H10F200145	1.90	0	0	2 026	20	20	20	20	20	20	20	20	20	20	20	20
C_H10F200159	1.90	0	0	41 684	3 446	100	77	77	77	77	77	77	77	77	77	77
C_H10F200164	1.90	0	0	1 665	34	1	1	1	1	1	1	1	1	1	1	1
C_H10F200169_C	1.90	0	0	9 614	549	27	27	27	27	27	27	27	27	27	27	27
C_H10F200176	1.90	0	0	226 597	40 605	1 263	180	180	180	180	180	180	180	180	180	180
C_H10F200182	1.90	0	0	66 473	2 133	319	319	319	319	319	319	319	319	319	319	319
C_H10F200006	2.09	0	0	0	49 335	1 555	52	52	52	52	52	52	52	52	52	52
C_H10F200095	2.09	0	0	0	0	0	1 865 684	37 314	3 731	3 731	3 731	3 731	3 731	3 731	3 731	3 731
C_H10F200118	2.09	0	0	0	1 047 533	45 100	865	865	865	865	865	865	865	865	865	865
C_H10F200131	2.09	0	0	0	42 255	1 020	37	37	37	37	37	37	37	37	37	37
C_H10F200142	2.09	0	0	0	20 851	417	42	42	42	42	42	42	42	42	42	42
C_H10F200143	2.09	0	0	0	104 244	1 923	75	75	75	75	75	75	75	75	75	75

Compartment	Priority	Year 01	Year 02	Year 03	Year 04	Year 05	Year 06	Year 07	Year 08	Year 09	Year 10	Year 11	Year 12	Year 13	Year 14	Year 15
C_H10F200144	2.09	0	0	0	98 269	1 523	60	60	60	60	60	60	60	60	60	60
C_H10F200188	2.09	0	0	0	31 669	2 600 410	26 513	451	451	451	451	451	451	451	451	451
C_H10F200203	2.09	0	0	4 586	29 435	504	92	92	92	92	92	92	92	92	92	92
C_H10F200204	2.09	0	0	16 590	47 932	1 970	155	155	155	155	155	155	155	155	155	155
C_H10F200227	2.09	0	0	5 266	76	53	53	53	53	53	53	53	53	53	53	53
C_H10F200067	2.21	0	0	0	343 869	13 251	3 439	640 828	41 682	4 713	4 713	4 713	4 713	4 713	4 713	4 713
C_H10F200072	2.21	0	0	0	0	0	652 009	1 218 811	13 362	3 716	3 716	3 716	3 716	3 716	3 716	3 716
C_H10F200097	2.21	0	0	0	531 839	6 344	773 193	74 507	2 481	1 558	1 558	1 558	1 558	1 558	1 558	1 558
C_H10F200099	2.21	0	0	0	0	1 241 786	1 139 200	107 980	3 598	2 260	2 260	2 260	2 260	2 260	2 260	2 260
C_H10F200117	2.21	0	0	0	48 295	966	241	241	241	241	241	241	241	241	241	241
C_H10F200124	2.21	0	0	0	19 305	386	97	97	97	97	97	97	97	97	97	97
C_H10F200026	2.23	0	0	0	96 615	1 446	523	523	523	523	523	523	523	523	523	523
C_H10F200237	2.24	0	0	0	10 475	229	105	105	105	105	105	105	105	105	105	105
C_H10F200007	2.28	0	0	0	0	47 171	143	72 586	1 252	137	137	137	137	137	137	137
C_H10F200050	2.28	0	0	0	0	0	0	267 245	17 502	680	478	478	478	478	478	478
C_H10F200056	2.28	0	0	0	13 963	158 176	140	470 820	55 839	2 153	731	731	731	731	731	731
C_H10F200108	2.28	0	0	0	0	0	0	312 827	10 641	213	213	213	213	213	213	213
C_H10F200121	2.28	0	0	0	0	148 344	519	15 198	557	255	255	255	255	255	255	255
C_H10F200146	2.28	0	0	0	6 619	132	33	33	33	33	33	33	33	33	33	33
C_H10F200232	2.40	0	0	0	0	0	0	9 340	140	31	31	31	31	31	31	31
C_H10F200233	2.40	0	0	1 106	27	11	11	11	11	11	11	11	11	11	11	11
C_H10F200020	2.41	0	34	82	82	82	82	9 848	327	180	180	180	180	180	180	180
C_H10F200187	2.41	0	0	0	0	0	0	271 488	5 430	679	679	679	679	679	679	679
C_H10F200174	2.46	0	0	0	0	0	0	231 480	9 516	557	557	557	557	557	557	557
C_H10F200004	2.47	0	0	0	0	0	0	1 404	4 431	380	14	14	14	14	14	14
C_H10F200016	2.47	0	0	0	0	0	0	0	55 739	4 099	220	220	220	220	220	220
C_H10F200048	2.47	0	0	0	0	0	0	0	730 234	33 004	1 248	667	667	667	667	667
C_H10F200060	2.47	0	0	0	0	0	0	5 102	8 041	214	20	20	20	20	20	20
C_H10F200062	2.47	0	0	0	0	0	0	0	25 391	1 226	45	45	45	45	45	45
C_H10F200083	2.47	0	0	0	0	0	0	0	482 593	8 096	324	324	324	324	324	324

Compartment	Priority	Year 01	Year 02	Year 03	Year 04	Year 05	Year 06	Year 07	Year 08	Year 09	Year 10	Year 11	Year 12	Year 13	Year 14	Year 15
C_H10F200088	2.47	0	0	0	0	0	0	0	345 036	5 068	135	135	135	135	135	135
C_H10F200089	2.47	0	0	0	0	0	0	5 665	196 965	3 640	172	172	172	172	172	172
C_H10F200104	2.47	0	0	0	0	0	0	0	51 310	1 026	257	257	257	257	257	257
C_H10F200114	2.47	0	0	0	0	0	0	0	31 873	637	159	159	159	159	159	159
C_H10F200127	2.47	0	0	0	0	0	0	3 617	72	36	36	36	36	36	36	36
C_H10F200132	2.47	0	0	0	0	0	0	61 920	182 445	5 807	173	173	173	173	173	173
C_H10F200133	2.47	0	0	0	0	0	0	63 086	79 922	2 860	129	129	129	129	129	129
C_H10F200138	2.47	0	0	0	0	0	0	2 272	33	23	23	23	23	23	23	23
C_H10F200139	2.47	0	0	0	618	6	6	768	14	14	14	14	14	14	14	14
C_H10F200140	2.47	0	0	0	0	0	0	2 620	26	26	26	26	26	26	26	26
C_H10F200189	2.47	0	0	0	0	0	0	125 159	9 099	371	30	30	30	30	30	30
C_H10F200195	2.47	0	0	0	0	0	0	13 534	967	40	40	40	40	40	40	40
C_H10F200202	2.47	0	0	0	0	0	0	42 827	1 384	86	86	86	86	86	86	86
C_H10F200206	2.47	0	0	0	0	0	0	162 450	18 659	630	144	144	144	144	144	144
C_H10F200207	2.47	0	10	1 446	53	24	24	7 202	311	39	39	39	39	39	39	39
C_H10F200216	2.47	0	0	0	0	0	0	228 821	8 570	239	239	239	239	239	239	239
C_H10F200217	2.47	0	0	0	0	0	0	874	9	9	9	9	9	9	9	9
C_H10F200218	2.47	0	0	0	3 005	376	3 014	381	14	9	9	9	9	9	9	9
C_H10F200134	2.59	0	6	6	6	0	6	6	4 022	247	14	14	14	14	14	14
C_H10F200135	2.59	0	0	226	2	2	2	2	2 995	35	8	8	8	8	8	8
C_H10F200136	2.59	0	4	4	4	4	4	4	5 120	69	10	10	10	10	10	10
C_H10F200137	2.59	0	0	12	12	0	12	12	18 193	1 316	34	34	34	34	34	34
C_H10F200234	2.59	0	0	73	0	0	73	73	14 678	365	146	146	146	146	146	146
C_H10F200005	2.59	0	0	0	0	0	0	0	0	944 320	78 523	2 130	1 232	1 232	1 232	1 232
C_H10F200027	2.59	0	0	0	0	0	0	0	21 421	395 515	40 682	1 226	720	720	720	720
C_H10F200069	2.59	0	0	0	0	0	0	0	0	1 168 007	62 737	1 937	1 937	1 937	1 937	1 937
C_H10F200081	2.59	0	0	0	0	0	0	0	129 456	8 260	330	165	165	165	165	165
C_H10F200084	2.59	0	0	0	0	0	0	0	297 980	16 065	1 239	1 239	1 239	1 239	1 239	1 239
C_H10F200092	2.59	0	0	0	0	0	0	0	60 776	608	608	608	608	608	608	608
C_H10F200094	2.59	0	0	0	0	0	0	0	374 775	12 734	585	585	585	585	585	585

Compartment	Priority	Year 01	Year 02	Year 03	Year 04	Year 05	Year 06	Year 07	Year 08	Year 09	Year 10	Year 11	Year 12	Year 13	Year 14	Year 15
C_H10F200096	2.59	0	0	0	0	0	0	0	976 860	1 136 524	107 837	3 591	2 255	2 255	2 255	2 255
C_H10F200175	2.59	0	0	265	0	0	265	487	126 346	3 722	649	649	649	649	649	649
C_H10F200150	2.66	0	0	0	0	0	0	0	1 488	30	15	15	15	15	15	15
C_H10F200183	2.66	0	0	0	0	0	0	0	0	103 923	11 733	440	147	147	147	147
C_H10F200236	2.78	0	0	0	0	0	0	0	10 787	259	108	108	108	108	108	108
C_H10F200024	2.80	0	0	0	0	0	0	73	14 745	440	220	220	220	220	220	220
C_H10F200061	2.97	0	0	0	0	0	0	0	0	36 905	1 648	47	47	47	47	47
C_H10F200046	2.98	0	0	0	0	0	0	0	0	106 096	3 587	182	182	182	182	182
C_H10F200163	2.98	0	0	0	0	0	0	0	0	133 780	10 702	268	268	268	268	268
C_H10F200002	3.04	0	0	0	0	0	0	0	0	0	28 790	2 093	60	45	45	45
C_H10F200028	3.04	0	0	0	0	0	0	0	0	0	98 910	1 484	198	198	198	198
C_H10F200035	3.04	0	0	0	0	0	0	0	0	0	78 596	10 269	370	101	101	101
C_H10F200036	3.04	0	0	0	0	0	0	0	0	109 114	3 386	363	363	363	363	363
C_H10F200041	3.04	0	0	0	0	0	0	0	0	10 533	316	53	53	53	53	53
C_H10F200049	3.04	0	0	0	0	0	0	0	0	0	38 527	1 541	77	77	77	77
C_H10F200155	3.04	0	0	0	0	0	0	0	0	1 733	70 174	6 822	208	127	127	127
C_H10F200158	3.04	0	0	0	0	0	0	0	0	0	36 132	3 008	90	65	65	65
C_H10F200162	3.04	0	0	7	7	0	7	7	1 058	2 119	81	39	39	39	39	39
C_H10F200181	3.04	0	0	0	0	0	0	433	4	3 387	4 156	512	21	15	15	15
C_H10F200208	3.04	0	0	12	0	0	12	12	8 413	3 708	129	45	45	45	45	45
C_H10F200209	3.04	0	0	0	0	0	0	0	0	45 694	25 326	2 324	100	73	73	73
C_H10F200210	3.04	0	0	0	0	0	0	0	0	68 465	7 116	233	93	93	93	93
C_H10F200228	3.04	0	0	0	0	0	0	0	0	64 569	764	98	98	98	98	98
C_H10F200241	3.16	0	0	0	0	0	0	0	0	0	9 774	163	65	65	65	65
C_H10F200038	3.16	0	0	0	0	0	0	0	0	0	8 529	483	85	85	85	85
C_H10F200044	3.16	0	0	0	0	0	0	0	0	0	45 466	1 084	78	78	78	78
C_H10F200045	3.16	0	0	0	0	0	0	0	0	0	358 615	23 214	774	193	193	193
C_H10F200152	3.16	0	0	0	0	0	0	0	0	0	6 021	60	60	60	60	60
C_H10F200172	3.16	0	0	0	0	0	0	0	0	0	80 653	2 366	332	332	332	332
C_H10F200213	3.16	0	0	0	0	0	0	0	0	1 564	1 595	31	31	31	31	31

Compartment	Priority	Year 01	Year 02	Year 03	Year 04	Year 05	Year 06	Year 07	Year 08	Year 09	Year 10	Year 11	Year 12	Year 13	Year 14	Year 15
C_H10F200106	3.23	0	0	0	0	0	0	0	209	209	34 244	1 911	549	549	549	549
C_H10F200107	3.23	0	0	0	0	0	0	0	221	221	221	221	221	221	221	221
C_H10F200151	3.23	0	0	0	0	0	0	0	0	0	33 088	673	90	90	90	90
C_H10F200196	3.23	0	0	0	0	0	0	0	0	0	41 175	708	18	18	18	18
C_H10F200221	3.23	0	0	0	0	0	0	0	0	0	2 041	41	20	20	20	20
C_H10F200223	3.23	0	0	0	0	0	0	0	25	25	25	25	25	25	25	25
C_H10F200225	3.23	0	0	0	0	0	0	0	0	0	1 569	31	16	16	16	16
C_H10F200238	3.29	0	0	0	0	0	0	0	0	0	4 667	93	23	23	23	23
C_H10F200047	3.35	0	0	0	0	0	0	0	0	0	365 853	17 240	575	192	192	192
C_H10F200082	3.35	0	0	0	0	0	0	0	0	0	0	2 801 411	2 197 454	34 815	2 246	2 246
C_H10F200085	3.35	0	0	0	0	0	0	0	0	0	1 200 328	13 843	1 384	1 384	1 384	1 384
C_H10F200110	3.35	0	0	0	0	0	0	0	0	0	235 040	10 656	2 024	2 024	2 024	2 024
C_H10F200194	3.35	0	0	0	0	0	0	0	0	0	4 797	309	48	48	48	48
C_H10F200102	3.42	0	0	0	0	0	0	0	0	0	306 382	23 554	399	243	243	243
C_H10F200239	3.47	0	0	0	0	0	0	0	0	0	1 273	25	6	6	6	6
C_H10F200230	3.54	0	0	0	0	0	0	0	0	0	7 359	136	74	74	74	74
C_H10F200235	3.54	0	0	0	0	0	0	0	0	0	16 719	279	111	111	111	111
C_H10F200147	3.61	0	0	0	0	0	0	0	0	0	28 415	783	39	39	39	39
C_H10F200149	3.61	0	0	0	0	0	0	0	0	0	2 013	40	20	20	20	20
C_H10F200219	3.61	0	0	0	0	0	12	0	24	24	24	24	24	24	24	24
C_H10F200222	3.61	0	0	0	0	0	0	0	0	0	7 297	134	73	73	73	73
C_H10F200224	3.61	0	0	0	0	0	0	0	0	0	7 720	142	77	77	77	77
C_H10F200240	3.67	0	0	0	0	0	0	0	0	0	11 859	277	79	79	79	79
C_H10F200065	3.73	0	0	0	0	0	0	0	0	0	118 608	3 267	163	163	163	163
C_H10F200075	3.73	0	0	0	0	0	0	0	0	0	427	427	1 716 056	39 681	950	688
C_H10F200090	3.73	0	0	0	0	0	0	0	0	0	551 870	8 016	763	763	763	763
C_H10F200197	3.73	0	0	0	0	0	0	0	65	0	19 059	451	255	255	255	255
C_H10F200032	3.74	0	0	0	0	0	0	0	0	0	4 897	73	49	49	49	49
C_H10F200033	3.74	0	0	0	0	0	0	0	0	0	142 901	11 525	459	323	323	323
C_H10F200141	3.80	0	0	0	0	0	0	0	0	0	19 581	196	56	56	56	56

Compartment	Priority	Year 01	Year 02	Year 03	Year 04	Year 05	Year 06	Year 07	Year 08	Year 09	Year 10	Year 11	Year 12	Year 13	Year 14	Year 15
C_H10F200001	3.92	0	0	0	0	0	0	0	0	0	0	42 353	2 634	208	208	208
C_H10F200031	3.92	0	0	0	0	0	0	0	0	0	0	4 128	83	21	21	21
C_H10F200042	3.92	0	0	0	0	0	0	0	129	0	504	504	504	504	504	504
C_H10F200043	3.92	0	0	0	0	0	0	0	0	0	143	41 773	4 306	351	351	351
C_H10F200051	3.92	0	0	0	0	0	0	0	0	0	8 513	170	43	43	43	43
C_H10F200052	3.92	0	0	0	0	0	0	0	0	0	0	37 467	1 169	58	58	58
C_H10F200053	3.92	0	0	0	0	0	0	0	0	0	0	36 435	729	73	73	73
C_H10F200055	3.92	0	0	0	0	0	0	0	0	0	0	869 880	91 309	3 088	600	600
C_H10F200148	3.92	0	0	0	0	0	0	0	0	0	3 279	66	33	33	33	33
C_H10F200177	3.92	0	0	0	0	0	0	0	0	0	39 873	68 130	3 260	130	130	130
C_H10F200231	3.92	0	0	0	0	0	0	0	0	0	0	3 684	74	37	37	37
C_H10F200019	3.94	0	0	0	0	0	0	0	0	0	0	48 919	678	226	226	226
C_H10F200030	4.12	0	0	0	0	0	0	0	0	0	0	198 760	11 012	449	328	328
C_H10F200039	4.12	0	0	0	0	0	0	0	0	0	0	40 621	1 074	106	106	106
C_H10F200184	4.12	0	0	0	0	0	0	0	0	0	0	43 384	982	87	87	87
C_H10F200101	4.18	0	0	0	0	0	0	0	0	0	0	0	93 859	939	469	469
C_H10F200022	4.30	0	0	0	0	0	0	0	0	0	0	0	20 223	1 887	135	135
C_H10F200034	4.30	0	0	0	0	0	0	0	0	0	0	0	11 850	218	118	118
C_H10F200037	4.30	0	0	0	0	0	0	0	0	0	0	29 704	619	297	297	297
C_H10F200040	4.30	0	0	0	0	0	0	0	0	0	0	10 212	145	73	73	73
C_H10F200054	4.30	0	0	0	0	0	0	0	0	0	0	0	0	619 269	69 647	2 387
C_H10F200192	4.30	0	0	0	0	0	0	0	0	0	0	0	189 855	15 508	372	202
C_H10F200193	4.30	0	0	0	0	0	0	0	0	0	0	3 043	30	30	30	30
C_H10F200229	4.56	0	0	0	0	0	0	0	0	0	0	458	9	5	5	5
C_H10F200220	4.87	0	0	0	0	0	0	0	0	0	0	0	3 922	39	39	39
C_H10F200123	5.06	0	0	0	0	0	0	0	0	0	0	0	0	320 803	43 876	1 626
C_H10F200226	5.32	0	0	0	0	0	0	0	0	0	0	0	2 269	23	23	23
C_H10F200100	6.08	0	0	0	0	0	0	0	0	0	0	0	69 550	69 777	813	470
		4 499 997	**4 500 000**	**4 499 993**	**4 499 996**	**4 499 995**	**4 499 991**	**4 499 998**	**4 499 908**	**4 499 943**	**4 499 983**	**4 499 275**	**4 498 368**	**1 181 736**	**194 854**	**84 571**

Appendix 6: *Working for Water's Training Matrix*

#	Course Name	Priority	Accreditation	Unit Standard	NQF Level	Credits	Duration (days)
FUNCTIONAL - TERRESTRIAL CLEARING							
1	Induction	Before operations	Aligned	117049	2	1	3
2	Plant identification	Before operations	Aligned	252453	2	3	1
3	Chainsaw Operations	Before operations	Yes	117049 117058 117061 117062 117064 117069	2 2 2 2 2 2	1 4 3 2 5 2	10
4	Chainsaw refresher	every 6 months	Aligned				1
5	Brushcutter operations	Before operations	Yes	123243	2	5	10
6	Brushcutter refresher	after 6 months	Aligned				1
7	Herbicide Applicator	Before operations	Yes	123134 123135 252453	1 1 2	3 1 3	3
8	Herbicide refresher	Every 6 months	Aligned				1
9	Pest control operators course	First month	Yes	123134	1	3	5
10	Environmental literacy	First month	Yes	116064 119554	2 2	4 5	6
11	Chainsaw management	After 6 months	No				5
FUNCTIONAL - AQUATIC CLEARING							
12	Aquatic weed team induction	Before operations	Aligned	117049	2	1	1
13	Aquatic weed plant identification	Before operations	Yes	252453	2	3	1
14	Herbicide applicator (aquatic)	Before operations	Yes	123134 123135 252453	1 1 2	3 1 3	3
15	Boat handling	Within 1 month	No				5
16	Boat operators	Within 3 months	No				5
17	Advanced Boat Operators	Within 6 months	No				5

#	Course Name	Priority	Accreditation	Unit Standard	NQF Level	Credits	Duration (days)
18	Aquatic refresher training	Every 6 months	No				2
19	Bio-control induction	Before operations	No				1
20	Bio-control plant & agent identification	Before operations	No				5
21	WIMS/GPS Mapping introduction	Before operations	No				2
HEALTH AND SAFETY							
22	First Aid I	Within 1 month	Yes	119567	1	5	2
23	First Aid II	Within 6 months	Yes	120496	2	5	5
24	First Aid III	Within 12 months	Yes				5
25	Health & Safety level I	Within 6 months	Aligned	259622	2	3	2
26	Health & Safety level II	Within 12 months	Yes	259639 9964	2 2	4 3	3
27	Fire awareness	Before operations	Yes	117079	1	2	1
28	Fire fighting	Within 6 months	Yes	117082 123140	1 1	2 1	3
29	Workplace Risk Assessment	Within 3 months	Yes				5
30	Understanding COIDA Procedures	Within 6 months	Yes				3
31	Preliminary Incident Investigation	Within 6 months	Yes				3
32	Advanced Driving	Within 3 months	Yes	257025 123257	2 2	4 10	5
33	Dangerous Animals Awareness	Within 1 month	No				1
34	Field Safety and Survival	Within 1 month	No				1
35	Snake Awareness	Within 1 month	No				1
36	Safety & First Aid in WfW Refresher	Annually	No				1
37	First Aid level I for Aquatic Teams	Within 1 month	Yes	119567	1	5	3
38	First Aid level 2 for Aquatic Teams	Within 6 months	Yes	120496	2	5	3
39	Water Safety Level 1	Before operations	No				3
40	Water Safety Level 2	Within 3 months	No				1

#	Course Name	Priority	Accreditation	Unit Standard	NQF Level	Credits	Duration (days)
SOCIAL DEVELOPMENT							
41	HIV/AIDS	Annually	Yes	8494	2	4	1
42	Peer Educator Course	Before appointment	Yes	9224	5	4	5
43	Counselling	Within 3 months	Yes	13203	5	3	10
44	Healthy living	Within 6 months	Yes	14659	1	4	1
45	Personal finances	Within 12 months	Yes	15092	1	5	1
46	Diversity (Race and Gender)	Within 12 months	Yes	14664	1	3	2
47	Adult learning (literacy/numeracy ABET)	As arranged	Yes				
CONTRACTOR DEVELOPMENT							
48	WfW Contractor course unit 1 - 11	Within 6 months	No				10
49	WfW Contractor course practical	Within 6 months	No				2
50	WfW Contractor course unit 12 - 16	Within 12 months	No				5
51	WfW Contractor course unit 17 - 19	Within 18 months	No				3
52	Advanced entrepreneur course	Within 24 months	No				2
53	Worksite management	Within 6 months	No				1