Department of Sustainability and Environment

Vegetation Work Standards

Victorian Investment Framework

State Government Victoria

Acknowledgements

The development of the Victorian Investment Framework (VIF) Vegetation Work Standards has involved the collective effort of a number of departments and individuals. In particular, VIF would like to thank the steering committee members (DSE, CMAs and Melbourne Water), whose knowledge and experience ensured the development of the standards and the various stakeholder groups and individuals whose practical knowledge ensured a usable set of standards.

Acronyms

BES	Biodiversity and Ecosystem Services
CMA	Catchment Management Authority
DPI	Department of Primary Industries
DSE	Department of Sustainability and Environment
EVC	Ecological Vegetation Class
MER	Monitoring, Evaluation and Reporting
MW	Melbourne Water
NR	Natural Resources
NRM	Natural Resource Management
SWE	Sustainable Water Environments
VIF	Victorian Investment Framework

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1 Introduction

1.1 Background

The Victorian Investment Framework (VIF) vegetation work standards (the standard) are another stage in a long-term commitment of the Victorian Government to the application of high quality delivery of Natural Resource Management investment.

Catchment management Authorities (CMAs), Melbourne Water (MW), Department of Primary Industries (DPI), Department of Sustainability and Environment (DSE) and their respective service delivery partners have led the way in developing various regional standards to improve the way they do business. Whilst regional ownership of tried and true methods is important, the lack of state-wide standards has resulted in inconsistency in the application of investment or reporting of investment across the state.

The VIF Vegetation Work Standard seeks to address inconsistencies in delivery of investment in vegetation related works and will be integral to support high-quality decision-making and reporting on investment.

The standards will remove inconsistency by:

- Defining the level of service required in the delivery of vegetation management projects at the point-of-investment (landholder scale); and
- Enabling evaluations against standards to demonstrate
    - How effectively vegetation investments are being implemented
    - Progress made towards achieving state-wide targets.

The standard is part of the broader DSE drive to develop standards under the draft DSE Monitoring, Evaluation and Reporting (MER) Framework (the Framework). The Framework has been developed by DSE to improve the quality and alignment of MER undertaken by DSE. The Framework, together with associated MER standards, such as this standard, provides specific guidance for DSE MER delivery.

The standard, along with Protocol for VIF Standard Outputs, offer a great opportunity to demonstrate accountability for investment, support adaptive management, provide documentation for training and facilitate reporting against statewide targets. Audits against the standard may occur from time to time to facilitate learning and to understand how standards can be used to improve accountability.

1.1.1 Objective

The key objective of the standard was to develop a set of open, up-to-date, consistent, and accessible standards for use by the DSE, DPI, CMAs, MW and their respective service delivery partners that focused on VIF vegetation management activities at the point-of-investment.

It is anticipated that the standards will be used for all vegetation management investment through the Victorian Investment Framework (VIF).

1.1.2 Scope

The standards detail the minimum state-wide standards for the delivery of vegetation management activities at the point of investment for CMA/MW works through VIF projects.

The 11 standards are:

- Ecological burning (to be finalised early 2012) (section 2)
- Ecological grazing (section 3)
- Ecological thinning of Eucalypt species(section 4)
- Herbaceous weed control (section 5)
- Minimising the spread of weeds and plant pathogens (section 6)
- Plant establishment (section 7)
- Planting density, diversity and placement for seedlings (section 8)
- Soil preparation for re-planting (section 9)
- Stock fencing (section 10)
- Vertebrate Pest animal control (section 11)
- Woody weed control (section 12).

The standards do not consider:

- Priority setting;
- Preliminary site assessments (to determine which Standards apply); or
- The effectiveness of works in improving environmental outcomes.

1.1.3 Methodology

The key tasks performed in the development of the standard were:

- Development of a document template
- Desktop review of information relevant to the development of the standards (i.e. a literature review of standards currently used within Victoria)
- Development of the standards.

Delivery of these tasks involved consultation at various levels, most notably:

- Oversight, review and feedback from a steering committee (all tasks); and
- Review and feedback from stakeholders (standards).

1.1.4 Governance and maintenance

The standard is managed by the DSE Natural Resources Division on behalf of VIF and the project steering committee. For further information or feedback please email Statewide.MRProgram@dse.vic.gov.au

1.1.5 Report structure

This report details the development of state-wide Vegetation Works Standards, under the following sections:

- Section 1.1 provides an introduction to the standard
- Section 1.2 presents the approach undertaken to develop the standards, including:
    - Document structure adopted
    - Key findings of the desktop review
    - Consultation process
- Section 1.3 discusses how the standards can be used (both individually and collectively) and suggests how to deal with non-compliance
- Section 1.4 presents possible next steps and recommendations
- Sections 2 - 12 presents the detailed standards

1.2 Development of the standard

1.2.1 Standards template

To ensure consistency across standards, a document template was developed. This template consisted of the following key headings:

- Scope – what the standard will and will not cover
- Background – why the standard is required
- Method – how to apply the standard. Where appropriate this included information on:
    - Applicability e.g. to avoid damage to vegetation assets
    - Technique e.g. fencing standards that describe number/type of wires to exclude livestock
    - Timing e.g. duration and frequency for weed control
    - Licences/permits requirements e.g. the need for a permit to remove native vegetation
    - Maintenance provisions e.g. targeted weed control following an ecological burn
    - Reference to more detailed and/or regional standards endorsed by DSE (where appropriate).

The template was used for all standards.

1.2.2 Desktop review

Fourteen vegetation works topics were identified at the outset of the project by the steering committee as requiring standards development. These were:

- Pest animal control
- Woody weed control
- Herbaceous weed control
- Fencing
- Species selection
- Planting
- Direct seeding
- Disease management
- Thinning
- Fire management
- Controlled grazing
- Pest animal management – maintenance
- Weed management – maintenance
- Landholder agreements.

However, these were further refined through the project as described in Section 1.2.5.

1.2.3 Approach

A desktop review relevant to these topics was undertaken and involved:

- Collation and tabulation of available information from various sources (including Greening Australia, DSE, DPI, CMAs, MW and Land and Water Australia)
- Development of proposed approaches for each standard
- Identification and documentation of any synergies/conflicts between proposed approaches and current processes utilised by regional/state agencies
- Identification of any gaps or limitations in implementing the standards.

It should be noted that the development of the Standard was a consolidation of existing information.

1.2.4 Key findings

Key findings from the review included:

- Availability of information. A considerable amount of information is available relevant to the development of the standards, however this information is currently housed in a number of locations and is often documented in various forms
- State-wide consistency. No significant conflicts in recommended management approaches between references were noted (which suggests methods will be applicable to most applications)
- Prescription. References generally provide clear descriptions for how activities should be undertaken (e.g. technique, timing), but are less clear in defining when an activity is appropriate i.e. how to assess threats at a site scale
- Proven methods. Most standards can be developed from proven methodologies (e.g. pest animal control), however some standards will require further testing/research (e.g. ecological thinning, controlled grazing)
- Complexities. Cannot prescribe a recommended approach for some standards as there are too many variables (e.g. rabbit control) – in these cases only advantages/ disadvantages of particular options can be provided
- Funding cycles. Stakeholders currently apply most aspects of best management relevant to vegetation activities although application of some techniques (e.g. weed control prior to revegetation) is limited by the short timeframes associated with funding cycles. The standards have been developed without any constraints posed by funding.

1.2.5 Revised list of standards

Review of available information resulted in some amalgamation, renaming and/or addition of particular standards. For example:

- Maintenance activities such as pest animal management are part of the delivery of the vertebrate pest animal control standard;
- Fire management as part of vegetation enhancement is best described as ecological burning; and
- Soil preparation was added as a new standard.

The revised list of standards is detailed in Table 1.1.

1.2.6 Standards

Based on the desktop review, working drafts of the revised list of standards were developed and forwarded to the steering committee and stakeholders for review and comment

The working drafts were then updated and a final set of standards developed.

Table 1.1 - Original and final list of vegetation works standards

Original list	Final list
Pest animal control	Vertebrate pest animal control
Pest animal management - maintenance	
Woody weed control	Woody weed control
Herbaceous weed control	Herbaceous weed control
Weed Management - Maintenance	
Fencing	Stock fencing
Species selection	Planting density, diversity and placement
Planting	Plant establishment
Direct seeding	
Disease management	Minimising the spread of weeds and plant pathogens
Thinning	Ecological thinning of Eucalypt species
Fire management	Ecological burning
Controlled grazing	Ecological grazing
Landholder agreements*	
	Soil preparation**

* A landholder agreement standard was determined to be out of scope by the steering committee.
** A soil preparation standard was not initially identified for development but later agreed for inclusion in the project.

1.2.7 Consultation

Steering committee

The project was a collaborative project between three DSE Divisions:

- Biodiversity and Ecosystem Services (BES)
- Natural Resources (NR)
- Sustainable Water Environments (SWE)

A steering committee was established to oversee the project, and involved representatives from these divisions together with representatives from CMAs and MW.

Stakeholders

Various stakeholder groups were engaged throughout the project, including:

- DSE Natural Resource Management Plan Directors Reference Group
- Waterway Health Monitoring, Evaluation, Reporting and Improvement Steering Committee
- DSE Victorian Investment Framework Investment Referral Group
- CMA CEOs, Waterway Managers, Biodiversity Managers and Monitoring, Evaluation and Reporting groups/forums.

These groups were invited to review and comment on two drafts of the standards.

1.3 Applying the standards

1.3.1 How to use the standards

Point of investment

The primary purpose of the standards is to define the minimum state-wide best management practices for the delivery of vegetation management activities at the point-of-investment i.e. at the landholder scale.

The standards are appropriately applied during the planning, implementation and reporting phases of a project, providing valuable information and guidance on:

- Applicability i.e. when does a particular activity apply or not apply
- Technique i.e. what approaches best fit the project need and situation
- Timing i.e. what resources are required when and in what order should activities be undertaken
- What licences or permits may be required.

Other uses

In addition to the above, the standards can also be used to audit projects and assist in adaptive management.

State-wide auditing

The standards can be used as a reference when auditing projects to:

- Assess how effectively vegetation investments are being implemented
- Assess the progress made towards achieving state-wide targets.

Adaptive management

The standards can also support adaptive management by providing a standard set of approaches to vegetation management that can be tested both temporally and spatially through implementation across the state.

A review process that enables natural resource managers to identify opportunities for improvement from program delivery and evaluation will be critical in this regard.

1.3.2 How the standards fit together

Determining which standards should apply to a particular vegetation management project is dependent on a number of factors, including:

- The project goal
- The relevant ecological vegetation class (EVC) for the project site
- The condition and extent of remnant vegetation at the project site, which in turn determines whether the project will focus on:
    - Protection of remnant vegetation
    - Establishment of overstorey and/or understorey plants within a remnant patch i.e. supplementary planting
    - Establishment of native vegetation in formerly cleared areas outside of a remnant patch i.e. revegetation.
- Specific site conditions e.g. soil type, slope
- The type and severity of threats present.

Therefore, each standard should not be read in isolation, but rather sequenced and applied with other relevant standards as appropriate.

The above factors fall outside the scope of the current project but should always be a consideration for any project management best management procedure. It is therefore the responsibility of the project manager to determine the appropriate combination and sequencing of standards to apply in order to meet the needs of their program and the particular site involved.

1.3.3 Exceptional circumstances

The standards have been developed to operate at a relatively high level to accommodate regional differences. However, it is acknowledged that on occasion a diversion from a standard or a component of a standard, may be appropriate based on specific site conditions. For example the use of particular herbicides 'off-label' to control weeds[1].

In such cases, the onus is on the project manager to demonstrate why an alternative approach is necessary. This can be achieved by documenting the following (at a minimum):

- The justification for a diversion from the draft standard
- The alternative approach to be adopted
- How the alternative approach will be evaluated.

This documentation will assist in:

- Any auditing of the project
- Reviewing/improving particular standards (especially those where non-compliance becomes routine).

Please record this within project reports and send recommended changes to the project steering committee for consideration, Statewide.MRProgram@dse.vic.gov.au.

[1] Many environmental weeds do not currently have any herbicides registered for their control. Using a herbicide to control a weed when it is not registered for that particular species or situation ('off-label' use) is sometimes legal in Victoria without a permit (Ainsworth (2004. *Weed Management in Riparian Zones. A Guide for Grazing Properties in Southwest Victoria.* Department of Primary Industries).).

1.4 Next steps

Whilst the key objective of this project was to develop a set of standards focusing on vegetation activities at the point-of-investment, a number of stakeholder issues have been raised. In particular, stakeholders have requested consideration of the following items:

- Check list
- Familiarisation training
- Continual improvement

1.4.1 Check list

A high priority request from stakeholders was for DSE to clarify data collection requirements. The steering committee is developing a check list that will be available in December 2011.

1.4.2 Familiarisation training

This was high demand for familiarisation sessions from stakeholders and as such, the steering committee will arrange these in early 2012.

1.4.3 Continual improvement

The standards will be implemented within the 2012/13 investment period and beyond and it is requested that ongoing constructive feedback is provided to the Steering Committee. The information and learnings gathered will then be consolidated as the Standards are reviewed and updated. Please provide feedback to Statewide.MRProgram@dse.vic.gov.au.

2 Ecological burning

To be updated early 2012

3 Ecological grazing

This standard forms part of a set of state-wide standards for the delivery of vegetation management activities through Victorian Investment Framework (VIF) projects at the landholder scale.

Where ecological grazing is to be undertaken as part of a VIF project, this standard **MUST** be applied.

Note that this standard does not cover grazing of high country for fuel and bushfire risk management.

Determining whether ecological grazing is an appropriate activity for a particular vegetation management project is the responsibility of the project manager and will be dependent on a number of factors, including:

- The project goal
- The relevant ecological vegetation class (EVC) for the project site
- The condition and extent of remnant vegetation at the project site, which in turn determines whether the project will focus on:
    - Protection of remnant vegetation
    - Establishment of overstorey and/or understorey plants within a remnant patch i.e. supplementary planting
    - Establishment of native vegetation in formerly cleared areas outside of a remnant patch i.e. revegetation.
- Specific site conditions e.g. soil type, slope
- The type and severity of threats present.

Therefore, this standard should not be read in isolation, but rather sequenced and applied with other relevant standards as appropriate.

3.1 Preface

The outcomes from grazing as a tool for managing native vegetation can be variable and are complex. Ecological grazing is a strategy that aims to maintain and improve the condition of native vegetation. The removal of biomass may be an important management strategy in some grassy vegetation systems, which require maintenance of open areas for recruitment of native species. Grazing may also be useful tool for reducing weed cover in areas where other weed management strategies are difficult to implement.

There are often multiple outcomes that can arise from grazing native vegetation, some positive and others negative. For example the use of grazing to reduce weed cover can also result in soil compaction and increased nutrient levels, which in turn may exacerbate weed invasion.

Due to the uncertainties associated with achieving desirable outcomes and the potential for adverse impacts, users should carefully consider the range of management options available when deciding whether ecological grazing is an appropriate management action.

A future decision-support standard is under development that will allow users to determine when grazing may be appropriate to achieve improved native vegetation and broader environmental outcomes. In the meantime, project managers should first decide on the objectives for the site and use this as the basis for determining the appropriate grazing management strategy in consideration of any possible negative impacts.

3.2 Scope

This standard covers the use of livestock (in particular sheep and cattle) as a management tool to maintain or enhance the cover and diversity of native plants within:

- Grasslands
- The grassland areas within grassy woodlands.

This standard does not cover:

- Grazing in the high country for fuel and bushfire risk management. Note also the EPBC Regulations 2000 requires domestic grazing in the Australian Alps National Parks and Reserves must be referred to the Commonwealth Government for assessment
- Grazing of woodland areas within grassy woodlands (ecological grazing within these areas should not be required as the trees reduce light and moisture levels preventing excessive grass cover (Barlow 1998))
- Grazing within non-grassy EVCs
- The use of livestock to control herbaceous or woody weeds (refer to the Herbaceous Weed Control and Woody Weed Control standards for information and methods)
- The use of other livestock (e.g. goats) as a management tool.

3.3 Background

Natural grassy vegetation communities in temperate Australia have a ground layer dominated by mostly tussocky perennial plants, often composed of only a few species of tussock grasses and an exceptionally diverse array of herbaceous plants and wildflowers including lilies, peas, daisies and other ground flora (Tremont and McIntyre 1994 cited in Water Technology 2009).

For such vegetation communities, significant research has shown repeatedly that the ground layer vegetation is strongly controlled by the relationship between the tussock-forming graminoids (grasses, sedges, rushes) that dominate this layer, and the gaps between them (Water Technology 2009), with the majority of non-grass plant species growing in the inter-tussock spaces(Eddy 2002).

When the tussock canopy closes over these gaps, it shades and out competes the smaller non-grass plants (Eddy 2002). Therefore, some form of biomass reduction (e.g. grazing, slashing, fire) may be required to maintain the structure and botanical composition of grasslands and sparsely treed grassy woodland ecosystems.

3.3.1 Grassland management

Pre-European settlement

Before the introduction of domestic livestock and rabbits, and the displacement of the many species of native fauna, biomass reduction in grasslands was performed by:

- Native animals, including both large and small mammals and grasshoppers and other insects
- Fire, both naturally occurring and those lit by Aboriginals (Eddy 2002).

Post-European settlement

Since European settlement, commercial grazing by domestic livestock has been (and is likely to continue to be) the primary use and consequently the main method of biomass reduction in native grasslands (Eddy 2002).

The use of traditional grazing strategies (such as continuous or set-stocking) within native grasslands and grassy woodlands encourages weed invasion and degrades native vegetation. This is because palatable plants are continually selected by the grazing animals, allowing only unpalatable species to increase. Additionally, regular soil disturbance caused by hooves and nutrient increase from animal droppings provide a constant supply of suitable sites in which weeds can establish (Barlow 1998).

These grazing strategies also deplete the energy reserves of perennial native grasses, prevent native seed set and prevent recruitment of woody species within grassy woodlands, leading to their decline and an increase in annual grass and broad-leaf weed cover.

As such, continuous grazing is not considered to be an appropriate tool to maintain or enhance the cover and diversity of grasslands and grassy woodlands.

Ecological grazing

Considering that many vegetation types (particularly grassy ecosystems) still require some level of disturbance (e.g. grazing, slashing, fire), the use of livestock in limited and carefully controlled conditions (known as ecological grazing) can form part of a sustainable vegetation management plan. For example, ecological grazing can:

- Allow for native regeneration - grazing in grasslands can prevent excessive grass cover and therefore maintain a diverse array of plants and fauna habitats that would otherwise be smothered
- Maintain habitat structure
- Control weeds (predominantly the management of annual exotic grasses) (Barlow 1998).

3.4 Method

The recommended approach for developing and implementing an ecological grazing program involves:

- Describing the desired goal (or ecological objective) for the project
- Assessing the problem
- Considering the control options/methods available and determining if ecological grazing would:
    - Be effective in treating the problem
    - Be practical in treating the problem
    - Create potential risks to either on-site or off-site values.
- Developing an ecological grazing strategy
- Implementing the strategy
- Maintaining a monitoring and review program.

3.4.1 Applicability

The view that stock grazing is always detrimental to ecosystem integrity is not universal. VEAC (2006 and 2007 cited in Water Technology 2009) recognised that stock grazing can have positive effects on the environment if applied in a targeted manner in a limited range of grassy ecosystems. This is supported by BushTender (Department of Sustainability and Environment 2009), where ecological grazing is identified as a potential tool for maintaining/enhancing native vegetation quality in specific grasslands.

Table 3.1 – Ecological grazing: advantages and disadvantages

Advantages	Disadvantages
• Removal of biomass maintains inter-tussock spaces (important habitat for a range of flora and fauna species) • A higher proportion of plants are grazed (without over-grazing[2]) rather than a smaller proportion of overgrazed plants (as often occurs with continuous grazing where the regrowth from a grazed plant is more palatable and preferable to livestock, leading to a mix of overgrazed and overrested[3] plants) • Inexpensive • Productivity benefit to primary producers	• Timing limitations • Effort to manage • Inappropriate for many ecosystems (e.g. forests) • Can degrade system if not managed appropriately by: o Compacting soils o Encouraging weed growth o Damaging native vegetation o Preventing natural recruitment o Elevating nutrient levels in soil and water o Initiating/accelerating erosion o Degrading habitat for threatened species

BushTender (Department of Sustainability and Environment 2009) has identified two grassy ecosystems where the use of ecological grazing can assist in maintaining or enhancing the cover and diversity of native plants and fauna habitats, namely:

- High rainfall grasslands; and
- Treeless grassy areas within dryland grassy woodlands.

Based on this information, a decision tree has been developed and **MUST** be used to identify those project sites where ecological grazing may be an applicable management tool (refer to Figure 3.1).

High rainfall grasslands

In high rainfall grasslands (i.e. rainfall areas above 500mm per annum), the absence of periodic biomass removal (e.g. by fire) increases the risk of the native grassy sward becoming dominant over time leading to a loss of the inter-tussock spaces that are important as habitat for a range of plant and animal species. If biomass is not removed then there can be a dramatic decline in overall vegetation quality within a 10-year period (Department of Sustainability and Environment 2009).

As such, for high rainfall grassland EVCs, avoiding a decline in site condition requires some form of active biomass management (Department of Sustainability and Environment 2009). This may include the application of ecological grazing.

Treeless grassy areas within dryland grassy woodlands

Dryland grassy woodlands often occur naturally as a mosaic of two structural components, 'woody' areas containing mature trees, regenerating trees or woody understorey interspersed with 'grassy' areas lacking woody vegetation (Department of Sustainability and Environment 2009).

[2] Overgrazing – severe/repeated grazing during a plant's active growing period that results in reduced vegetation production and ultimately death of the plant.

[3] Overresting – Prolonged absence of grazing that creates an accumulation of old plant material which in turn decreases light penetration resulting in reduced growth and/or death of the plant.

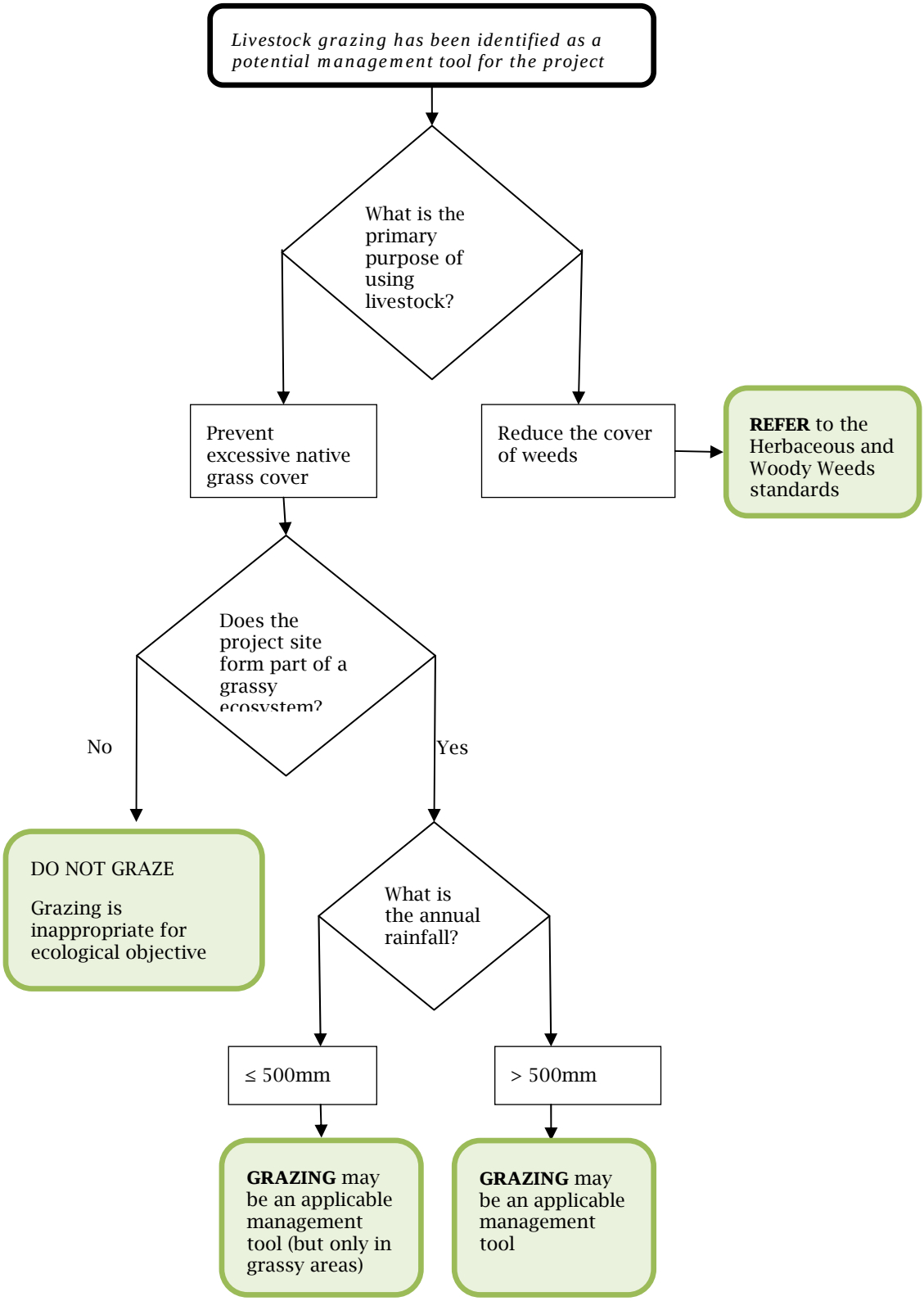

Figure 3.1 – Decision tree to identify projects sites where ecological grazing may be an applicable management tool

Different management approaches may be required to maintain and enhance native vegetation quality within these different grassy vegetation types (Department of Sustainability and Environment 2009). One approach may include the application of ecological grazing.

However, ecological grazing is typically only appropriate in the grassy areas within a grassy woodland and stock **SHOULD** be excluded from any area containing trees and shrubs (to allow woody regeneration to occur).

3.4.2 Technique

Development of an ecological grazing regime is dependent on a number of factors, most notably:

- The protection of valued site attributes from grazing
- The type of livestock to be used
- The grazing pressure exerted by livestock (which involves stocking rates, grazing durations and rest periods)
- The timing of grazing.

The following sections detail approaches to addressing these factors, namely:

- Assessing the site prior to ecological grazing
- Considering the grazing habits of the available livestock
- Determining the grazing intensity required for a project site
- Identifying the optimum time to undertake grazing.

Pre works risk assessment

Due to the uncertainties (and potential negative impacts) in implementing ecological grazing programs, project managers **MUST** develop detailed risk assessments to determine whether ecological grazing is an appropriate management action for a particular project site.

The risk assessment **MUST** consider the following site attributes:

- The type of vegetation and its dependence on some form of biomass reduction (e.g. grazing, slashing, fire) to maintain structure and botanical composition
- The appropriateness of employing ecological grazing (as opposed to other disturbance mechanisms) to maintain/enhance native vegetation cover and diversity
- The extent, conservation status and condition of the vegetation types to be grazed
- The extent, conservation status and habitat requirements of any rare or threatened species occurring in the area to be grazed.

Livestock type

Most grazing animals selectively graze to some extent, preferentially grazing some species and avoiding others. This tends to disadvantage the most palatable, accessible, and actively growing plant species (Water Technology 2009).

Project managers **MUST** be aware of the differences in the grazing pressures likely to be exerted by livestock on the native vegetation at a project site and plan accordingly. For example:

- Sheep are more selective grazers than cattle (Barlow 1998)
- Sheep graze closer to the ground than cattle (Water Technology 2009)
- Sheep tend to cause greater soil compaction, but less pugging, than cattle (Barlow 1998).

Grazing pressure

With any grazing, the pressure applied to an individual plant is a site location, stock density, continuity and time-dependent variable (Water Technology 2009).

Continuous grazing gives vegetation no chance to recover and often leaves a patchwork of overgrazed and overrested plants (Savory 1999). This results in either:

- Native vegetation dying out and being replaced with unpalatable, weedy species
- An over-abundance of particular native species that are unpalatable to livestock (Staton and O'Sullivan 2006).

In contrast, ecological grazing that includes both active grazing periods and rest/recovery periods (e.g. rotational or cell grazing) can be effective in maintaining grasslands and grassy woodlands.

Therefore, continuous grazing **MUST NOT** be used as a management tool to maintain or enhance the cover and diversity of grasslands and grassy woodlands.

Determining the grazing intensity for a project site

Grazing intensity is a collective term that is a function of two components of the grazing regime: stocking rate and duration (Water Technology 2009).

Determining the optimal number of livestock and grazing duration to maintain or enhance the cover and diversity of native plants will be different for each project site. As such, the exact requirements for ecological grazing **MUST** be determined on a case-by-case basis in consultation with DSE. However the presence of the following taxa **SHOULD** be used as indicators of the likely grazing intensity that may be appropriate for a site:

- Many species within genera such as Austrostipa (Spear-grasses), Austrodanthonia (Wallaby grasses), Chloris (Windmill grasses), Juncus (rushes) and Carex (sedges). These species have been shown to tolerate moderate intensity grazing
- Species such as Microleana (Weeping Grass) and Joycea (Wallaby-grass) and many Acacia (wattles). These species have been shown to be tolerant of low intensity grazing
- Orchids, lilies, saltbushes, and grasses such as Poa and Themeda (Kangaroo Grass) spp. These plants are sensitive to grazing, and have been shown to decline rapidly in abundance with even low stock grazing intensities.

Timing of grazing

Refer to Section 3.4.3.

3.4.3 Timing

The appropriate time to undertake ecological grazing is dependent on:

- The growth phase of desirable plant
- Site specific conditions e.g. soil moisture levels.

Growth phase of desirable plants

Heavy grazing when indigenous graminoids are entering their annual growth phase can damage or substantially weaken natural vegetation by reducing their ability to set seed and send out new growth (Staton, J. and O'Sullivan, J., 2006).

Therefore, ecological grazing **MUST NOT** be used when native plants are in flower or setting seed i.e. during spring and early summer (Water Technology 2009, Staton and O'Sullivan 2006).

Ecological grazing **SHOULD** be implemented when the majority of native plants are dormant i.e. from late summer to early winter (provided the ground is not too wet or too dry),

ensuring that the total vegetation cover does not fall below 70 per cent (Department of Sustainability and Environment 2009, Staton and O'Sullivan 2006).

Site conditions

Irrespective of the time of year, ecological grazing **MUST NOT** be used when:

- Soil moisture levels are high. Grazing at such times will lead to pugging and compaction (Staton and O'Sullivan 2006, Water Technology 2009)
- Soil is very dry e.g. during a drought. At such times, the ground layer may be too sparse, leading to over-grazing and soil erosion (Staton and O'Sullivan 2006, Water Technology 2009).

In addition, ecological grazing **MUST NOT** be used following heavy rains, floods or wildfire as these events usually trigger germination in native plants (Staton and O'Sullivan 2006).

3.4.4 Animal hygiene

Entering a project site

To prevent the introduction of weeds, livestock **MUST** be grazed on weed-free fodder or pasture for between one and seven days (depending on the type of livestock and seed ingested) prior to their introduction to the project site for ecological grazing (Water Technology 2009).

In addition, where sheep are to be used for ecological grazing, they **SHOULD NOT** enter a project site until after shearing. This will further ensure that additional weed seeds are not brought into the project site as sheep carry the seed of many kinds of weeds in their coats (Staton and O'Sullivan 2006).

Exiting a project site

Following ecological grazing, all livestock **MUST** be kept in a controlled area until any seeds ingested have the opportunity to pass through their system (between one and seven days). This will prevent the introduction of any weeds to other sites. Stock containment areas are particularly useful for this purpose.

3.5 References

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4 Ecological thinning of Eucalypt species

This standard forms part of a set of state-wide standards for the delivery of vegetation management activities through Victorian Investment Framework (VIF) projects at the landholder scale.

Where ecological thinning is to be undertaken as part of a VIF project, this standard **MUST** be applied.

Determining whether ecological thinning is an appropriate activity for a particular vegetation management project is the responsibility of the project manager and will be dependent on a number of factors, including:

- The project goal
- The condition and extent of remnant vegetation at the project site
- Specific site conditions e.g. soil type, slope
- The type and severity of threats present.

Therefore, this standard should not be read in isolation, but rather sequenced and applied with other relevant standards as appropriate.

4.1 Preface

The outcomes from thinning as a tool for managing native vegetation can be variable and complex. Ecological thinning (eco-thinning) is the removal of some trees or stems within native vegetation where the current canopy cover is significantly higher than would be expected in the vegetation type. The strategy of ecological thinning aims to:

- Restore an appropriate number and distribution of overstorey trees
- Increase the growth rate and time to maturity of retained overstorey trees
- Facilitate an increase in the diversity and cover of native understorey.

Eco-thinning may be more effective in some vegetation types that are not regularly subject to natural disturbance events which would otherwise contribute to a process of natural thinning and recruitment. The decision to intervene and selectively remove trees or stems from within a site faces a number of issues. Determining the number of stems to be removed will require consideration of:

- The current and likely/predicted future health of individual trees
- The number of stems per hectare to retain in order for natural processes to be reinstated
- Impact of disturbance (use of tractors or other equipment)
- The retention of existing biodiversity values such as species habitat (e.g. adequate canopy cover)
- The likely outcomes for the site if eco-thinning was undertaken i.e. will the action achieve the objectives
- Requirements for planning permits.

Users should carefully consider the range of management options available when deciding whether eco-thinning is an appropriate management action.

A future decision-support standard is under development that will allow users to determine when thinning may be appropriate to achieve improved native vegetation and broader environmental outcomes. In the meantime, project managers should first decide on the objectives for the site and use this as the basis for determining whether eco-thinning is the appropriate management strategy in consideration of any possible negative impacts.

4.2 Scope

This standard considers the ecological thinning of Eucalypt species as a management tool to re-establish natural processes and allow the remaining dominant trees to grow faster and ultimately larger.

This standard does not consider:

- The thinning of Eucalypt species for non-ecological purposes e.g. flood mitigation, access, firewood collection
- The ecological thinning of other early successional species (e.g. Acacia spp.) as they play a different role in the vegetation community and there is insufficient knowledge of this role to set management principles at this stage (Department of Sustainability and Environment 2009).

4.3 Background

In some circumstances, regeneration (and some direct seeding and revegetation projects) may result in dense stands of seedlings, which may take decades to naturally thin themselves out (Greening Australia 2008). This type of regeneration may result from both natural (e.g. flood, fire) or anthropogenic (e.g. forest clearing) events.

Having a large number of trees competing for limited resources (light, water, nutrients) usually results in smaller trees with poor growth rates and tree form[4] and a limited understorey (Murray and Thompson 2000).

Furthermore, Vesk *et al.* (2007) found that densely planted revegetation projects resulted in reduced tree girth growth rates which can delay the development of large boughs, tree hollows and fallen timber by decades. Such habitat is essential for establishing and maintaining viable faunal populations.

4.4 Method

Ecological thinning is the process of selecting and removing some smaller trees or stems to allow others to grow and reach their mature size faster (Department of Sustainability and Environment 2009, Parks Victoria 2010). This in turn:

- Increases structural diversity, including restoration of an appropriate number and distribution of overstorey trees on the site
- Promotes better tree form
- Allows for the development of large boughs and tree hollows (Vesk et al. 2009)
- Allows for the regeneration of understorey species by increasing light and water penetration to the ground layer and reducing competition from overstorey species (Department of Sustainability and Environment 2009).

4.4.1 Applicability

Ecological thinning operations **MUST** have clear 'ecological objectives' and should only be considered where there are demonstrable single or multiple ecological benefits.

[4] Tree form - the shape or branching habit of a tree.

Ecological thinning is typically applied to sites where there are trees of young, even-aged regeneration (Department of Sustainability and Environment 2009). This can be the result of:

- Unnatural disturbance events e.g. timber harvesting or clearing for agriculture
- Natural disturbance events e.g. mass germination following a flood or fire
- Mass planting and direct seeding of tree species in revegetation plots.

Whilst some self-thinning will occur naturally (but at very slow rates) it may be advantageous to thin tree numbers (Department of Sustainability and Environment 2009). This work **SHOULD** be undertaken as part of, or in combination with, other ecological management/enhancement interventions for a remnant patch e.g. remnant fencing, stock exclusion, supplementary planting etc.

4.4.2 Technique

The following sections detail the key standards that apply when undertaking ecological thinning of Eucalypt species, namely:

- Assessing the site prior to thinning
- Identifying the target number of trees to be retained
- Determining the appropriate thinning method to apply.

Pre works risk assessment

Project managers **MUST** develop detailed risk assessments to determine whether ecological thinning is an appropriate management action for a particular project site.

The risk assessment **MUST** consider the following site attributes:

- The extent, conservation status and condition of the vegetation types to be thinned
- The extent, conservation status and habitat requirements of any rare or threatened species occurring in the area to be thinned
- Any other specific values within the proposed thinning area e.g. habitat features such as hollows, shrubby cover, leaf litter.

Work is currently underway to inform this pre-works risk assessment process.

Target number

The goal of ecological thinning is to remove only enough stems to allow for natural processes to be restored.

Ecological Vegetation Class (EVC) benchmarks provide an approximate density of mature trees per hectare e.g. the density of mature trees for Floodplain Riparian Woodlands (EVC 56) is 15 large trees/ha.

However, many seedlings and young trees die over time to end up with this density.

Therefore, it is important that any proposed ecological thinning operation leaves enough trees to cover future losses from storms, disease, termites, fire or wind.

As an example, Rawlings *et al* (2010) cited the following target numbers for thinning trees in grassy woodlands (to achieve a benchmark density of 30 trees/ha):

- For small trees (less than 10cm diameter at breast height), leave at least 400 stems per hectare (approximately 5 x 5 m spacing)
- For larger trees, thin to no less than 250 stems per hectare (6 x 7 m spacing).

As there are a number of factors affecting the actual composition of an EVC, the exact requirements for ecological thinning **MUST** be determined on a case-by-case basis in consultation with DSE.

Ecological thinning methods

There are numerous methods available for thinning depending on the size of the project, the density and age of tree species and the cost. Methods include:

- Slashing (suitable for young seedlings only)
- Brush-cutter (for young plants i.e. <5 years with a diameter <7cm)
- Stem-injection (where dead stems are allowed to remain standing - refer to the Woody Weed Control standard for technical details)
- Chainsaws for felling of larger trees (Greening Australia 2008, Murray and Thompson 2000).

A decision tree has been developed and **MUST** be used to determine which thinning method is the most appropriate for a particular project site

Whichever method is adopted the following principles **MUST** be followed (adapted from Department of Sustainability and Environment (2009):

- Avoid unnecessary disturbance of trees or native understorey plants to remain on the site.
- Thin only enough stems to allow natural processes to be restored or 'sped-up'.
- All ecological thinning plans should include the retention of all:
    - Large and senescing trees
    - Standing dead trees
    - Trees containing hollows, or the largest age-class trees in the patch
    - Trees with signs of current or recent occupation by fauna.
- Thin from below i.e. remove the youngest and the smallest tree from a group, especially in multi-stemmed or coppice growth.
- Thin so retained trees are distributed (but not evenly) over the whole site. This is important as most of the younger cohorts are in patches without any mature trees. Creating a 'patchy' mosaic is more ecologically desirable.
- Thin so that the current proportion of tree species within the site is more or less retained (unless ecological knowledge of the site indicates otherwise).

In addition, all felled timber **MUST** be retained on-site to provide ground habitat except where retaining all felled timber is deemed inappropriate e.g. where the volume of felled timber would pose a significant impediment to understorey regeneration or where it would pose an unacceptable fire risk to nearby property assets.

4.4.3 Timing

Mechanical thinning operations **MUST** be avoided when:

- The risk of fire is high
- The ground will be excessively disturbed (e.g. following rain events)
- Vegetation is providing active animal habitats (e.g. bird nesting).

Based on these restrictions, the optimum time of year to undertake ecological thinning operations is generally from Autumn to early Winter when the ground is hard.

4.4.4 Licences/permits

Clause 52.17 of the Victorian Planning Provisions requires a permit to remove, destroy or lop native vegetation. As ecological thinning in remnant areas involves the removal of native vegetation, a planning permit from the relevant local council will be required (unless the removal is exempt under the planning scheme).

A permit may also be required for native vegetation removal under a planning scheme overlay such as the Environmental Significance Overlay, Vegetation Protection Overlay, Significant Landscape Overlay, Heritage Overlay, Salinity Management Overlay, Erosion Management Overlay or Public Acquisition Overlay.

The removal of timber from a site as part of a thinning operation may also trigger the Timber Production provisions of the Victorian Planning Provisions.

Therefore, if ecological thinning is proposed within a project site, the project manager **MUST** determine if a permit is required from the relevant local council.

4.4.5 Maintenance

Weed management

Whilst ecological thinning can encourage the regeneration of understorey species it can also increase the number of weeds (by either increasing light/water penetration to the ground layer or direct disturbance of the site).

Therefore, where the understorey is susceptible to weed invasion, targeted weed control **MUST** be planned and implemented for the period following any thinning operations (refer to the *Herbaceous Weed Control* standard for details).

Regrowth

At a minimum, all thinned trees with diameters ≥7cm **MUST** be routinely checked over a 12 month period and any regrowth treated (refer to the *Woody Weed Control* standard for details).

4.5 References

Department of Sustainability and Environment (2009). *BushTender Standards for Management - Ecological Thinning of Eucalypts, Information Sheet No. 12*. Victorian Government, Melbourne.

Greening Australia (2008). *Maintenance - Thinning*. Retrieved May 31, 2010, from Florabank: http://www.florabank.org.au/default.asp?V_DOC_ID=969

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5 Herbaceous weed control

This standard forms part of a set of state-wide standards for the delivery of vegetation management activities through Victorian Investment Framework (VIF) projects at the landholder scale.

Where herbaceous weed control is to be undertaken as part of a VIF project, this standard **MUST** be applied.

Determining whether herbaceous weed control is an appropriate activity for a particular vegetation management project is the responsibility of the project manager and will be dependent on a number of factors, including:

- The project goal
- The relevant ecological vegetation class (EVC) for the project site
- The condition and extent of remnant vegetation at the project site, which in turn determines whether the project will focus on:
    - Protection of remnant vegetation
    - Establishment of overstorey and/or understorey plants within a remnant patch i.e. supplementary planting
    - Establishment of native vegetation in formerly cleared areas outside of a remnant patch i.e. revegetation.
- Specific site conditions e.g. soil type, slope
- The type and severity of threats present.

Therefore, this standard should not be read in isolation, but rather sequenced and applied with other relevant standards as appropriate.

5.1 Scope

This standard provides technical information for a range of chemical, mechanical and manual methods to control herbaceous[5] weeds:

- In preparation for replanting
- To assist native species regeneration within remnant vegetation.

This standard does not provide advice on:

- Assessing the problem (e.g. weeds present, mode of spread, etc)
- Undertaking risk assessments (e.g. plant densities/distributions) to determine if particular control methods are required/appropriate.

[5] A herbaceous plant is a plant that has leaves and stems that die down at the end of the growing season to the soil level. They have no persistent woody stem above ground. They may be annual, biennial or perennial and include forbs (herbaceous flowering plants that are not graminoids) and graminoids (grasses, sedges and rushes).

5.2 Background

Herbaceous weeds compete with native plants for space, light, nutrients and water (Schirmer and Field 2000, TreeProject 2003, Corr 2003).

Therefore, careful weed control can be considered one of the most important factors contributing to the survival and growth rates of both planted vegetation (Schirmer and Field 2000) and natural regeneration by suppressing the growth of undesirable weeds.

5.2.1 Impacts in replanting areas

Weed control is usually the most important factor for the successful establishment of vegetation in agricultural areas (Corr 2003).

Young seedlings need time to develop a vigorous and deep root system that can tap into reliable sources of soil moisture (Greening Australia 2008c). Weeds can reduce a plants early growth rate by up to 70 per cent compared to weed free sites, and can decrease survival from an expected 90 per cent of trees planted to as little as 10 per cent (TreeProject 2003). This is supported by Casey and Chalmers (1993 cited in Schirmer and Field 2000), who reported that tree seedlings grown in a weed-free soil bed showed up to 20 times the canopy volume of seedlings grown in weed infested areas after only 12 months.

The effects with direct seeding are even more dramatic. Failure to control competing herbaceous vegetation can result in complete failure of direct sowing attempts.

5.2.2 Impacts in remnant vegetation

Within remnant vegetation, herbaceous weeds can impact on:

- Abundance - by entirely occupying a niche utilised by an indigenous plant
- Diversity - by displacing one or more plants simply by competition
- Structure - by displacement of a strata or stratum
- Function - by altering or excluding critical resources for fauna (e.g. herbaceous weeds outcompeting native wallaby grass which is an essential food source for Golden Sun Moth)
- Process - by altering nutrient composition and cycling of soils and hence altering the process of a site to advantage further exotic colonisation.

5.3 Method

The recommended approach for developing and implementing a weed control program involves:

- Describing the desired vegetation community (i.e. the vision or goal)
- Assessing the problem6
- Considering the control options/methods and determining:
    - Their effectiveness in treating the problem
    - Their practicality in treating the problem
    - Potential risks of application to both on-site and off-site values. This needs to also consider the risks around the control options.
- Developing a weed control program
- Implementing the program
- Maintaining a monitoring and review program

However, as problem assessment and control option considerations are dependent on site specific values, conditions and weed species, the scope of this standard is limited to the most common techniques to control herbaceous weeds, namely:

- Chemical control
- Mechanical/manual control.

5.3.1 Chemical control

Applicability

Advantages and disadvantages of chemical control are provided in Table 5.1.

Table 5.1 – Chemical Control: advantages and disadvantages

Advantages	Disadvantages
• Cost effective and efficient option compared with mechanical or manual methods • Can be used selectively, with precision, in difficult topography • Often the only effective method for weeds that are difficult to control e.g. perennial weeds • Limits physical disturbance to site and avoids promotion of subsequent weed establishment associated with mechanical methods	• High risk in sensitive areas such as along waterways • Risk of off-target damage to desirable native herbs (and remnant vegetation generally), unless skilfully applied • Risk of off-target damage to adjoining properties (e.g. vineyards undergoing springtime bud-burst) • Not appropriate for organic farms • requires an Agricultural Chemical Users Permit (ACUP) to use some chemicals • Precise hand spraying can be time consuming • A very high degree of expertise is required particularly when working in high quality remnants • Has associated chemical safety requirements for storage and use of chemicals

[6] This assessment should also identify the presence of indigenous herbaceous vegetation that must be protected from any control activities.

Technique

The following sections detail the key standards for the use of herbicide to control herbaceous weeds, namely:

- Determining the appropriate technique to apply the herbicide; and
- Identifying the type of herbicide applicable to the landscape feature.

Herbicide application techniques

In preparation for replanting

Site preparation weed control usually aims for selective removal of undesirable vegetation present on the site (Schirmer and Field 2000).

In highly disturbed areas, the most common herbicide application technique is strip (or boom/line) spraying. This technique uses machinery such as a tractor or quad bike to spray strips 2 to 4 metres wide[7] with a grassy strip retained between rows (Greening Australia 2008c, Corr 2003, TreeProject 2003, Perry 2004). Blanket spraying of an entire area **SHOULD** be avoided as it leaves the site open to further weed invasion and soil erosion.

An alternative technique, known as spot spraying, involves the use of knapsack sprayers to apply herbicide in spots 1-1.5m in diameter (Corr 2003, TreeProject 2003, Perry 2004). This technique **SHOULD** be employed where:

- Supplementary planting will be undertaken within existing remnants (to reduce potential off target damage to native vegetation from spray drift)
- Minimal weed infestation has occurred
- Replanting will be undertaken adjacent to a waterway
- Existing herbaceous weed cover is considered advantageous e.g. buffer protection from catchment runoff, habitat for fauna.

Figure 5.1 presents the recommended approach that **SHOULD** be followed to determine the most appropriate technique to apply herbicide in preparation for replanting.

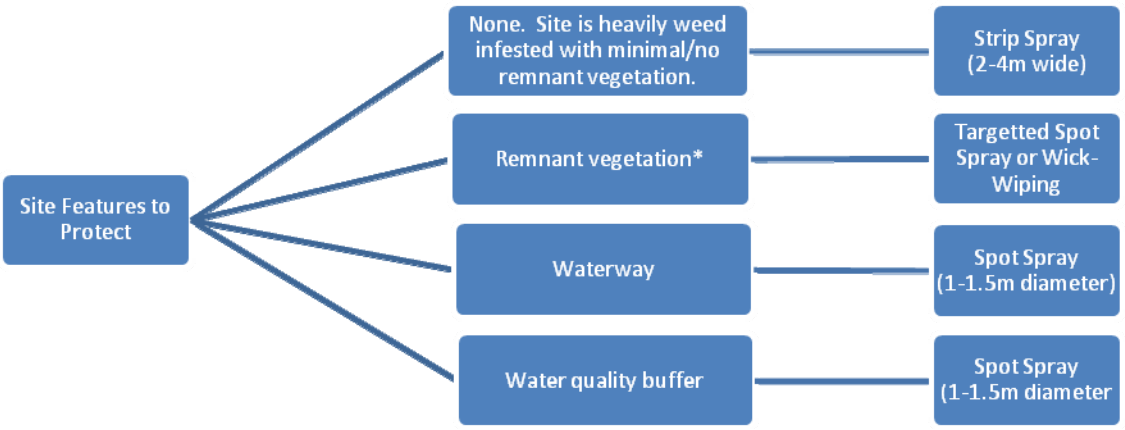

Figure 5.1 - Determining the Appropriate Technique to Apply Herbicide in Preparation for Replanting

* Spraying within remnant vegetation may require greater precision. 1-1.5m diameter spots are inappropriate.

[7] Pre-planting weed control is likely to be ineffective if application bands are too narrow (perennial weeds can regrow across a narrow band).

To assist native species regeneration within remnant vegetation

The application of chemicals to control herbaceous weeds in remnant vegetation requires an even more targeted approach than those described for replanting site preparation. In these areas, specialist plant identification and herbicide application skills are essential.

The two techniques most commonly employed for the chemical control of herbaceous weeds in remnant vegetation are:

- Spot-spraying. In many cases, this technique will be much more targeted than those described for replanting site preparation and may require the use of specialised nozzles. It may also be necessary to carry out some level of hand weeding prior to spraying where sensitive and important ground flora is present
- Wick-wiping. This is a very targeted technique that involves the use of a herbicide-coated wick to wipe herbicides onto specific weeds.

Chemicals must be very accurately applied to the foliage of herbaceous weeds with no overspray. This is particularly important where extensive areas of herbaceous weeds are controlled and regeneration is the objective.

Liquid marking dye additives **SHOULD** be used to assist in the control of overspray and to ensure that all necessary areas have been treated.

Types of herbicide

There are three main types of herbicide used to control herbaceous weeds prior to replanting:

- Contact herbicides. These herbicides kill the above ground parts of weeds, acting by contact on the green tissue of the plant. They are most useful for control of annual weeds. They will not control perennial weeds which can propagate from underground parts (e.g. Couch grass) as they only affect tissue they contact. Generally, contact herbicides are non-selective, which means that they damage or kill any type of plant (Hannah 2004)
- Systemic knockdown herbicides. These herbicides are translocated throughout the plant and can kill perennial plants and those with underground perennating organs. Generally, systemic herbicides are broad-spectrum, i.e. they are non-selective and will kill most species (if applied at sufficient concentration). They can, nevertheless be used selectively, for example:
    - By spatially targeted application (to avoid desirable plants)
    - By reduced concentration to target annual and other highly susceptible plants amongst perennial or otherwise resistant plants
    - By seasonal application to minimise impact on dormant species while targeting actively growing weeds.
- Residual (pre-emergent) herbicides. These herbicides are applied to bare, moist soil and kill the germinating weeds before they emerge from the soil (but may have little or no effect on existing weeds). Residuals remain active in the soil for between two and twelve months, depending on the type of chemical, application rate and soil type (Hannah 2004).

When used correctly, these herbicides can be very effective with limited impact to the environment. This is particularly true in non-riparian situations where correctly applied herbicides tend to remain at or close to the point of application until they break down to harmless substances (Ainsworth and Bowcher 2005).

However, application of these herbicides in riparian areas can pose a greater risk to aquatic and riparian plants and animals through spray drift, runoff or overbank flooding. This is particularly true for some residual herbicides which can be toxic to aquatic plants and animals including fish and invertebrates (Noble 2002).

Therefore the use of residual herbicides in riparian areas **MUST** be avoided[8]. Furthermore, any herbicide selected for use to control herbaceous weeds **MUST** be registered, i.e. on label, for that particular weed problem and situation

Figure 5.2 presents the recommended approach that **SHOULD** be followed to determine the appropriate herbicide type to control herbaceous weeds.

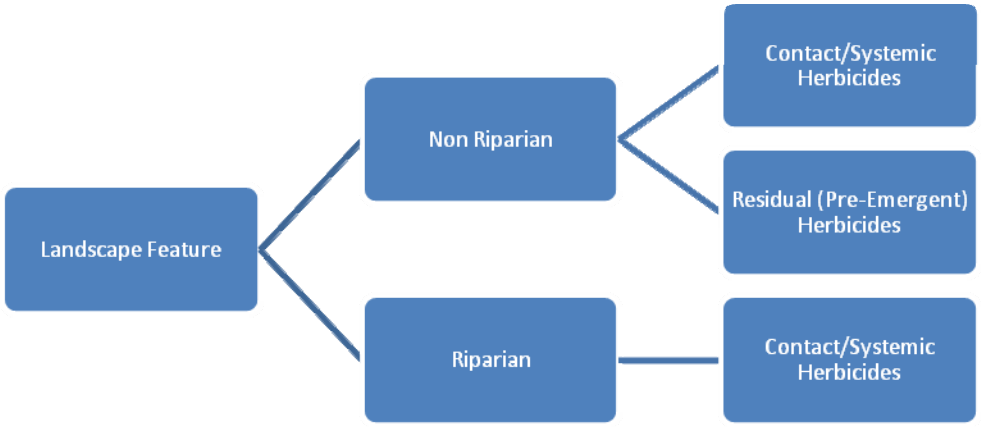

Figure 5.2 - Determining the appropriate herbicide type to control herbaceous weeds

Timing

In preparation for replanting

The experience of many practitioners around Australia shows that the best results are achieved by keeping the planting zone weed-free for two years prior to planting (Andrews 2000). Satisfactory results are achieved by controlling weeds for at least one full year before planting (Greening Australia 2008c)

To ensure that plantings have the best chance of success, site preparation **SHOULD** include both pre-season and pre-planting weed control (refer to Figure 5.3). This involves the application of a herbicide in the year before planting (when weeds/grasses are actively growing) followed by a second application one month prior to planting (Corr 2003, Perry 2004). This pre-season application is essential if highly competitive but winter-dormant perennial weeds (e.g. Couch grass, Sorrel) are present (as they cannot be controlled by the pre-planting application).

[8] The same recommendation applies to the use of surfactants and wetting agents in riparian areas (unless they are approved for use in aquatic environments).

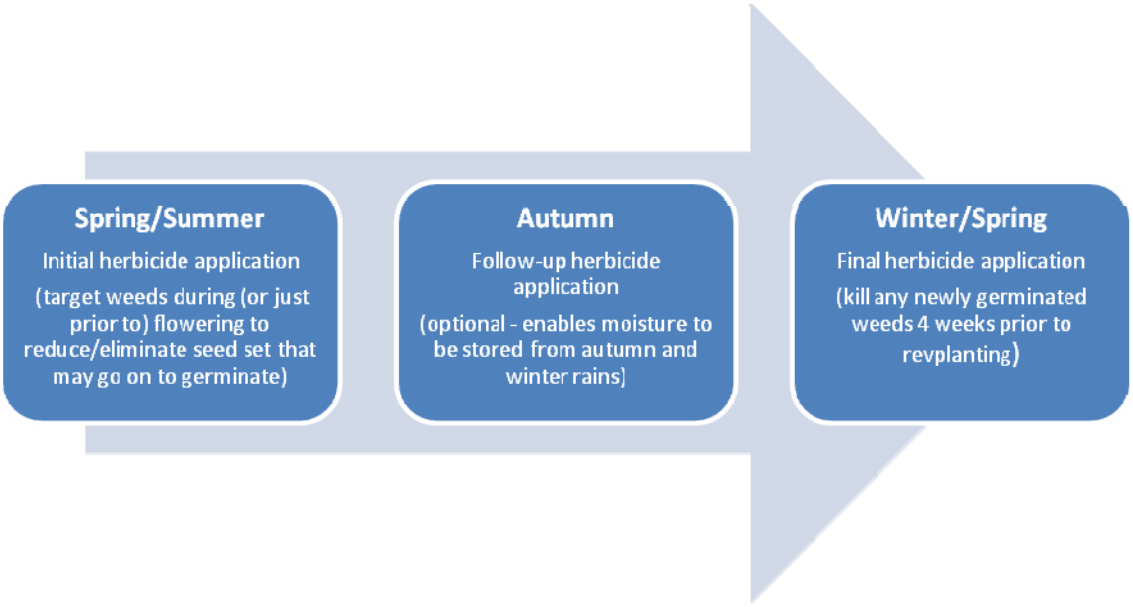

Figure 5.3 – Timeline for herbicide application prior to replanting*

* Where weeds are difficult to control, herbicide application **SHOULD** begin at least two years prior to planting.

To assist native species regeneration within remnant vegetation

The aim of weed control in remnants is to remove the competitive mass of the weed and/or exhaust the weed seed bank so that niches are available for regeneration of indigenous plants to occur. For example control of Yellow Flag Iris on waterways, prior to or at flowering in early Spring, prevents seed set and enables a niche to be exploited by Tall Sedge which releases seed in February and germinates opportunistically to occupy available niches. Likewise the control of Galenia in early spring provides a niche to be occupied by Wallaby Grasses which set seed in early summer and germinate in autumn and spring or when conditions are favourable.

Therefore, herbaceous weed control **SHOULD** be timed in a way that takes account of the mechanism for seed dispersal and establishment of both desired and undesired flora and times action to advantage the indigenous species. As is standard with any weed management intervention control **SHOULD** be carried out when plants are actively growing.

To manipulate the site to advantage remnant vegetation and exclude/suppress exotic vegetation, project managers **SHOULD** utilise contractors with proven skills in plant identification (indigenous and exotic) and ecological restoration.

Licences/permits

Before using any herbicide, users **MUST**:

- Ensure that it is registered for the particular weed problem and situation9
- Read the product label and follow all label instructions carefully.

Legal use of some chemicals requires the user to possess an Agricultural Chemical User Permit (ACUP). In Victoria, an ACUP is required to use agricultural chemical products that are 'restricted use' chemicals. These are chemicals that have a potentially higher risk of adversely affecting the user's health, the environment and trade and include ester formulations of MCPA, 2,4-D, 2,4-DB or triclopyr, which are particularly relevant for woody weed control. A full list of restricted use chemicals can be found on the DPI website here[10].

Other restrictions on chemical use apply within Chemical Control Areas (CCAs). Nine CCAs have been established in Victoria to protect high value herbicide sensitive crops. These areas can be found on the DPI website here[11].

Maintenance

Good pre-planting weed control minimises the need for post planting spraying (TreeProject 2003, Perry 2004). However, weeds often grow back after planting (TreeProject 2003).

An appropriate allocation of resources for weed maintenance **MUST** be included as an essential component in all replanting projects. If replanting sites cannot be maintained in an appropriate condition they **SHOULD NOT** be established.

The long term success of a planting project will depend on the level of maintenance. Herbaceous weed control in remnant vegetation will require ongoing maintenance depending on the invasiveness of the target herbaceous weed and the value/sensitivity of the remnant flora being protected.

Technique

Options for weed management post planting include:

- Manual weed removal (see Hand removal or chipping section)
- Chemical control by overspray with a selective herbicide e.g. where grasses are dominant, plantings may be over-sprayed with a selective herbicide which does not damage broadleaved plants (TreeProject 2003)
- Chemical control by spot spraying or wick-wiping.

Timing

Replanting sites

Weeds **SHOULD** be controlled when they are actively growing, before they set seed and before they begin to compete with newly installed plants (Greening Australia 2008a). Reducing surrounding competition is most important when seedlings are in their first year of growth (Heytesbury District Landcare Network 2009).

[9] Using herbicides other than as strictly described on the label will often require a permit; consult DPI for details.

[10] http://new.dpi.vic.gov.au/agriculture/farming-management/chemical-use/restricted-use

[11] http://new.dpi.vic.gov.au/agriculture/farming-management/chemical-use/agricultural-chemical-use/control-areas

To maximise survival and growth of newly installed plants, the area within one metre of plantings **MUST** be kept weed-free for a minimum of two summers following plant installation (TreeProject 2003, Perry 2004, Greening Australia 2008a).

Natural regeneration

Herbaceous weed control to assist natural regeneration within remnant vegetation may require several years of follow-up treatment (dependent on species, degree of infestation and site conditions). Once again the objective is to remove the competitive mass of the weed, and/or exhaust the seed bank so that niches are available for regeneration of indigenous plants to occur.

5.3.2 Mechanical/manual control

In many cases it is more environmentally sensitive to consider non-chemical weed control (TreeProject 2003). This is particularly the case when using herbicides near waterways.

In these circumstances, it is important to consider other techniques that can be alternatives to, or complementary with, the use of herbicides (Ainsworth and Bowcher 2005).

The suitability of the most common mechanical/manual approaches used to control herbaceous weeds are summarised in Table 5.2 and detailed in the following sections.

Table 5.2 - Mechanical/manual approaches to control herbaceous weeds

Control option	Suitability for application	
	Assisted native species regeneration	In preparation for replanting
Cultivation	×	✓
Scalping	×	✓
Mulching	×	✓
Weed matting	×	✓
Fire	✓	✓
Grazing, slashing or mowing	✓	✓
Hand removal or chipping	✓	✓

✓ - suitable × - unsuitable

Cultivation

Applicability

Cultivation is carried out to remove competing weeds, thereby improving moisture and nutrient availability to planted seedlings; (Stackpole 1998).

However, it can also allow other weeds to invade or aid the spread of weed seed through the soil (Perry 2004). Table 5.3 **SHOULD** be used to assess the suitability of cultivation for herbaceous weed control under a range of landscape conditions.

Table 5.3 – Suitability of cultivation for herbaceous weed control

Condition	Suitability	Comments
Light, well drained and friable soils	✓	increases water infiltration and stimulates germination of weed seed by exposing it to light and water (Perry 2004) caution is required in areas prone to wind erosion
Heavy soils	×	may destroy soil structure (Perry 2004)
Soils of high and very high erosion classes	×	on slopes above 10% and 15% respectively (Stackpole 1998)
Areas of high erosion potential e.g. proximity to waterway	×	
Areas of very high rainfall	×	for some moderate and moderate-high erosion class soils above 15% slope (Stackpole 1998)
Cultural heritage sites	×	
Sites with intact native cover	×	

✓ - suitable × - unsuitable

Cultivation **MUST NOT** be used for herbaceous weed control to assist natural regeneration within remnant vegetation.

Timing

Where applicable, cultivation **SHOULD** be undertaken in the season before planting. This will increase the effectiveness of any pre-planting herbicide that may be used (Perry 2004, TreeProject 2003).

Scalping

Applicability

Scalping involves the removal of the top few centimetres of soil containing the weed seeds (Corr 2003, Perry 2004). This can be undertaken by machine (e.g. grader) or by hand (e.g. shovel).

Scalping gives effective long-term weed control by removing the nutrient rich topsoil (Perry 2004) and a large proportion of weed propagules and can provide conditions suitable for restoration of indigenous ground flora.

Scalping **MUST** be undertaken if the site has been sprayed using residual or pre-emergent herbicide (Corr 2003).

Scalping **SHOULD NOT** be used for herbaceous weed control to assist natural regeneration within remnant vegetation.

Scalping by machine **MUST NOT** be used on hilly terrain or highly cultivated erodible soils.

Technique

Scalping should remove the top few centimetres of soil containing the weed seeds through the use of a machine (e.g. grader) or by hand (e.g. shovel).

Timing

Scalping **SHOULD** be undertaken just prior to planting.

Application of mulch

Applicability

Mulches **SHOULD** only be used for very small-scale projects (Corr 2003).

Mulches **SHOULD NOT** be used to assist natural regeneration within remnant vegetation.

Mulches are likely to be ineffective if not used in combination with other techniques, in particular herbicide treatment.

Technique

Materials

Many materials can be used as mulch including straw or hay, bulk organic material such as wood chips, sawdust or cotton waste, newspaper, rice hulls, gravel, carpet, grass or leaf mould (Corr 2003, Greening Australia 2008b, TreeProject 2003, Perry 2004). Some materials (e.g. hay and straw) may include seeds of weed species not already on site (or even in the district) – refer to the *Minimising the Spread of Weeds and Plant Pathogens* standard for details.

Other materials include commercial jute mats and woven jute matting (refer to weed matting section).

Once a material has been selected, the main considerations when placing mulches are:

- Thickness
- Proximity to plant stems.

Thickness

Whilst a thick layer of mulch placed around young plants helps to conserve soil moisture, improve soil structure, modify soil temperatures and suppress weed growth (Greening Australia 2008b, TreeProject 2003, Perry 2004, Corr 2003) care should be taken to ensure that mulch layers are not too thick.

For example, the most commonly used mulches (wood chips and barks) **SHOULD** be layered to a thickness no greater than 100mm. Thicker mulch layers can:

- Be expensive
- Limit opportunities for natural regeneration from seed fall from revegetated plants (Corr 2003)
- Retain too much moisture in the root zone leading to root rot
- Inhibit water penetration from rainfall, leading to drought stress
- Increase susceptibility to frost by preventing radiant heat being released overnight.

As a general rule, the thickness of the mulch layer depends on the material being used (with finer materials resulting in thinner mulch layers).

Proximity

Mulching materials **MUST** be kept clear of the seedling stem as contact can cause collar rot (Greening Australia 2008b, Corr 2003, TreeProject 2003, Perry 2004).

Timing

Mulches **SHOULD** generally be applied either just prior to planting or at the time of planting.

In very cold areas, mulches **SHOULD NOT** be placed during winter as they can prevent the soil from warming and lead to frozen soil around the roots (Greening Australia 2008b).

Weed matting

Applicability

Advantages and disadvantages of weed matting are provided in Table 5.4.

Table 5.4 – Weed matting: advantages and disadvantages

Advantages	Disadvantages
• Improve soil moisture content by acting as a mulch • Effective way of suppressing weed growth, particularly in areas where herbicides are undesired or inappropriate	• Inhibits ability of plants to uptake moisture • Expensive when revegetating a large area • Decomposes quickly especially in riparian areas

Table adapted from (TreeProject 2003).

In low rainfall areas, weed matting can inhibit a plant's ability to uptake moisture. As such, the use of weed matting **SHOULD** generally be limited to areas with medium to high rainfall (annual rainfall >500mm) where weed competition is the greater issue not moisture availability.

In addition, weed matting **SHOULD NOT** be used to assist natural regeneration within remnant vegetation.

Technique

Weed matting can be purchased as either:

- Long rolls of weed mat (with pre-cut slits) for lines of plantings
- Small squares of weed mat for individual seedlings (TreeProject 2003).

After unrolling, weed matting rolls are secured in place with metal pins at a rate of 4-5/m^2 (but allow for extra pins in flood prone areas).

Weed mat squares have three slits for stakes (so that they can be used in conjunction with plastic tree guards and stakes) and a central slit for the seedling. Where no tree guard is used, the weed mat is secured with four pins.

Timing

Installation of weed matting rolls **SHOULD** be undertaken after at least one initial spray run and prior to planting (with the plants subsequently installed into the pre cut holes). Weed mat squares **SHOULD** be placed after plants have been placed in the ground. This will prevent soil clods being left on top of the matting and reduce maintenance costs.

Mulch can also be placed over weed mat or jute rolls to increase the sites resistance to weed invasion and retain moisture.

Fire

Applicability

The use of fire to control herbaceous weeds is generally employed where there is an objective to reduce chemical use and is more effective on broadleaf weeds than grasses, which are more resistant to heat methods (CRC for Australian Weed Management 2003).

Techniques

Spot burning with a flame burner is the preferred technique for fire treatment of herbaceous weeds.

Flame burners are devices that employ propane gas or kerosene as fuel to provide a constant flame and use a hand wand to allow the flame to be applied onto the target weeds. The method does not require that the plant is burnt; in fact for many species this may actually stimulate regrowth. Rather, the method works best when plant leaves are severely wilted as a result of exposure to the intense heat and subsequently die (CRC for Australian Weed Management 2003).

Spot burning **SHOULD** target a particular plant or small area rather than a general burn of an area.

Timing

Spot burning **SHOULD** be undertaken in spring to reduce weed seed-set.

Grazing, slashing or mowing

Applicability

Replanting sites

Grazing, slashing or mowing of a replanting site can be used to reduce weed biomass prior to chemical control (Perry 2004).

Natural regeneration

Within remnant vegetation, ecological grazing is an available technique but **SHOULD** only be used within specific vegetation communities (refer to the *Ecological Grazing* standard for details).

Technique

Grazing

Grazing **SHOULD** be managed to maximise the vegetation condition, rather than for animal condition. This optimal grazing **SHOULD** be applied based on a combination of the indigenous plant diversity, vegetation structure, and the plant biomass (Water Technology 2009).

Refer to the *Ecological Grazing* standard for specific details.

Slashing/mowing

The basic technique is to slash/mow the weeds as low as possible. General equipment for slashing/mowing include:

- Tractor slashers (for large areas)
- Mowers, brush-cutters or whipper-snippers (for medium to small areas).

Timing

Grazing for natural regeneration

The key to the control of weeds within grassy ecosystems is to time grazing with the critical stages in the weed life cycle (CRC for Australian Weed Management, 2004). This is usually after weed flowering but prior to seed set i.e. over spring and summer. However, this timing coincides with the critical life stages of native plants which tend to flower and set seed during late spring and early summer.

Therefore, in combination with appropriate fencing to protect adjacent native vegetation, grazing for herbaceous weed control **SHOULD** only occur in autumn and late winter/early spring. Irrespective of the time of year, livestock **MUST NOT** be used to control herbaceous weeds when:

- Soil moisture levels are high. Grazing at such times will lead to pugging and compaction (Staton and O'Sullivan 2006, Water Technology 2009).
- Soil is very dry e.g. during a drought. At such times, the ground layer may be too sparse, leading to over-grazing and soil erosion (Staton and O'Sullivan 2006, Water Technology 2009).

Grazing in replanting sites

Grazing **SHOULD** be avoided where replanting has occurred, until plants are beyond browsing height. This will normally be after three years from planting (TreeProject 2003, Perry 2004).

Slashing/mowing

Slashing/mowing will not eradicate weeds but can prevent or greatly reduce weed seed production if timed appropriately i.e. after weed flowering but prior to seed set.

Hand removal or chipping

Applicability

Pulling out weeds by hand or digging them out with a hoe (chipping), along or beside a seeding or planting line is a simple and effective method for small scale projects (Corr 2003). However, it does not prevent growth of new weed seedlings (Horlock 1998 in Corr 2003).

Technique

When removing weeds by hand, care **SHOULD** be taken to:

- Create minimal disturbance
- Avoid disturbing the roots of any remnant, sown or planted seedlings
- Remove all plant parts capable of re-growth (Corr 2003).

Timing

This technique **SHOULD** be undertaken prior to weeds flowering and producing seed (generally late winter/early spring) (Horlock 1998 in Corr 2003).

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6 Minimising the spread of weeds and plant pathogens

This standard forms part of a set of state-wide standards for the delivery of vegetation management activities through Victorian Investment Framework (VIF) projects at the landholder scale. This standard **MUST** be applied to all VIF projects.

6.1 Scope

This standard presents methods to minimise the spread of weeds and plant pathogens (hereafter referred to as 'invasive species') into, within, and from a project site.

The standard covers both:

- Planning ahead
- Risk mitigation measures
- General hygiene protocols for vehicles, plant and equipment.

6.2 Background

Invasive species can be spread by human activities with any isolated outbreaks being the result of movement via contaminated:

- Machinery and equipment
- Clothing and footwear
- Materials (such as topsoil, fill, gravel, potting mix, plant stock, mulch, water etc) Department of Primary Industries 2009, Environmental Protection Agency 2009, South West Pest Plant and Animal Program 2001).

Individuals and organisations have a duty of care (and in some cases a legal responsibility under the *Catchment and Land Protection Act 1994* (CaLP Act)) to minimise the spread of invasive species, particularly those that may cause significant economic or environmental damage[12] (South West Pest Plant and Animal Program 2001).

6.3 Method

6.3.1 Planning ahead

Pre-Work risk assessments

Machinery, equipment and vehicle users **MUST** aim to limit the introduction or spread of invasive species within a project site (Tyers et al 2004).

This is best achieved by undertaking a detailed risk assessment that involves assessment of both:

- The likelihood of introducing and/or spreading invasive species to, within or from a site
- The consequences of such actions.

[12] Transporting or depositing onto land declared noxious weeds that are capable of growing is illegal under the CaLP Act (unless a permit from the DSE Secretary is obtained). This applies even to the seeds or plant fragments of a noxious weed that may be on a vehicle (Department of Primary Industries 2009).

Pre-work risk assessments **MUST** be conducted prior to the commencement of any works on a project site (Department of Primary Industries 2009).

Assessing the likelihood

Before commencing any works on a project site, the project manager **MUST** assess the likelihood of either:

- Introducing invasive species to a site
- Spreading them from an already infested site via:
    - Unclean vectors (i.e. vehicles, plant and equipment and personal attire)
    - Contaminated materials (i.e. topsoil, fill, sand, gravel, mulch, water or tube stock).

Assessing the likelihood of introducing or spreading invasive species may include:

- Pre-work surveys, reference to plans/databases and/or discussions with staff/other agencies/local experts to identify opportunities for vectors to contact/transmit invasive species during works, taking into account the:
    - Degree of infestation and the biology of the invasive species (e.g. time of seed set, pathogenicity of diseases)
    - Types of activity and vectors used
    - Weather and site conditions
- Visual examination of vectors to be used on the project
- Checks of materials to be used or moved as part of the project.

Assessing the consequences

Where the likelihood of introduction or spread is identified, the consequences **MUST** be quantified with respect to:

- Breaching provisions of the CaLP Act 1994, section 70A
- The potential impact of spreading invasive species further in an area or introducing invasive species, taking into account issues such as the:
    - Management objectives of the project
    - Susceptibility of the project site to plant diseases
    - Scale of the activity relative to other activities in the area that may spread or introduce invasive species.

Assessing the consequences of introducing or spreading invasive species may include reference to plans/databases and/or discussions with staff/other agencies/local experts.

Planning based on the level of risk

Based on the likelihood and consequences of a particular activity, a plan may be required to minimise the risk of introducing or spreading invasive species from known or potentially infested sites. The detail of the plan **MUST** be commensurate with the risk.

A key requirement of plans is that all CMA/MW vehicles, plant and equipment used on a project site **are** clean and free of reproductive material prior to leaving a contaminated project site or entering a clean site. See Appendix A for details on methods such as:

- Inspecting machinery and equipment before departure from a project site
- Establishing clean-down areas (where justified)
- Applying appropriate clean-down options
- Maintaining clean-down areas
- Disposing of waste and contaminants.

The plans should aim to minimise the time and effort spent cleaning machinery, vehicles and equipment. This may be achieved by using the risk mitigation measures described in Section 6.3.2.

6.3.2 Risk mitigation measures

Minimising spread from known or potentially infested sites

Where the spread of invasive species within a project site has been identified as a potential risk, project managers **MUST** develop and implement appropriate measures to minimise or remove the risk. Possible measures include:

1. Timing and coordinating work to limit contamination and spread by avoiding:
    a. Times when weed seeds and diseases may be picked up.
    b. Wet weather and muddy sites when there is a greater likelihood of contamination. Driving/walking on poorly maintained roads, tracks, paddocks or bushland in wet weather or heavy dew increases the likelihood of adhesion of reproductive material onto vehicles, plant and/or equipment (Environmental Protection Agency 2009).
2. Considering chemical treatment or manual removal of weeds before starting work. When undertaking management or control of any invasive species, CMA/MW staff and/or contractors could do control operations beginning at the outlying limits of an infested area. In addition, where long-term vehicle or pedestrian movements within a project site may result in the spread of reproductive material, the potential sources along any access routes could be treated prior to the start of any work (Environmental Protection Agency 2009).
3. Establishing and monitoring entry and exit points, for contamination on vehicles and machinery.
4. Avoiding movement through higher risk areas by:
    a. Limiting off track movement where feasible
    b. Choosing routes less likely to lead to contamination
    c. Quarantining highly infested sites from unnecessary access to people and machinery (areas may be fenced off)
    d. Leaving vehicles on site for duration of activities to minimise clean down effort
    e. Leaving work in these areas until last (other than direct invasive species management).
5. 5. Using machinery, equipment etc that is:
    a. Clean and free of reproductive material upon entry to minimise cleaning effort upon exit
    b. Least likely to cause soil disturbance (e.g. using rubber tracked machines such as slashers/mulchers rather than bulldozers for vegetation clearance)
    c. More readily cleaned and least likely to become contaminated. Consider using modified machinery to reduce contamination (e.g. use slasher covers, or removable screens over grills to prevent seeds lodging in internal parts such as the radiator).
6. Ensuring all vectors are ‘clean upon exit’ (this includes waste and contaminants disposal) - refer to Appendix A and the Guide for Machinery Hygiene for Civil Construction (Civil Contractors Federation 2011). Prior to leaving a site known to be infested with invasive species, CMA/MW staff could clean themselves of any reproductive material on, or in, clothing and footwear to prevent the spread of reproductive material beyond the infested area. The washing and disinfecting of footwear **SHOULD** be standard practice prior to entry and exit of every property (South West Pest Plant and Animal Program 2001).

7. Ensuring time and resources are scheduled for:
    a. On-site clean-down including waste and contaminant management
    b. On-going inspection and management if necessary of materials if stockpiled and not transported away.
8. Ensuring contaminated material is not taken:
    a. From the infested area to be used in other clean areas
    b. Without a permit from DPI to allow transport of soil, sand, gravel or stone containing declared noxious weeds

Where a risk is unavoidable, it may be appropriate to decide to not start or continue with the planned project or activity that gives rise to the risk (where this is practicable)[13].

Safeguarding clean sites

To safeguard clean sites, project managers **MUST** develop and implement appropriate measures to avoid the introduction of invasive species. Possible measures include:

1. Scheduling activities before working in infested areas. Where feasible, work (other than direct invasive species control) **SHOULD** be undertaken first in areas not subject to invasive species, and then in any infested areas (Environmental Protection Agency 2009, Tyers et al 2004). If not feasible, then vehicles, plant, equipment and footwear **MUST** be cleaned prior to entering an uninfested area (Environmental Protection Agency 2009)
2. 2 Ensuring vectors are 'clean-on-entry'. All vehicles, trucks, earthmoving equipment and other machinery, as well as clothing, boots and tools **MUST** be clean and free of foreign matter on arrival at a project site (South West Pest Plant and Animal Program 2001). In particular:
    a. For CMA/MW staff, the project manager **MUST** take all reasonable steps to ensure that:
        i. CMA/MW vehicles, plant and/or equipment are clean and free of reproductive material prior to entering a project site
        ii. Clothing and footwear of CMA/MW staff are clean and free of reproductive material prior to entering a project site
        iii. CMA/MW watercraft (including trailers and other relevant equipment) are clean (particularly of plant material) prior to entering a waterway.
    b. All contractors engaged to work on a CMA/MW project site **MUST** supply all plant and equipment in a clean state, free of foreign reproductive material. The project manager **MUST** take all reasonable steps to ensure that contractors:
        i. Understand all machinery hygiene requirements
        ii. Apply machinery hygiene protocols as a standard practice
        iii. Undertake physical inspections of their equipment before entering a project site to confirm that, as far as practicable, it is clean and free of reproductive material (Tyers et al 2004).
3. Quarantining higher risk sites from unnecessary access – where practical

[13] However Standards Australia/Standards New Zealand (2004) notes that risk avoidance can occur inappropriately if individuals or organizations are unnecessarily risk-averse. This avoidance may increase the significance of other risks on the project site.

4. Ensuring material intended for use in an area is 'clean'. All imported materials such as soil, mulch or rock have the potential to spread invasive species to a project site (Environmental Protection Agency 2009). Therefore, all material imported to a project site **MUST** be:
    a. Clean and free of reproductive material and **SHOULD** come from sources known or likely to be clean (i.e. sources tested free of invasive species or suppliers whose operations are accredited for hygiene protocols)
    b. Stored or stockpiled in locations that are clean and inspected regularly for outbreaks of invasive species (Environmental Protection Agency 2009).
5. Adopting hygiene standards for livestock. Livestock **MUST** be grazed on weed-free fodder or pasture for between one and seven days (depending on the type of livestock and seed ingested) prior to their introduction to the project site for ecological grazing (Water Technology 2009). In addition, if sheep are to be used for ecological grazing they **SHOULD** NOT enter a project site until after shearing. This will further assist in preventing additional weed seeds being brought into the project site as sheep carry the seed of many kinds of weeds in their coats (Staton and O'Sullivan 2006)
6. Preventing the spread of certain horticultural pests and diseases. There are restrictions on the movement of certain plants, plant products and agricultural machinery within Victoria. Four types of zones are established in Victoria concerned with:
    a. Queensland fruit fly (movement of fruit)
    b. Phylloxera (grapes, grapevine material, agricultural equipment and soil)
    c. Potato cyst nematode (potatoes, potato plant material, agricultural equipment and soil)
    d. Toolangi Plant Protection District (nursery plants, cut flowers, leafy vegetables, strawberry plants, rubus plants and potato tubers).

    Project managers **MUST** adhere to all prohibitions, restrictions and requirements[14] when working within these zones.

6.4 References

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[14] Refer to http://www.dpi.vic.gov.au/agriculture/horticulture/moving-plants-products/moving-plants-within-victoria.

6.5 Appendix A - General hygiene protocols for vehicles, plant and equipment

6.5.1 Inspecting machinery and equipment

The process of inspecting machinery and equipment will vary according to its type, the working environment and the level of contamination (Department of Primary Industries 2009).

6.5.2 Establishing clean-down areas

A clean-down area is justified where:

- The consequences of invasive species being spread are high
- vehicles are considered the most likely vectors/carriers of invasive species
- There are no existing wash-down facilities nearby and no alternatives exist (Environmental Protection Agency 2009).

A clean-down area is not justified where:

- The consequences of invasive species spread are minimal
- Vehicles are not considered the most likely vectors/carriers of invasive species
- There are existing wash-down facilities nearby (Environmental Protection Agency 2009).

Where a clean-down area is required, the following minimum standards **MUST** be applied:

- The clean-down site **MUST** be located well away from watercourses and drainage lines to reduce the potential for reproductive material spread and/or watercourse pollution (e.g. from grease, detergents) (Department of Primary Industries 2009, Environmental Protection Agency 2009)
- The clean-down site **MUST** be easily identified (e.g. with a painted post and GPS location) for future reference as this location will need monitoring for future outbreaks in the following seasons (Environmental Protection Agency 2009).

In addition to the above, clean-down areas **SHOULD** be:

- Relatively flat (to help prevent run off and for safety reasons)
- In a well-grassed area to:
    - Reduce mud during cleaning down (Environmental Protection Agency 2009)
    - Provide competition for any weed seed that later germinates (Environmental Protection Agency 2009)
    - Enable efficient weed control (Tyers et al 2004).
- Close to exit/entry points (Department of Primary Industries 2009)
- Close to the infested area (to prevent further spread) (Environmental Protection Agency 2009).

6.5.3 Applying clean-down options

The most effective clean-down options are:

- Removal by hand
- Wash-down
- Air blast
- Vacuuming (Tyers et al 2004, Department of Primary Industries 2009).

The most appropriate clean-down option to apply **SHOULD** be determined by the project manager according to the level of contamination.

Physical removal

It is essential to remove the soil and debris from tools, equipment and machinery before decontamination can be carried out (South West Pest Plant and Animal Program 2001).

Physical removal may be labour intensive, but it will ensure that contaminants are removed and disposed of correctly. Brooms, brushes, shovels and scraping tools can help with clean down procedures (Tyers et al 2004).

Wash-down

Wash-down can be achieved by applying water to the machinery at high pressure using a pressure cleaner or spray tank and pump. The critical areas on equipment **MUST** be rigorously targeted and thoroughly washed clean. The use of approved cleaning detergents **SHOULD** be considered when using water. These may aid in the removal of built up grease, dirt and mud that can contain weed seeds (Tyers et al 2004).

Pressure hosing with water will be sufficient to remove debris from most tools, equipment and machinery (South West Pest Plant and Animal Program 2001).

Air blast

Air blast assists decontamination of machinery, especially for those hard-to-reach areas such as cavities and joints. A compressor with hose and suitable nozzles is required (Tyers et al 2004).

Vacuuming

Vacuuming can help remove contaminants from the interior surfaces of machinery e.g. driver's cab carpet (Tyers et al 2004).

Maintaining clean-down areas

Clean-down areas (where justified) **MUST** be monitored for invasive species outbreaks (Environmental Protection Agency 2009) and appropriate action taken to control spread.

Disposing of waste and contaminants

Contaminants resulting from clean-down procedures **MUST** be disposed of in an appropriate manner (Tyers et al 2004). Where possible, contaminants and waste **SHOULD** be destroyed within the clean-down area (Department of Primary Industries 2009) e.g. controlling weed seed germination in the clean-down areas through herbicide application.

7 Plant establishment

This standard forms part of a set of state-wide standards for the delivery of vegetation management activities through Victorian Investment Framework (VIF) projects at the landholder scale.

Where plant establishment is to be undertaken as part of a VIF project, this standard **MUST** be applied.

Determining whether plant establishment is an appropriate activity for a particular vegetation management project is the responsibility of the project manager and will be dependent on a number of factors, including:

- The project goal
- The condition and extent of remnant vegetation at the project site, which in turn determines whether the project will focus on:
    - Protection of remnant vegetation
    - Establishment of overstorey and/or understorey plants within a remnant patch i.e. supplementary planting
    - Establishment of native vegetation in formerly cleared areas outside of a remnant patch i.e. replanting.
- Specific site conditions e.g. soil type, slope
- The type and severity of threats present.

Therefore, this standard should not be read in isolation, but rather sequenced and applied with other relevant standards as appropriate.

7.1 Scope

This standard covers typical methods to establish plants as part of a revegetation project, namely:

- Direct seeding
- Seedling planting
- Long-stem planting
- Introducing seed banks to wetlands.

It does not cover the establishment of plants by encouraging natural regeneration, although this method **SHOULD** always be considered the first option for a revegetation project.

7.2 Background

Native vegetation is a vital component in the sustainability of the landscape and a key factor in the functioning of natural ecosystems. In particular, native vegetation:

- Binds, protects and nourishes soils
- Filters, purifies and protects waterways and wetlands
- Provides connectivity and corridors across the landscape for native species
- Lowers groundwater tables, helping to combat the effects of salinity
- Provides shelter for stock and improves farm productivity
- Creates essential habitats for birds, frogs and other animals
- Provides aesthetic and landscape significance (Peters 2010).

7.3 Method

The following sections describe appropriate techniques and timing to re-establish native vegetation species using:

- Direct seeding methods;
- Seedling planting methods;
- Long-stem planting methods; and
- Seed bank introduction methods.

7.3.1 Direct seeding

This method involves the sowing of seeds (either dry or pre-germinated[15]) directly onto a site to achieve germination and establishment (Corr 2003). There are several techniques available for direct seeding:

- Hand Sowing. This technique involves seed, usually mixed with a bulking agent, being placed onto a prepared seed bed
- Mechanical Direct Seeding. This technique involves the use of specialised direct seeding equipment, which is calibrated for different seed sizes and planting depths (Greening Australia 2008a)
- Brush Mulching. This is another technique of hand-seeding which uses cut stems of a plant with ripe fruit present, laid across a prepared site. This technique is often suitable in areas with few weeds or for coastal sites
- Hydromulching. This technique uses a slurry of mulch, water, fertiliser and seed sprayed across bare ground and can be quite useful for erosion control.

The two main methods (hand sowing and mechanical direct seeding) are discussed in detail in the following sections.

Applicability

Direct seeding is a cost-effective and highly efficient technique, particularly for broad-scale projects (Corr 2003).

[15] Pre-germination (seed conditioning or trimming) can significantly improve the success rate of direct seeding by bringing about a number of early germination stages. Species that give good results include: Acacia spp.; *Eucalyptus* spp.; *Melaleuca* spp.; *Callistemon* spp.; *Allocasuarina* spp and *Dodonea viscosa* (Department of Infrastructure, Planning and Natural Resources 2004).

Table 7.1 – Direct Seeding: advantages and disadvantages

Advantages	Disadvantages
• Natural look and more diversely structured • Establishes healthier plants • Enables early establishment of root systems • Increased growth rates of established plants post sowing e.g. within 2 years of germination most successful direct seeding plantations are larger, more diverse and better established than tubestock planted at the same time. • Less labour intensive than replanting and therefore often easier and cheaper to plan and implement • Existing farm equipment can be used together with direct seeding machines (which are often available for hire from local organisations e.g. landcare) • Plants 'self select' suitable establishment sites within the revegetation area, particularly if a diverse seed species mixture is sown • Higher plant densities after germination provides better shelter to new seedlings and reduces weed competition (this also allows natural selection of the stronger plants without creating gaps to be replanted) • Less maintenance is required after direct seeded plants are established as a complete canopy cover is established much quicker (due to the huge increase in stems/hectare)	• Long establishment times (can be patchy and can take several years) may lead to more maintenance such as weed control • Ants have been known to take seed • Growth rates and bough development can be delayed if plant densities are too high. This may require thinning at a later date • Not all species germinate from seed successfully • For mechanical direct seeding requires experienced operator to ensure seed is not too deep or too shallow

Table adapted from Greening Australia (2008a).

Project site factors

In addition to the above, to determine whether direct seeding is a suitable technique for plant establishment, a number of project site factors **SHOULD** also be considered, in particular:

- Soil type
- Landscape setting
- Project scale.

Table 7.2 - Suitability of direct seeding based on soil type (using hand and mechanical techniques)

Soil Type	Hand	Mechanical
Sands	✓	✓
Non-Wetting sands	✓	✓
Light soils	✓	✓
Heavy clays	✓	✓
Sticky clays	✓	✓
Cracking clays	✓	×
Heavy wet soils	✓	✓
Saline soils	✓	✓

✓ - suitable × - unsuitable

Table adapted from Corr (2003).

Table 7.3 - Suitability of direct seeding based on landscape setting (using hand and mechanical techniques)

Landscape setting	Hand	Mechanical
Flats	✓	✓
Light granitic hills	✓	✓
Rocky or stony country	✓	✓*
Waterlogged	✓	✓**
Rocky hill tops (difficult access)	✓	×
Steep hills	✓	✓***
Intact remnants and ground flora	✓	×
Riparian	✓	×
Isolated dead trees	✓	✓

✓ - suitable × - unsuitable

* Burford/Hamilton Tree Seeder

** M-Profile mounding

*** Burford Tree Seeder, Rippa Seeder, Dozer Terracing

Table adapted from Corr (2003).

Table 7.4 - Suitability of direct seeding based on project scale (using hand and mechanical techniques)

Project Scale	Hand	Mechanical
Broadscale	×	✓
Medium (e.g. belts)	✓	✓
Small (e.g. spots)	✓	×

✓ - suitable × - unsuitable

Table adapted from Corr (2003).

Technique

Specific techniques for direct seeding are set out in Greening Australia's handbook Revegetation Techniques. A Guide for Establishing Native Vegetation in Victoria[16] (refer to pages 69-94).

These techniques, together with local knowledge and expertise (e.g. DPI staff, landcare networks), **SHOULD** be used to guide direct seeding projects.

Timing

Direct seeding relies on effective weed control to allow development of a moisture bank in the soil during winter when evaporation is low. Following germination and initial growth, further plant growth can draw on the soil stored moisture even if rainfall is inadequate. This is usually sufficient for establishment if there have been adequate winter rains.

However, the establishment and growth of plants is enhanced by good follow up rains. This is especially the case in light soil and dry years when the moisture bank may be insufficient for plant establishment.

Therefore direct seeding **SHOULD** be timed to coincide with predictable, follow-up rainfall (Corr 2003).

Table 7.5 provides recommended seasons for undertaking direct seeding based on annual rainfall and **SHOULD** be used to assist in planning a direct seeding project.

Table 7.5 – Recommended seasons for direct seeding

Climatic region	Annual rainfall (mm)	Recommended season for direct seeding*		
		Autumn	Winter	Spring
Semi arid areas	250-500	✓	✓	×
Medium to high rainfall areas	>500	×	×	✓
Frost prone areas	N/A	×	×	✓

✓ - recommended × - not recommended

* Based on the long term average annual rainfall. Actual timing should be based on the local environmental conditions.

Table adapted from Corr (2003).

[16] http://live.greeningaustralia.org.au/nativevegetation/pages/pdf/Authors%20C/13_Corr.pdf

7.3.2 Seedling planting

This method involves the planting of seedlings[17] by hand or with a mechanical seedling planter.

Applicability

Advantages and disadvantages of seedling planting compared with direct seeding are provided in Table 7.6.

Table 7.6 – Seedling planting: advantages and disadvantages

Advantages	Disadvantages
• More reliable and immediate results • Placement of individual plants is controlled • Revegetation is visible to passers by • Uses small quantities of seed	• Often results in unnatural looking rows • Higher establishment costs than direct seeding (particularly for large areas) • Substantially more labour intensive and costly than direct seeding

Table adapted from Greening Australia (2008a).

Project site factors

In addition to the above, to determine whether seedling planting is a suitable revegetation technique, a number of project site factors **SHOULD** also be considered, in particular:

- Soil type
- Landscape setting
- Project scale
- Desired end result.

These factors are presented in Table 7.7 to Table 7.10.

Table 7.7 - Suitability of seedling planting techniques based on soil type (using hand and mechanical techniques)

Soil Type	Hand	Mechanical
Sands	✓	✓
Non-Wetting sands	×	×
Light soils	✓	✓
Heavy clays	✓	×
Sticky clays	✓	×
Cracking clays	✓	×
Heavy wet soils	✓	×
Saline soils	×	×

✓ - suitable × - unsuitable

Table adapted from Corr (2003).

[17] Seedlings are grown in a variety of containers to suit the scale and purposes of works; the most common being either individual containers (e.g. forestry tubes) or cells (multi-celled containers arranged in trays) (Corr 2003).

Table 7.8 - Suitability of seedling planting techniques based on landscape setting (using hand and mechanical techniques)

Landscape setting	Hand	Mechanical
Flats	✓	✓
Light granitic hills	✓	×
Rocky or stony country	✓	×
Waterlogged	✓	×
Rocky hill tops (difficult access)	✓	×
Steep hills	✓	×
Intact remnants and ground flora	✓	×
Riparian	✓	×
Isolated dead trees	✓	×

✓ - suitable × - unsuitable

Table adapted from Corr (2003).

Table 7.9 - Suitability of seedling planting techniques based on project scale (using hand and mechanical techniques)

Project scale	Hand	Mechanical
Broadscale	×	✓
Medium (e.g. belts)	✓	✓
Small (e.g. spots)	✓	×

✓ - suitable × - unsuitable

Table adapted from Corr (2003).

Table 7.10 - Suitability of planting techniques based on desired end result (using hand and mechanical techniques)

Desired end result	Hand	Mechanical
Random or natural	✓	×
Uniform spacings	✓	✓

✓ - suitable × - unsuitable Table adapted from Corr (2003).

Technique

The following sections present techniques for:

- Planting seedlings (either by hand or mechanical planter)
- Guarding, watering and fertilising seedlings at planting.

Planting by hand

The most common tools used for hand planting seedlings are:

- Mattock and shovel
- Planting spade
- Hamilton tree-planter (or similar)
- Potti-Putki
- Powered or hand auger.

Techniques, advantages and disadvantages of these tools are provided Table 7.11.

Planting using a mechanical seedling planter

Mechanical planters work on the principle of opening the soil with a broad tyne or shank so that a plant can drop into the space opened up in the ground. Press wheels then push the soil back around the plant as the machine travels forward. Different machines are able to plant different seedling stock, including cells, tubestock and open-rooted seedlings (Corr 2003).

Tree planting machines provide an efficient option for large-scale revegetation in the right conditions i.e. flat to undulating country with friable soil conditions. They are particularly suitable for projects which require regular, known, spacings of tree seedlings of similar size, such as farm forestry or narrow shelterbelts (Corr 2003).

Guarding

Placing tree guards around seedling is common practice and aims to increase the survival rate of plant establishment projects. Tree guards may be beneficial in protecting seedlings from:

- Rabbits and hares (particularly browsing of tasty new seedling shoot)
- Hot and cold winds
- Insect damage (e.g. wingless grasshoppers)
- Frost (particularly when planting in Autumn in frost prone areas)
- Spray drift from herbicides.

In addition, tree guards may stimulate plant growth by:

- Creating a warm and moist micro-climate
- Funnelling rainwater to the roots of plant.

However tree guards that shelter plants from wind may lead to development of non sturdy 'leggy' stems and weaker roots by over-sheltering plants. Plant stems can also be damaged or weakened by rubbing on tree guards as they are blown in the wind.

Tree guards that restrict light penetration (e.g. milk cartons) may also lead to weak or 'leggy' growth of short seedlings. Milk cartons also provide no significant protection from browsing/grazing animals once the plant grows clear of the tree guard.

Types

Tree guards **SHOULD** only be used for small to medium scale tubestock plantings. They add considerable cost to large scale plantings, and their use **SHOULD** be carefully weighed up against the cost of replacing plants lost in the first few years of the planting (Greening Australia 2008b).

The most common tree guards used to aid plant establishment are either milk cartons or translucent plastic sleeves. The advantages and disadvantages of each type are described in Table 7.12.

Where grazing/browsing of larger animals (e.g. wallabies) is an issue, neither milk cartons nor plastic sleeve provide adequate protection. To protect plants from these animals, an option is to use very tall tree guards of rigid corrugated plastic or heavy-duty weld mesh (refer to the *Pest Animal Management* standard for further details).

Table 7.11 – Seedling planting by hand: techniques, advantages and disadvantages

Planting tool	Technique	Advantages	Disadvantages
Mattock and shovel	1. Dig a hole slightly larger than the tubestock 2. Place the plant in the hole so that the top of the potting mix is just below ground surface 3. Backfill the hole ensuring that no air pockets exist 4. Leave a depression around the plant to catch water	Good for heavy/sticky clay or inaccessible sites	Hard on the back Slow and physically demanding
Planting spade	As for mattock and shovel	Relatively quick. Best for bare-rooted stock	Requires soft soil Requires bending
Hamilton tree planter and similar	1. Push in to the depth of the planter 2. Place plant in hole 3. Crumble soil plug (from previous hole) around plant 4. Firm in with hand or boot	Easy to use Cuts hole to the shape of the tubestock	Requires bending Not good for clay soils as: • Sides of the hole left smoothly polished and impenetrable to emerging roots; and • Soil plug difficult to remove • On loose soils, hole shape may collapse
Potti-Putki	1. Drive into the ground and lever open to create a hole 2. Drop seedling down the tube into the hole 3. Press in place with foot	Very quick, no bending, good root-soil contact Good for cell tray stock	Requires well-prepared soil

Planting tool	Technique	Advantages	Disadvantages
Powered or hand auger	1. Turn the auger until the desired hole depth is achieved (for most purposes a 100 mm long bit will be sufficient) 2. Roughen the sides of any polished holes 3. Place plant in hole 4. Firm in with hand/boot	Can enable penetration of compact soils Most suitable for: • Relatively soft soil; and • Small seedlings such as plugs or Hiko cells	• Less control over depth of planting hole • Not good for clay soils as sides of the hole left smoothly polished and impenetrable to emerging roots

Table adapted from Greening Australia (2008a) and TreeProject (2003).

Planting Notes: Plants **MUST** be moist prior to planting – soak thoroughly in their containers prior to planting.
Remove the plant from the tube or cell by turning upside down and tapping the rim of the tube. Never pull plants out by their stem.
Soil should not cover any previously exposed stem of a plant as this can lead to stem rot.

Table 7.12 – Tree guards: advantages and disadvantages

Tree Guard	Technique	Advantages	Disadvantages
Milk Carton	Supported by two bamboo stakes	• Most economical (TreeProject, 2003) • Biodegradable • Suitable for areas with the softer loamy or sandy soils (TreeProject, 2003)	• Not suitable in hard clay soils • Denies light and air flow to small seedlings, *reducing* their growth • Potential litter problem if site not maintained • High labour costs to install
Conflute Guards	Supported by two hardwood stakes	• Height of guard up to 600mm • Offers good protection from browsing animals, resistant to bending • Triangular profile resists dislodgement in floods • Reusable	• More expensive (materials and labour)
Plastic Sleeve	Supported by three bamboo stakes (or hardwood stakes for clay soils)	• Larger – provide greater protection, enable greater growth, allow more light penetration (TreeProject, 2003) • More suitable for harder ground as the stakes can be hammered in. (TreeProject, 2003)	• More expensive (materials and labour) • Not suitable near waterways, as the guards can easily get in to the waterway, posing a risk to fish and wildlife (TreeProject, 2003). • Can 'cook' seedlings in summer • Not biodegradable, hence follow-up removal is required

Maintenance

If tree guards are used, maintenance and future removal may be required (Corr 2003).

Plastic tree guards **MUST** be removed after the seedlings are healthy and well established – usually after 3-4 years[18] to prevent the plastic from blowing away and causing a litter problem (TreeProject 2003). If the tree guards are to be re-used for other projects, a shorter timeframe **SHOULD** be applied to avoid damage to both the guard and the plant.

[18] Establishment times can vary greatly e.g. as short as 18 months in well prepared riparian areas to as long as ten years in dry areas such as the Mallee.

Milk cartons may be left around the plant to breakdown naturally (as they are biodegradable; however this may be inappropriate in high profile and/or urban areas (TreeProject 2003).

Watering

At planting

If planting into very dry ground the plant will require some watering in. If soil moisture is high this is not necessary. However, an initial watering at the time of planting is advantageous to help overcome any transplant shock, to help remove air pockets from the roots and establish good root to soil contact (Corr 2003).

One or two litres of water (or more) poured slowly around the planted seedling **SHOULD** be sufficient (TreeProject 2003, Perry 2004).

Post planting

Provided soil preparation and weed control has been adequate, further watering **SHOULD NOT** be necessary. In fact, watering after plant establishment tends to encourage shallow rather than deep root development, reducing the plants ability to cope with dry conditions.

The only time that follow-up watering **SHOULD** be applied is if plants have been established in very dry seasons (Corr 2003) or when a lack of summer rains has induced drought stress (Perry 2004, TreeProject 2003).

Fertilising

As indigenous plants are generally adapted to low nutrient soils, fertilisers **SHOULD NOT** be used for revegetation programs (Corr 2003, TreeProject 2003, Perry 2004).

The exceptions are highly eroded sites with infertile soils. Planting under these conditions may be less successful without the addition of a slow release fertiliser (e.g. NPK) to enhance growth in the first few months (TreeProject 2003, Perry 2004).

If the addition of a fertiliser is deemed necessary, the planting site **SHOULD** be free from competitive weeds (refer to the *Herbaceous Weed Control* standard for detail). If weeds are present, fertilising will only stimulate further weed growth which will do much more harm than good to the success of the planting project (Anderson 2003).

Timing

The general principle to follow, given good weed control, is the lower the rainfall, the earlier the planting (Corr 2003).

In Victoria, for areas south of the Great Dividing Range, planting in spring allows good prior weed control, avoids most frosts and cold or waterlogged soil. Should spring rainfall not occur, planting after the following Autumn break may be preferential.

In areas north of the Great Dividing Range with less reliable spring rains, earlier planting in autumn or winter is recommended. This takes advantage of the winter rains (TreeProject 2003, Anderson 2003, Perry 2004).

Table 7.13 provides recommended seasons for undertaking seedling planting based on annual rainfall and **SHOULD** be used to assist in planning a planting project.

Table 7.13 – Recommended seasons for seedling planting

Climatic region	Annual rainfall (mm)	Recommended season for planting*		
		Autumn	Winter	Spring
Semi arid areas	250-500	✓	✓	×
Medium to high rainfall areas	>500	✓	×	✓**
Frost prone areas	N/A	×	×	✓**

✓ - recommended × - not recommended

* Based on the long term average annual rainfall. Actual timing should be based on the local environmental conditions.

** Traditional spring plantings may need to be reconsidered depending on the previous season's rainfall. Projects should be designed so that an earlier planting can be implemented if required.

Table adapted from Corr (2003).

Maintenance

Good pre-planting weed control minimises the need for post planting spraying (TreeProject 2003, Perry 2004). However, weeds often grow back after planting and **SHOULD** be controlled (TreeProject 2003). Refer to the *Herbaceous Weed Control* standard for specific techniques and timing.

In addition, some tubestock on planting sites may be lost in the short term (e.g. due to low rainfall). In these situations, it may be appropriate to include re-planting (in subsequent years) within the project site as part of a maintenance program.

An appropriate allocation of resources to maintenance **SHOULD** be included as an essential component in all replanting projects. If replanting sites cannot be maintained in an appropriate condition they **SHOULD NOT** be established.

7.3.3 Long-stem planting

This method involves the planting of long-stem tubestock by hand. Long-stem seedlings are grown in pots for 10-18 months, so that they develop long woody stems. These seedlings are then planted with about three quarters of their length below the soil surface (i.e. approximately one metre deep) (Australian Plants Society 2010).

Applicability

Long-stem planting is considered a successful planting method for a wide range of environments and conditions. In particular, long-stem planting can improve the survival of plants where:

- Surface soil conditions are generally unfavourable e.g. low moisture levels, high temperatures, high salinity
- Surface ground movement is likely to occur e.g. regularly flooded areas (Australian Plants Society 2010).

Advantages and disadvantages of long-stem planting compared with traditional seedling planting are provided in Table 7.14.

Table 7.14 – Long-stem planting: advantages and disadvantages

Advantages	Disadvantages
• Plants are more stable in the ground e.g. deeper plantings are better able to withstand effects of moving water such as flood conditions in riparian zones • Increases the chance of plant survival as: o The root ball is insulated from substantial changes in soil temperature, moisture or salt-encrusted topsoils o The plants are older and stronger at planting • Reduces post planting maintenance as shallow-rooted weeds do not compete with deep root ball	• Longer time required to dig holes • Higher cost per plant (due to longer timeframe within nursery)

Table adapted from Australian Plants Society (2010).

Technique

The following method, developed by the Australian Plants Society (2010), **SHOULD** be used to guide long-stem planting projects in Victoria:

1. Dig holes that are deep enough to allow three-quarters of the plant to be buried
2. Pour approximately one litre of water into the hole and allow it to soak in
3. Prune side branches or large leaves from the lower portion of the stem that impede placement of the seedling in the hole when planting
4. Place the plant in the hole and backfill carefully using soil and water alternately to ensure that no air pockets are left. This is important to prevent the roots from drying out
5. Create a dish-shaped depression around the stem of the plant and add the remaining water. The depression will assist in catching any rain
6. Since the root ball will be below the root zone of most weeds, competition from weed roots will be minimal. However, in moist environments some weed management may be necessary to prevent smothering weeds from affecting the above ground parts of the plant e.g. Lonicera sp. (honeysuckle).

Planting tools

Typical tools used to dig planting holes include shovels, post-hole diggers or augers.

Where water is readily available (e.g. from a nearby stream), holes may be dug using equipment that delivers water under high pressure (such as a water lance).

Watering

If a water supply is not available and the water needs to be carried to the site, two litres of water (or more if the sub-soil is dry) per plant **SHOULD** be sufficient (Australian Plants Society 2010).

Timing

Refer to Timing section under seedling planting.

7.3.4 Introducing soil seed banks to wetlands

Applicability

For wetland revegetation, an additional option to restore vegetation is to introduce a soil seed bank[19] from another wetland i.e. a donor wetland.

Advantages and disadvantages of introducing soil seed banks to wetlands are provided in Table 7.15.

Table 7.15 – Introducing soil seed banks: advantages and disadvantages

Advantages	Disadvantages
• Requires only a small amount of seed from donor wetland • Cheaper than installing propagated plants	• Requires a nearby donor wetland • Takes resources from donor wetland which can result in damage • Can introduce or spread undesirable species

Table adapted from Brock and Casanova (2000).

Technique

The following steps, described in Brock and Casanova (2000), **SHOULD** be followed when introducing a soil seed bank to a wetland:

1. Determine how much seed bank you will need to collect for the recipient wetland. Two or three 10 litre buckets of seed bank material will be sufficient for 20 lines 10 m long and 0.1 m wide. Remember, you are not aiming to install wetland vegetation in one go. You are simply providing a starting point for plant colonisation
2. Choose a site in the donor wetland and mentally divide it into different zones in relation to the water level e.g. high on the bank, the waters edge, and under the water. Within each zone decide how much seed bank you want to collect, then work within the zone
3. Dig up a trowel-full of soil and put it in the bucket. Move to a spot a metre away and repeat. Continue until you have as much seed bank from that zone as you think you will need. When you have completed collecting in one zone, move to the next and do the same thing
4. Take the soil (seed bank) home, then spread it out on a large piece of plastic and mix well. Mixing soil from all the zones means that wherever you eventually put the seed bank, all species have an opportunity to establish. This is a useful strategy when you don't know how water levels will vary over time
5. Let the soil dry out in the sun. This may take days or weeks (2–20 days), depending on the weather. Cover it overnight or if it rains. Drying the seed bank will maximise the number of plants germinating. When the seed bank is dry take it to the recipient wetland
6. Spread the seed bank material in lines perpendicular to the water's edge, going from above the water level to some way under the water. Make these lines at least a couple of metres apart. The lines of seed bank can be up to 30m apart and still be effective in allowing plants to establish. Work from above the high water mark to as deep in the water as you care to go, and spread a narrow line of seed bank. By spreading the seed bank down the slope you will be giving all species the chance of establishing, especially if water levels fluctuate in your wetland.

[19] A soil seed bank is the store of dormant seeds in the sediment of the wetland (Brock and Casanova 2000).

Timing

The best time to encourage the establishment of wetland plants is when wetland soil conditions are muddy/moist (i.e. when water is receding from wetland fringes).

Maintenance

If disturbance by ducks or other animals is likely to be a problem, project managers **SHOULD** consider covering the strips of soil seed bank with wire netting until plants are established (Brock and Casanova 2000).

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8 Planting density, diversity and placement for seedlings

This standard forms part of a set of state-wide standards for the delivery of vegetation management activities through Victorian Investment Framework (VIF) projects at the landholder scale.

Where seedling planting is to be undertaken as part of a VIF project, this standard **MUST** be applied.

Determining whether seedling planting is an appropriate activity for a particular vegetation management project is the responsibility of the project manager and will be dependent on a number of factors, including:

- The project goal
- The condition and extent of remnant vegetation at the project site, which in turn determines whether the project will focus on:
    - Protection of remnant vegetation
    - Establishment of overstorey and/or understorey plants within a remnant patch i.e. supplementary planting
    - Establishment of native vegetation in formerly cleared areas outside of a remnant patch i.e. replanting.
- Specific site conditions e.g. soil type, slope
- The type and severity of threats present.

Therefore, this standard should not be read in isolation, but rather sequenced and applied with other relevant standards as appropriate.

8.1 Scope

This standard covers approaches to determining the density, diversity and placement of seedlings[20] for planting projects.

It does not cover approaches to determining the density, diversity and placement of seed as part of direct-seeding projects.

8.2 Background

Species selection is an important step in delivering a seedling planting project. For seedling planting projects, it is usual to include a variety of species with representatives from all life form strata within the native vegetation community (a typical native vegetation community is comprised of species within an overstorey, understorey and groundcover).

The presence of a broad range of vegetation lifeforms (or structural diversity) provides a mix of habitats for the many different animals that live in the area, creating a more diverse ecosystem (Bruce and McInnes 2008).

[20] Seedlings are grown in a variety of containers to suit the scale and purposes of works; the most common being either individual containers (e.g. forestry tubes) or cells (multi-celled containers arranged in trays) (Corr 2003).

It is also very important to use species that are locally indigenous. These species:

- Require relatively lower inputs to be established and maintained
- Are more likely to recruit new individuals (without becoming weedy)
- Are tolerant of local environmental conditions
- Maintain the ecology and biodiversity of an area
- Provide a balanced and suitable habitat for native fauna
- Contribute to the productivity of farm enterprises
- Maintain the unique character of the landscape (Johnson 2001).

8.3 Method

The following sections detail three key elements in planning a replanting project:

- Planting density i.e. the number of plants required for the site
- Planting diversity i.e. the number/type of species to be planted (the species list)
- Placement i.e. where the plants will be placed in the landscape.

8.3.1 Planting density

Technique

To determine the number of plants required for a specific project site, the project manager **MUST**:

- Determine the planting objective for the project site
- Identify the relevant Victorian Bioregion[21] and EVC[22] for the project site
- Calculate the planting survival target for the relevant EVC
- Determine the total number of seedlings required to achieve the planting survival target.

These stages are detailed in the following sections.

Stage 1 - Determine the replanting objective

Replanting projects can be undertaken for many objectives, including:

- Restoring habitats for native vegetation and wildlife
- Rehabilitating landscapes (e.g. riparian stabilisation)
- Providing shade and shelterbelts
- Improving the amenity and/or aesthetics of an area.

Depending on the objective, the number and type of plants required for a particular project can vary (e.g. stabilising a streambank may require the planting of deep-rooted shrubs and tussock grasses only).

[21] Bioregions are areas based on the patterns of ecological characteristics and the underlying environmental features. There are 28 bioregions across Victoria.

[22] Ecological Vegetation Class is a classification of plant communities defined by a combination of floristics, lifeform, position in the landscape, and an inferred fidelity to particular environments. Approximately 300 EVCs have been described for Victoria.

Based on the most common objectives for replanting projects, four planting standards have been developed (refer to Table 8.1). Project managers **MUST** apply the appropriate planting standard to meet their specific project objective e.g. if the replanting objective for a project site is to restore important structural components of Ecological Vegetation Classes then the 'EVC Multi-Strata Planting Standard' must be applied.

Table 8.1 – Planting standards for various project objectives

Objective	Approach to replanting	Planting standard
Restore the structure and diversity of EVCs and maximise resilience to climate change driven stresses and/or Restore critical biodiversity functions/habitat requirements	**MUST** consider species diversity targets **MUST** consider species tolerance to climate change **MUST** consider establishment processes on successional stages **SHOULD** include establishment of particular overstorey, understorey and ground cover structure/diversity for key species habitat needs (e.g. feeding/foraging/nesting) in high priority fauna locations	Best Practice
Restore important structural components of Ecological Vegetation Classes	**MUST** be based on DSE Net Gain* objectives **MUST** use EVC benchmarks **MUST** include DSE Net Gain* density targets for overstorey and understorey woody life forms (and large tussocks in some grassy EVCs)	EVC Multi-Strata
Restore the overstorey of Ecological Vegetation Classes	**MUST** use EVC benchmarks **MUST** include DSE Net Gain* density targets (overstorey only)	EVC Overstorey
Rehabilitate landscapes e.g. streambank stabilisation, salinity control, general habitat improvements	Uses mixed indigenous and/or non-indigenous native species with no density targets Initial planting may focus on trees (and possibly shrubs) with future plantings undertaken as appropriate **SHOULD** reference EVC benchmarks and Net Gain* density targets	Mixed Species

* Refer to Stage 3 (below) and *Native Vegetation Revegetation Planting Standards - Guidelines for Establishing Native Vegetation for Net Gain Accounting* (Department of Sustainability and Environment 2006) for details.

Stage 2 - Identify the relevant Ecological Vegetation Class

To identify the relevant EVC for the project site, the following steps **SHOULD** be followed:

Step 1 Locate the geographical area of interest

- use DSE's **Biodiversity Interactive Map**[23]

Step 2 Identify the Bioregion and EVC for the area of interest

- Click vegetation folder under map layer and change map scale to ≤ 1:100,000
- Tick 1750 EVCs and the adjacent information icon ⓘ

[23] http://mapshare2.dse.vic.gov.au/MapShare2EXT/imf.jsp?site=bim

- Click refresh map (map will now display 1750 EVCs map layer)
- Click mouse on area of interest
- Read off EVC name, EVC number and Bioregion[24]
- Confirm by ground-truthing, with particular emphasis on:
    - Where the site is placed in the landscape e.g. slope, gully, plain
    - The dominant overstorey structure, either remnant canopy on-site or in nearby remnant vegetation e.g. forest, woodland
    - The dominant understorey structure, either remnants on-site or in nearby remnant vegetation e.g. grassy, shrubby
    - Any other site attributes e.g. soils, moisture, aspect
    - Local knowledge (including local revegetation guides)
- Download the relevant EVC benchmark from DSE's EVC benchmarks for each bioregion[25]

Stage 3 - Calculate the replanting survival target

The followings steps are the same as the 'Net Gain' approach adopted by DSE (2006) to calculate the target number of trees, understorey plants and groundcovers (per hectare) that should be surviving[26] after ten years for proposed planting project sites[27].

These steps **MUST** be applied for the following planting standards:

- EVC Multi-Strata standard (see steps 1-7 below)
- EVC Overstorey standard (see steps 1, 2 and 7 below).

For other planting standards (Best Practice and Mixed Species), a number of site specific factors will dictate the actual number and type of plants required. As such, for these standards, the following approaches to calculating replanting survival targets will apply:

- Best Practice standard –exact requirements **MUST** be determined on a case-by-case basis in consultation with DSE; and
- Mixed Species standard – steps 1-7 **SHOULD** be used to guide plant numbers/types, but are not mandatory requirements.

Step 1 Determine if the EVC benchmark for your area of interest includes an overstorey tree layer

- Does the EVC name include the descriptors woodland or forest?
  If yes go to Step 2. If no go to (b).
- Does the EVC benchmark include a tree canopy layer?
  If yes go to Step 2. If no, Eucalypt species should be excluded from the plant list for the project site (go to Step 3).

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[24] It should be noted that some project sites may contain more than one EVC and/or be a transitional zone (ecotone) between EVCs.

[25] http://www.dse.vic.gov.au/conservation-and-environment/ecological-vegetation-class-evc-benchmarks-by-bioregion

[26] The actual number of plants that must be planted to achieve the re-planting survival target for a particular project site will generally be higher than the survival target numbers, considering some expected attrition. Refer to Stage 4 for details.

[27] DSE mandates numbers of plants from selected lifeforms required to meet net gain objectives. Species are not nominated and only the following lifeforms are included: canopy trees, understorey tree or large shrubs, medium shrubs, small shrubs and (where benchmark foliage cover exceeds 10%) large tufted graminoids. Floristic restoration works commonly extend to other lifeforms so DSE's prescriptions **SHOULD** be considered a *minimum* standard.

Step 2 Calculate the 10-year planting survival target (per hectare) for trees using Table 8.2.

Table 8.2 - 10-year planting survival target for overstorey trees

EVC type	Target number of overstorey trees plants/ha
Woodland	50
Dry forest	100
Riverine/lowland/foothill forest	150
Damp/wet forest	200

Step 3 From the EVC benchmark, identify % cover for the following understorey lifeforms:

- Understorey Tree or Large Shrub (T) >5m tall
- Medium Shrub (MS) 1-5m tall
- Small Shrub (SS) <1m tall

Step 4 For each understorey life form, calculate the 10-year planting survival target (per hectare) using Table 8.3.

Table 8.3 - Ten year planting survival target for understorey life forms (excluding large tufted graminoids[28])

Understorey life forms	Target number of plants/ha (for each 5% cover in EVC benchmark)	Notes
Understorey tree or large shrub (T) >5m tall	50	Assume 10 plants/ha where benchmark cover is 1%
Medium shrub (MS) 1-5m tall	200	Assume 40 plants/ha where benchmark cover is 1%
Small shrub (SS) <1m tall	500	Assume 100 plants/ha where benchmark cover is 1%

Step 5 From the EVC benchmark, identify % cover of Large Tufted Graminoids (LTG) >1m tall.

Ground covers and native grasses are often substantially reduced in planting programs due to the high risk of failure from herbaceous weed competition. However, the planting of more robust ground covers (e.g. tussock grasses) may be considered for particular EVCs e.g. riparian zones if their benchmark state foliage cover exceeds 10% (Department of Sustainability and Environment 2006) or for supplementary plantings at a later date.

[28] 'Tussock' grass or grass-like plant >1m tall.

Step 6 Calculate the 10-year planting survival target (per hectare) for large tufted graminoids using Table 8.4.

Table 8.4 - Ten year planting survival target for large tufted graminoids

Understorey life forms	Target number of plants/ha (for each 5% cover in EVC benchmark)	Notes
Large Tufted Graminoid (LTG) >1m tall	500	Apply only where benchmark cover for LTG life form is ≥ 10%

Step 7 Calculate the 10-year planting survival target for your area of interest.

Multiply the plant numbers identified in Steps 2, 4 and 6 by your area of interest (in hectares).

Stage 4 - Determine the total number of seedlings required to achieve the planting survival target

The actual number of seedlings required to achieve the planting survival target for a particular project site will be dependent on a number of modifying factors, most notably:

- The extent and type of remnant vegetation
- General plant losses (e.g. from browsing, climatic conditions)
- Potential for species to regenerate naturally
- The success of site preparation (pest plants and animals)
- The degree of landscape modification
- Adverse climatic or hydrologic conditions (particularly in wetlands).

These modifying factors **SHOULD** be considered in determining the number of plants required at planting. However, they **SHOULD NOT** take away from the need for a well planned site preparation program and post planting maintenance program.

Timing

Plant numbers **SHOULD** be determined at least 12 months prior to planting to allow adequate time to either source seed and propagate plants or order plants from a nursery.

Species diversity

The basic criteria for the selection of plant species are that the plants:

- Are suitable for the site conditions;
- Can be reliably propagated in sufficient numbers (note that species availability from local nurseries may influence final species selection, particularly with respect to the use of small shrubs and ground covers);
- Will achieve the objectives of the planting; and
- Will last on the site (Corr 2003).

Local native (indigenous) species, with a diversity of life forms, are the preferred choice for planting and **MUST** be used wherever possible.

Local indigenous plants

Applicability

Planting for biodiversity purposes **MUST** first consider local native (indigenous) species because these species:

- Are best suited to the local conditions, for example, they are adapted to the soils, rainfall patterns and frosts and can survive droughts, flood and fire (Corr 2003, TreeProject 2003)
- Provide the best habitat for locally dependent fauna (Corr 2003, TreeProject,2003, Greening Australia 2008)
- Have their pollinators, predators and symbionts present (Greening Australia 2008)
- Are well suited to regenerating without assistance (Corr 2003).

Technique

To ensure that plantings include a range of suitable, local native (indigenous) species, a detailed species list is required. The following information sources are recommended for developing site-specific species lists:

- Regional/local indigenous plant guides
- Regional/local expertise, e.g. DSE, CMA/MW.

Non-local native plants

Applicability

On some sites, conditions may have altered to such a point whereby the exclusive use of local native (indigenous) vegetation is no longer practical or beneficial (Corr 2003, TreeProject 2003). For example:

- Where the environment has changed to the extent that some local species can no longer survive (salinity, altered soil structure, waterway morphology waterlogging, frost) (Corr 2003, TreeProject 2003, Greening Australia 2008)
- Where a species is needed to modify the environment so local species can thrive (such as where a salt tolerant species is used to lower water tables to reduce soil salinity) (Greening Australia 2008).

Under these conditions, the incorporation of non-indigenous native vegetation to a replanting project may be considered (although all locally native (indigenous) vegetation **SHOULD** be 'explored' first, as there is almost always local species that will suit the site e.g. salt tolerant plants).

Where conditions have changed to such a degree that the exclusive use of local species is considered unsuitable, species from adjoining and nearby EVCs **SHOULD** be the next consideration (as EVCs tend to grade into each other along a continuum). For example, a former swamp that is now a dry, eroded, pasture-dominated site in the middle of an agricultural landscape may now present conditions suitable for grassy woodland species.

8.3.2 Plant placement

Applicability

A general species list does not ensure that you have matched soil type, geology, hydrology, aspect and site conditions to a plant's growing conditions and requirements. Understanding the site requirements of a particular species is important for planting success (Corangamite Seed Supply and Revegetation Network 2006)

Technique

Zonation

The key to good plant placement is putting species where they would have naturally grown (Corr 2003). This means matching species with soil type, aspect and where they occur in the landscape.

For example,

Table 8.5 describes appropriate riparian planting zones for six commonly planted acacia.

Table 8.5 - Riparian planting zones example

Botanical name	Common name	Swampy	Wet	Moist	Well-Drained	Dry
Acacia dealbata	Silver Wattle		✓	✓	✓	
Acacia mearnsii	Black Wattle				✓	✓
Acacia melanoxylon	Blackwood		✓	✓	✓	
Acacia paradoxa	Hedge Wattle				✓	✓
Acacia pycnantha	Golden Wattle				✓	✓
Acacia verticillata	Prickly Moses		✓	✓		

Regional revegetation guides **SHOULD** be utilised in conjunction with local knowledge. However, it is also important that observations be made 'on-ground' to identify where species are naturally occurring.

It should be noted that in some circumstances plant placement may need to be modified/adjusted to cater for social and/or economic factors e.g.:

- particular trees or shrubs may be excluded from some plantings near dwellings to decrease fire risk; or
- dense shrubs may be excluded in some urban plantings to increase sight lines for cyclists.

Vegetation mosaics

In addition to planting within the correct zone, planting **SHOULD** also aim to replicate nature by establishing patchiness within vegetation (particularly with understorey species) rather than ordered rows or spacings of plants.

This technique creates a mosaic effect which provides:

- Greater opportunities for wildlife (Bennett, Kimber and Ryan 2000 in Corr 2003)
- A competitive advantage against weeds in the dense patches (Department of Sustainability and Environment 2006).

8.4 References

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9 Soil preparation for re-planting

This standard forms part of a set of state-wide standards for the delivery of vegetation management activities through Victorian Investment Framework (VIF) projects at the landholder scale.

Where soil preparation for re-planting is to be undertaken as part of a VIF project, this standard **MUST** be applied.

Determining whether soil preparation for re-planting is an appropriate activity for a particular vegetation management project is the responsibility of the project manager and will be dependent on a number of factors, including:

- The project goal
- The relevant ecological vegetation class (EVC) for the project site
- The condition and extent of remnant vegetation at the project site, which in turn determines whether the project will focus on:
    - Establishment of overstorey and/or understorey plants within a remnant patch i.e. supplementary planting
    - Establishment of native vegetation in formerly cleared areas outside of a remnant patch i.e. revegetation.
- Specific site conditions e.g. soil type, slope, location in the landscape (e.g. floodplain)
- The type and severity of threats present.

Therefore, this standard should not be read in isolation, but rather sequenced and applied with other relevant standards as appropriate.

9.1 Scope

This standard covers standard physical methods to prepare soil for re-planting, namely:

- Ripping
- Mounding.

It does not cover chemical methods to address poor soil health (e.g. nutrient deficiencies or pH issues).

9.2 Background

In some areas, soil preparation is required to produce loose, well drained and aerated soil ready for re-planting (Corr 2003).

The major benefits and potential issues associated with soil preparation are outlined in Table 9.1.

Table 9.1 - Soil preparation: benefits and issues

Major Benefits	Potential Issues
• Creates an easier path for roots to penetrate the soil • Makes re-planting easier	• Cost • Can stimulate weed germination

Table adapted from Greening Australia 2008.

9.3 Method

The following sections describe appropriate techniques and timing to prepare soils for re-planting.

9.3.1 Ripping

Ripping is used to improve aeration, rainwater infiltration and moisture retention of particular soils to improve the root development of seedlings through faster downward root growth and deeper soil penetration (Anderson 2003, Perry 2004, Corr 2003, TreeProject 2003).

In addition, ripping can enable the efficient use of manual planting tools and mechanical planters (Corr 2003).

Applicability

To determine whether ripping is necessary/ suitable for a re-planting project, a number of factors **MUST** be considered, in particular:

- Soil type and condition
- Landscape setting.

These factors are detailed in the following sections and have been developed into a decision tree (refer to Figure 9.1). The decision tree **MUST** be used to determine whether ripping is necessary/suitable for a particular re-planting project site.

Soil type and condition

Ripping is **SHOULD** only be used for those soil types and conditions that impede root growth. For other soils, ripping will result in either negligible project benefit or an overall degradation of the project area.

Table 9.2 - Ripping suitability for various soil types and conditions

Soil Type	Suitability	Comments
Clay loams	✓	Assists root development by re-aerating soils (Corr, K., 2003)
Compacted soils	✓	Breaks up subsoil and allows deeper penetration and faster growth of plant roots by improving aeration and infiltration of rain water (Stackpole, D., 1998), (TreeProject, 2003)
Cracking clays	×	Tends to crack along the rip lines in summer, exposing the plant roots to the drying air and pests (TreeProject, 2003)
Heavy clay soils or sub-soils	✓	Breaks up subsoil allowing root penetration and exploration (Stackpole, D., 1998) (Corr, K., 2003)
Highly erodible soils	×	Disturbance should be minimised on highly erodible soils
Light, sandy soils	minimal benefit	Little advantage in ripping sands as water will readily penetrate to the roots of the seedlings (TreeProject, 2003), (Stackpole, D., 1998)
Sodic soils	×	Can bring sodic material to the soil surface and cause or increase soil crusting (McMullen, B., 2000)
Soils with a hardpan layer	✓	Breaks up any impediments to tree root development (Anderson, G., 2003)
Wet soils	minimal benefit	Unlikely to have any benefits as the soil needs to be dry to produce cracks (McMullen, B., 2000)

✓ - suitable × - unsuitable

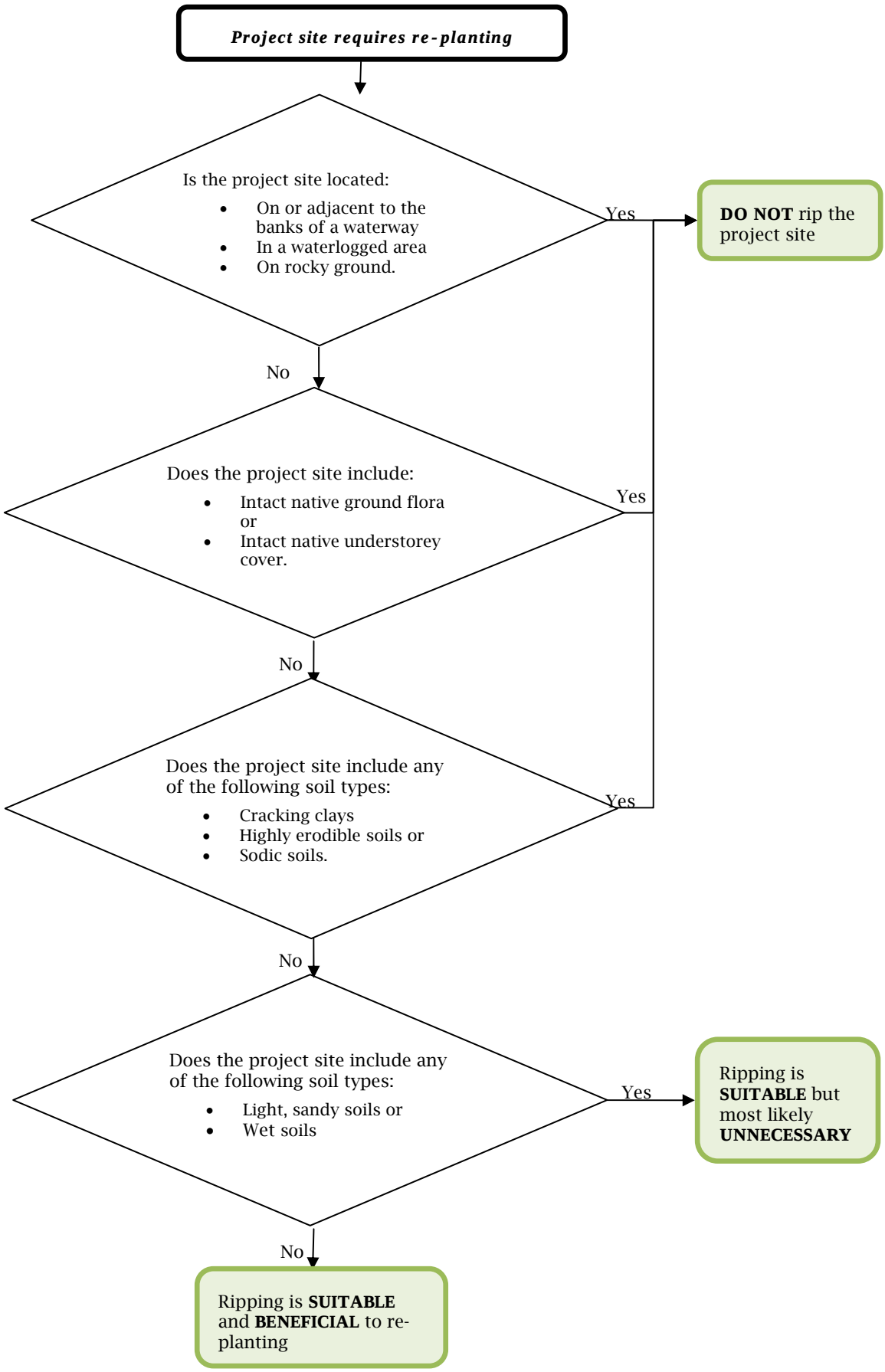

Figure 9.1 – Decision tree to determine whether ripping is necessary/suitable

Landscape setting

Ripping produces a high level of soil disturbance which may make it an inappropriate method for soil preparation on some sites (Corr 2003). In particular, ripping **MUST NOT** be undertaken on:

- The banks of waterways (Perry 2004) and waterlogged areas
- Riparian areas
- Sites of cultural significance
- Rocky ground (Perry 2004)
- Sites where there is a high level of intact native ground flora (Corr 2003).

Project scale

For small-scale projects (e.g. <2,000 plants), ripping may be too costly or difficult. In these situations, individual planting holes **SHOULD** be dug using a spade or tree planter (Perry 2004).

Technique

Ripping is usually done with either a bulldozer or three-point linkage, tractor-mounted, winged[29] ripping tyne (Corr 2003).

The key considerations when ripping re-planting lines are:

- Depth of rip lines
- Removal of air pockets
- Orientation of rip lines
- Topography of project area
- Proximity to existing vegetation.

Depth

The recommended depth of rip lines varies from 30cm to 100cm (Anderson 2003, Corr 2003, TreeProject 2003, Perry 2004), depending on the depth of the impeding soil layer.

For the majority of re-planting projects, ripping to a depth of 50-60cm **SHOULD** be sufficient to alleviate compaction. Deeper ripping (up to 100cm) **SHOULD** only be required to increase drainage in dense subsoils.

Removal of air pockets

It is essential ripping does not result in the creation of air pockets beneath the soil.

A concrete roller (at least 60 cm wide) should be attached behind the ripper to help crush rocks, remove air pockets and settle the soil. Alternatively, a tractor tyre can be used although narrow tractor tyres should be avoided as they can cause compaction and guttering).

[29] The addition of 'wings' to the ripping tyne maximises the shattering and soil lifting effect as well as improving weed control by throwing the sod sideways.

Orientation

To create a more natural aesthetic, ripping **SHOULD** follow either:

- A 'wavy' pattern
- A linear pattern (to allow for ease of management e.g. weed maintenance) with plants installed alternatively across rip lines.

Topography

On slopes, riplines **MUST** follow contours to reduce erosion risk (Perry 2004, TreeProject 2003).

Proximity to existing vegetation

To avoid damage to remnant vegetation, ripping **MUST NOT** occur:

- Where there is intact native understorey and/or ground flora
- Within an area twice the diameter of the canopy of existing indigenous trees.

Timing

Deep ripping **MUST** be timed to allow maximum shattering of the soil, ensuring that the soil is easy to work but not so wet that the soil glazes affecting root penetration (Perry 2004). These conditions tend to occur in late summer/autumn (Anderson 2003, TreeProject 2003, Corr 2003).

However, ripping before the autumn break may prove difficult with commonly available equipment, so the standard practice is often to rip after the autumn break (Perry 2004, TreeProject 2003).

All ripping **SHOULD** be done at least six months in advance of re-planting. This will allow enough time for both:

- Rain events and soil settling to minimise air pockets between soil clods; and
- Adequate weed control prior to re-planting (see Maintenance section below).

Longer timeframes may be required on some sites e.g. those with clay or compacted soils.

Licences/permits

High impact activities in culturally sensitive landscapes (e.g. deep ripping within 200m of a named waterway) can cause significant harm to Aboriginal cultural heritage.

In these situations the Aboriginal Heritage Act 2006 may require the project manager to prepare a Cultural Heritage Management Plan or obtain a cultural heritage permit or enter into a cultural heritage agreement with the relevant Registered Aboriginal Party.

If ripping is proposed within a culturally sensitive landscape, the project manager **MUST** determine if a Cultural Heritage Management Plan or cultural heritage permit is required. Specific information on considering Aboriginal cultural heritage needs can be sourced here.

Maintenance

The extensive soil disturbance created by ripping may inevitably lead to an increase in weed cover, either through invasion or the spread of weed seed through the soil.

This weed cover **MUST** be controlled quickly to minimise any competition with re-plantings (refer to the *Herbaceous Weed Control* and *Woody Weed Control* standards for details).

Mounding

This is a technique involving the mounding of topsoil over a rip line to provide improved conditions for tree establishment (Anderson 2003).

Applicability

There are five main reasons for mounding:

- Soft soil makes re-planting easier
- To improve drainage and soil aeration
- To build up a friable soil bed to allow rapid root growth
- To combat cracking soils
- To combat saline soils (Corr 2003).

Mounding is most commonly undertaken to facilitate early plant growth on:

- Heavy soils (Corr 2003)
- Wet and poorly drained sites30 (Corr 2003, Stackpole 1998, Perry 2004)
- Saline soils (critical for moderate to highly saline soils) (Corr 2003, Perry 2004.

It should be noted that mounding produces a high level of soil disturbance and **MUST NOT** be used for soil preparation on the following sites:

- Fragile saline sites (Perry 2004)
- Sites with cultural heritage values (Perry 2004)
- Sites where there is a high level of intact native ground flora (Corr 2003).

Technique

Specific techniques for mounding (e.g. m-profile mounding for saline sites, mouldboard ploughing for heavy wet soils) are set out in Greening Australia's handbook Revegetation Techniques. A Guide for Establishing Native Vegetation in Victoria (refer to pages 78-82).

These techniques **SHOULD** be followed for mounding projects in Victoria.

Timing

Mounds **SHOULD** be created at least six months in advance of re-planting to enable the mound to settle and, in saline areas, to allow salts to flush out (Corr 2003, TreeProject 2003, Stackpole 1998).

[30] Wet and poorly drained sites do not refer to natural wetlands. Mounding is considered an inappropriate method for wetlands.

9.4 References

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10 Stock fencing

This standard forms part of a set of state-wide standards for the delivery of vegetation management activities through Victorian Investment Framework (VIF) projects at the landholder scale.

Where stock fencing is to be undertaken as part of a VIF project, this standard **MUST** be applied.

Determining whether stock fencing is an appropriate activity for a particular vegetation management project is the responsibility of the project manager and will be dependent on a number of factors, including:

- The project goal
- The relevant ecological vegetation class (EVC) for the project site
- The condition and extent of remnant vegetation at the project site, which in turn determines whether the project will focus on:
    - Protection of remnant vegetation
    - Establishment of overstorey and/or understorey plants within a remnant patch i.e. supplementary planting
    - Establishment of native vegetation in formerly cleared areas outside of a remnant patch i.e. revegetation.
- Specific site conditions e.g. soil type, slope, location in the landscape (e.g. floodplain)
- The type and severity of threats present.

Therefore, this standard should not be read in isolation, but rather sequenced and applied with other relevant standards as appropriate.

10.1 Scope

This standard covers typical methods to exclude the most common domestic livestock that can threaten areas of native vegetation, in particular:

- Beef cattle
- Dairy cattle
- Sheep.

This standard does not cover methods to exclude pest animals (e.g. rabbits). For these animals, refer to the *Pest Animal Management* standard.

10.2 Background

Livestock grazing and trampling can cause serious damage to both remnant and planted native vegetation. For areas adjoining waterways and wetlands, livestock can also compact soils, destabilise beds and banks and degrade water quality.

In addition, the disturbance created by livestock through grazing of plants and opening up of bare ground, together with increased nutrient levels from animal manure and urine, creates an ideal situation for the establishment of weeds (Land and Water Resources Research and Development Corporation 1996).

Therefore, if the area adjoining a project site is grazed or there is a risk of future grazing from adjoining areas, then the project site **MUST** be fenced according to the methods described in this standard.

Appropriate stock fencing will also be required if an ecological grazing regime is to be implemented as a management tool for a project site – refer to the *Ecological Grazing* standard for more details.

10.3 Method

The most common types of stock exclusion fencing used are:

- Conventional fencing i.e. standard post and wire fencing, typical on many rural properties
- Mesh fencing i.e. prefabricated wire fencing often used for sheep (e.g. ring- lock, hinge joint)
- Electric fencing (often added to conventional fencing to enhance livestock control).

10.3.1 Applicability

Each fencing type has advantages and disadvantages and choosing the type most appropriate to a particular project site will depend on several factors, in particular:

- The type of stock to be excluded
- The risk of damage e.g. from flooding
- Site topography e.g. river meanders
- Cost (Staton and O'Sullivan 2006).

Advantages and disadvantages of each fencing type are provided in Table 10.1 to Table 10.3.

Table 10.1 - Conventional fencing - advantages and disadvantages

Advantages	Disadvantages
• Does not collect as much flood debris when compared with mesh fencing • Cheaper than mesh fences • Simple to cut if flood imminent, to reduce damage and can be designed to lay down in flood events • Simple to repair • Relatively effective against cattle • Additional wires can improve effectiveness against sheep and lambs	• Higher cost if droppers (used to spread stock pressure from a single wire to all wires in a fence) are needed, depending on post spacing • Difficult to follow curves (e.g. river meanders) • Less effective against sheep than mesh fences

Table adapted from Department of Sustainability and Environment (2006) and Staton and O'Sullivan (2006).

Table 10.2 - Mesh fencing - advantages and disadvantages

Advantages	Disadvantages
• Forms a solid, impenetrable barrier to cattle, sheep and some vermin • Most effective against lambs • Stronger than conventional fences at the same post spacings • Copes well with minor damage as snapped wires are supported by surrounding wires	• Expensive in relation to other types of fencing • Susceptible to flood damage • Difficult to follow curves • Difficult to repair if many wires are cut • Can restrict the movement of wildlife

Table adapted from Department of Sustainability and Environment (2006) and Staton and O'Sullivan (2006).

Table 10.3 - Electric fencing - advantages and disadvantages

Advantages	Disadvantages
• Comparatively cheap and quick to erect as less wire, and fewer and smaller posts, are required • Relatively flood proof • Effective against a range of stock and feral animals • Curved fence line possible • Can be used easily to fence off stock crossings and watering points • Easy to move (good option for temporary fencing) • Less damage or injury to cattle (as opposed to conventional fencing with barbed wire) • Can be used in a very flexible manner to manipulate stock numbers and grazing impact	• Not as effective against sheep (but additional wires and closer spacing can improve effectiveness) • Droppers may be needed • Requires a reliable source of power and a strong electric current • Can impact wildlife through electrocution • Vegetation and animals can cause shorting (the risk of vegetation shorting can be reduced by slashing or spraying along fencelines) • Can be a fire risk • More labour intensive as fence needs to be checked regularly for shorts • Can be an issue for: o Remote or large properties o Absentee landholders who visit the site infrequently

Table adapted from Department of Sustainability and Environment (2006) and Staton and O'Sullivan (2006).

Based on the information detailed in the above tables, a decision tree has been developed (refer to Figure 10.1) to assist in determining the most likely type of stock exclusion fence required for a particular project site. This decision tree **SHOULD** be used as a guide as it does not consider all variables (advantages and disadvantages) relevant to a particular site.

In addition, where the risk of flood damage to a fence is high, alternatives to the standard fence types may be required e.g. drop down fences (where property boundaries run perpendicular to flood flows) or sacrificial fences (where fences cross high energy reaches of a waterway). Detailed information on these alternative flood resistant fence types can be obtained here[31].

10.3.2 Technique

The following sections present recommended standards for:

- Fence location
- Fencing wire (based on fence type and stock type)
- Wildlife movement
- In-line posts (including spacings) and end assemblies
- Gates.

Fence location

Fences **SHOULD** be located a suitable distance from native vegetation (approximately 10m from the drip-line of the tree canopy) to minimise damage to vegetation during construction and to minimise maintenance requirements from fallen branches etc during the life of the fence.

Fences **SHOULD** also be located after consideration of land classes and topographic features (e.g. waterways, gullies, steep slopes).

[31] http://www.nynrm.sa.gov.au/Portals/7/pdf/LandAndSoil/43.pdf

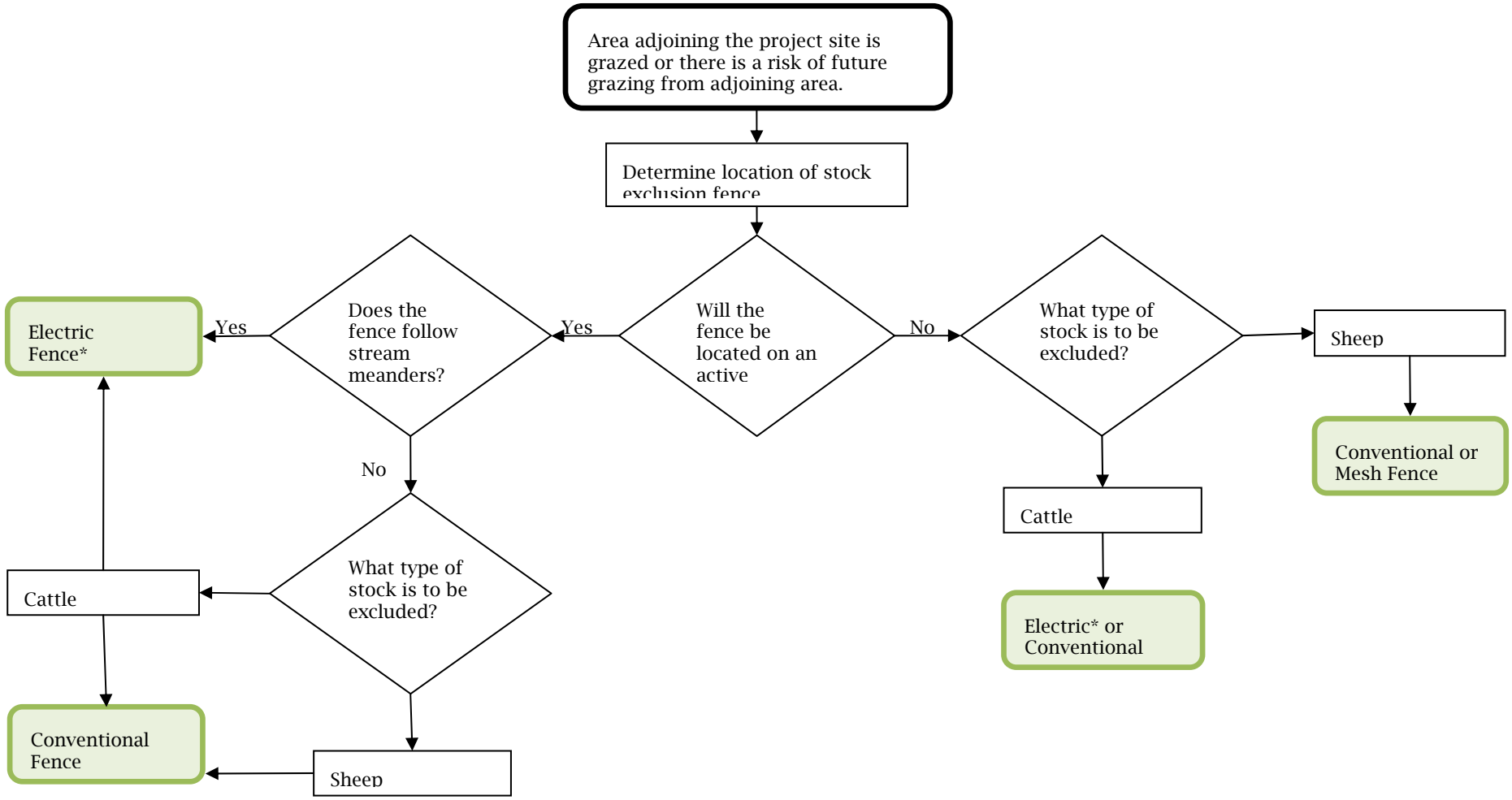

Figure 10.1 – Decision tree to assist in determining the most likely type of stock exclusion fence

* Electric fencing may be inappropriate in some situations e.g. remote or large properties or properties with absentee landholders.

Fencing wire

Wire specifications for the three most common types of stock exclusion fencing are detailed in Table 10.4. These specifications **SHOULD** be applied to all fencing projects aimed at controlling stock access.

Exception to the above requirements are:

- Where fencing will be erected on flood prone land. In these situations, the project manager **MUST** determine the most appropriate number of wires to both control livestock and minimise flood damage to fence (e.g. from debris build-up)
- Where fencing restricts the movement of native wildlife

Table 10.4 –Wire specifications by stock type

Fence type	Beef cattle	Dairy cattle	Sheep
Conventional	7 strand plain wire*		
Mesh	Standard 6/70/30 or 7/90/30 ring lock and plain wire*		
Electric	4 strand plain wire with at least 2 electrified strands	3 strand plain wire with at least 2 electrified strands	5 strand plain wire with at least 3 electrified strands ensuring that the bottom wire is earthed**

* A common addition to these fence types (that can prolong their life) involves the installation of an electrified offset wire. The height of this wire **SHOULD** be approximately two-thirds the height of the animal to be excluded.

** Note - long grass may short-out fence, hence site will require regular maintenance.

Table adapted from Department of Sustainability and Environment (2006) and Staton and O'Sullivan (2006),

Wildlife movement

Fences can restrict the movement of native wildlife and can disrupt the feeding, migration, breeding and social patterns of wild animals, as well as cause deaths (Land for Wildlife Queensland no date). Therefore, the spacing and location of wires **MUST** consider the movement of wildlife (Corangamite Seed Supply and Revegetation Network 2006). For example:

- Kangaroos may become caught in the wires of an electric fence and be killed by the current (Platt and Temby 1999)
- Fence visibility can be an issue near wetlands where large birds need sufficient space to land and take-off
- Ringlock can be a potential hazard to wildlife e.g. brolgas
- Live wires placed low to the ground may kill animals, such as echidnas and snakes (Platt and Temby 1999).

Wire spacings and fence height

Given the vast diversity in the size, shape and movements of wildlife, fences need to be designed to suit local wildlife species and conditions (Land for Wildlife Queensland no date).

As such, a minimum set of standards for wire spacings and fence height cannot be ascribed. However, preferred fencing methods that **SHOULD** be considered to enable wildlife movement include:

- Allowing a 50cm gap between the ground and the lowest fence strand to assist the movement of ground-living wildlife
- Ensuring fences are no more than 1.2 metres high (Land for Wildlife Queensland no date).

Barbed wire

More than 70 Australian species of wildlife have been identified as occasional or regular victims of barbed wire fences. Most entanglements occur on the top one or two strands of a barbed wire fence (Land for Wildlife Queensland no date).

As such, the use of barbed wire **MUST** be avoided wherever possible, particularly in high wildlife risk areas e.g. ridgelines, near waterways or near feed or roosting trees.

The alternative to barbed wire **SHOULD** be to use electric fencing (which is more effective at containing cattle than barb wire) (Platt and Temby 1999, Department of Sustainability and Environment 2006).

Where electric fencing is deemed inappropriate (refer to disadvantages under Table 10.3) and the use of barbed wire becomes unavoidable, the following methods **MUST** be employed to reduce the risk of entanglement to wildlife:

- Use plain wire for the top two strands of the fence; and/or
- Make the fence more visible and easier to cross by stringing electric fence tape above the top strand of barbed wire (Land for Wildlife Queensland no date).

In line posts and end assemblies

A number of in line post types are suitable for livestock fencing and include treated pine, concrete, recycled plastic and steel[32].

The general in line post spacing for livestock control **SHOULD** be 8-10m, with either:

- Wooden, steel or plastic droppers at 2.5 to 3m spacings
- 1650mm or 1800mm steel pickets at 4-5m spacings.

However, it is acknowledged that site conditions can have a significant bearing on the actual spacing of posts e.g. wider spacings are possible on flat country. Therefore the recommended spacings are provided as a guide only.

End assemblies are also generally constructed from treated pine, concrete and or pre-fabricated metal e.g. Ezy Slot posts, Adjusta-Stays.

[32] An alternative to in line posts involves using steel pickets with the occasional wooden/steel/concrete post at changes in direction for stability.

Gates

Gates are important features of fencing projects, allowing:

- Efficient removal of any stock that may stray into a project area
- Management of livestock access where ecological grazing is being implemented
- Access for spot spraying weeds, baiting for vermin or fire fighting (Staton and O'Sullivan 2006).

All fencing projects **MUST** incorporate a minimum of one gate (or two gates for riparian projects, to be located at either end of a project area) for management access.

The type of gate (e.g. prefabricated gate, electric fence gate or cocky's gate) will be dependent on the type of fence constructed and the level/type of access required.

10.3.3 Timing

Fencing **MUST** be completed before any other vegetation management works (e.g. pest plant and animal control) are undertaken. Possible exceptions include where:

- Large earthmoving equipment is required to access and negotiate a site e.g. for willow removal or deep-ripping
- Livestock can be removed from the project site during the works phase e.g. to another paddock.

Fencing **SHOULD** be undertaken when the soil is easy to work (e.g. for post hole construction) but not so wet that posts cannot be stabilised (e.g. to tension wires). In addition, fencing **SHOULD** be avoided during the fire danger period (especially if using welders or other heat-generating equipment).

10.4 References

Corangamite Seed Supply and Revegetation Network (2006). *Improving Biodiversity Outcomes in Revegetation Activities - Protocols, Resources and Supporting Documents.*

Department of Sustainability and Environment (2006). *Native Vegetation Revegetation Planting Standards - Guidelines for Establishing Native Vegetation for Net Gain Accounting.* Department of Sustainability and Environment, Victorian Government, East Melbourne.

Land and Water Resources Research and Development Corporation (1996). *Managing Stock. Riparian Management Fact Sheet 6.*

Land for Wildlife Queensland (no date). *Wildlife Friendly Fencing and Netting. Note G4*

Platt, S. and Temby, I. (1999). *Fencing Wildlife Habitat.* Land for Wildlife Notes - LW0029. Department of Natural Resources and Environment. Victoria.

Staton, J. and O'Sullivan, J. (2006). *Stock and Waterways: A Manager's Guide.* Land & Water Australia, Canberra.

11 Vertebrate pest animal management

This standard forms part of a set of state-wide standards for the delivery of vegetation management activities through Victorian Investment Framework (VIF) projects at the landholder scale.

Where pest animal management is to be undertaken as part of a VIF project, this standard MUST be applied.

Determining whether pest animal management is an appropriate activity for a particular vegetation management project is the responsibility of the project manager and will be dependent on a number of factors, including:

- The project goal
- The relevant ecological vegetation class (EVC) for the project site
- The condition and extent of remnant vegetation at the project site, which in turn determines whether the project will focus on:
    - Protection of remnant vegetation
    - Establishment of overstorey and/or understorey plants within a remnant patch i.e. supplementary planting
    - Establishment of native vegetation in formerly cleared areas outside of a remnant patch i.e. revegetation.
- Specific site conditions e.g. soil type, slope
- The type and severity of threats present.

Therefore, this standard should not be read in isolation, but rather sequenced and applied with other relevant standards as appropriate.

11.1 Scope

This standard covers methods for the control of the most common (state-wide) vertebrate pest animal species and overabundant native herbivores that can threaten native vegetation projects, namely:

- Rabbits
- Hares
- Pigs
- Goats
- Deer
- Native herbivores (particularly kangaroos and wallabies.

This standard does not cover:

- Preliminary site assessments (e.g. pest animal densities/distributions) to determine if control methods are required
- Methods for the control of invertebrate pest animal species.

11.2 Background

Native plants (especially the more palatable species) are most vulnerable to pest animal damage when less than one metre in height (as they can be completely eaten or severely damaged at this stage). However, above this height, plants can still be attacked through leaf and shoot browsing, trampling, scratching, rubbing or bark chewing (Greening Australia 2008).

Adequate and appropriate pest animal control can reduce grazing and browsing pressure, maintaining the integrity of remnant native vegetation and enabling the establishment and maintenance of planted vegetation.

11.3 Method

The recommended approach for developing and implementing a pest animal management program involves:

1. Describing the desired goal for a project
2. Assessing the problem[33]
3. Considering the control options/methods and determining:
    - Their effectiveness in treating the problem
    - Their practicality in treating the problem
    - Potential risks of application to both on-site and off-site values. This needs to also consider the risks around the control options.
4. Developing a pest animal management program
5. Implementing the program
6. Maintaining a monitoring and review program.

The following sections cover the third point, namely the consideration of options/methods to manage the most common (state-wide) pest animal species that can threaten native vegetation projects, namely:

- Rabbits
- Hares
- Pigs
- Goats
- Deer
- Native herbivores (particularly kangaroos and wallabies.

11.3.1 Rabbits

Rabbits are preferential grazing animals that:

- Compete with native wildlife for food and shelter (Deppeler 2007)
- Graze native plants
- Prevent plant regeneration by eating seeds and seedlings (Deppeler 2007, Corr 2003)
- Damage and destroy planted trees (Corr 2003)
- Increase soil disturbance
- Increase weed spread
- Can be particularly destructive in riparian zones where soils are soft (Deppeler 2007).

Rabbits are particularly abundant in areas of deep sandy soils (where warrens can be easily established), but occur across a range of habitats and will also inhabit infestations of woody weeds and escarpments (rocky outcrops) when digging is not possible (Deppeler 2007).

[33] This assessment should also identify the presence of indigenous vegetation that must be protected from any control activities as well as any biodiversity values (e.g. fauna habitat).

Control options

Effective long term control of rabbits requires:

- Coordinated group action
- An integrated control program
- Ongoing maintenance.

Coordinated action

Coordinated group action at a landscape scale involving neighbouring landholders and land managers (regardless of land tenure) provides the most effective means of large-scale rabbit control (Department of Primary Industries 2007, Corr 2003).

Working in isolation is rarely effective in suppressing rabbits except for short periods of time (Department of Primary Industries 2007).

Integrated control

A number of control options are available for the management of rabbits, namely:

- Baiting
- Warren fumigation
- Warren destruction
- Shooting
- Fencing
- Harbour removal
- Guarding
- Habitat manipulation.

The following sections provide technical information for implementing each control option. However, in order to achieve the best outcome from rabbit control, an integrated approach employing a number of complementary control techniques **SHOULD** be adopted (Deppeler 2007, Department of Sustainability and Environment 2009). A good example of integrated rabbit management has been documented by Read *et al* (2011).

As such, a set of decision trees has been developed that considers control options for a range of project types and site conditions (refer to Appendix A). The decision trees **SHOULD** be used to guide the development of rabbit control programs.

Regardless of which control option (or options) is used, any rabbit management program **MUST** be appropriately planned and coordinated using the most effective, safe and humane methods available – refer to the *Model Code of Practice for the Humane Control of Rabbits* (Sharp and Saunders 2004a)[34] for details.

Ongoing maintenance

For long-term success (i.e. to keep rabbit numbers at an acceptably low level[35]), monitoring of the project site **MUST** be maintained and appropriate action undertaken if/when required. Failure to maintain a site for the long term can result in the site returning to its pre-control condition in just a few years.

[34] http://www.environment.gov.au/biodiversity/invasive/publications/pubs/cop-rabbits.pdf

[35] Acceptable rabbit densities (as determined by the project manager) will be proportionate to the vegetation community. For example, low rabbit density in a high rainfall area may be acceptable but low rabbit density in a semi-arid area may still pose a risk to vegetation.

A good resource for guidance on assessing rabbit numbers at project planning and following treatment can be found here[36].

Baiting

Applicability

Baiting with poisoned carrots or oats is the most common first-step method to reduce rabbit populations (particularly when densities are medium to high) (Department of Primary Industries 2007).

Advantages and disadvantages of baiting are provided in Table 11.1.

Table 11.1 – Baiting: advantages and disadvantages

Advantages	Disadvantages
• Relatively cheap if 1080 can be used, otherwise not cheap • Can be used in difficult terrain, including by aerial application • Useful to reduce dense rabbit populations prior to ripping and fumigation campaigns, thereby reducing recolonisation • Can be integrated with stock quarantine measures • Pindone bait has an antidote, vitamin K1, and is generally safer to use then 1080 where non target animals like domestic dogs are at risk	• Risk of non-target kills if correct procedures are not followed (whilst rabbits are susceptible to the effects of 1080, other species including humans, native animals and birds, and domestic livestock are also vulnerable) • Risk of secondary poisoning from 1080 where scavengers and carnivores feed upon unrecovered rabbit carcasses • Short-term effectiveness if not implemented in conjunction with other control techniques • Population dynamics and availability of alternative feed affect efficacy • Need to remove stock and provide suitable water supplies, pasture and fencing • Only part of grazing properties can be treated in any one year, increasing the risk of recolonisation • Difficult to know when it is safe to return stock to poisoned paddocks • 1080 baiting cannot be used where there is an unacceptably high risk to humans or companion animals, such as in urban/residential environments • There is no effective antidote for 1080 poison

[36] http://www.feral.org.au/rabbits-a-threat-to-conservation-and-natural-resource-management/.

Technique

Types of bait

There are two toxins available for the baiting of rabbits in Victoria:

- 1080 (sodium monofluoroacetate)
- Pindone.

1080 is the most efficient, humane and species-specific lethal poison registered to control vertebrate pest species (rabbits, foxes, wild dogs and wild/feral pigs) (Department of Primary Industries 2007). For rabbit poisoning, 1080 is applied to carrot or oats and laid in a trail or broadcast from the ground or air.

Pindone is an anticoagulant poison that acts by reducing the blood clotting abilities of the body. After ingestion of pindone by rabbits, the time to death is around 10 to 14 days, during which time the poison can cause distress, disability and/or pain – which is considered inhumane. As such, pindone baiting **MUST** only be used to reduce rabbit populations in areas where 1080 rabbit bait cannot be used i.e. in close proximity to urban areas where the risk of accidental poisoning to humans and pets is greatest.

Baiting technique

All pest animal bait products **MUST** be used in accordance to the directions for use and the product label.

Timing

Baiting **MUST** be timed to occur when rabbits are least territorial and when other foods are scarce (Platt and Temby 1999). This is generally in the late summer/early autumn period (Department of Primary Industries 2007, Platt and Temby 1999).

Licences/permits

All pest animal bait products are dangerous and care **MUST** be taken to ensure they are used safely. They **MUST** be used in accordance with the directions for use and the product label.

The Australian Pesticides and Veterinary Medicines Authority allows registration of a number of products that are suitable for poisoning rabbits as part of a control program. The relevant product label for the prepared bait or poison concentrate provides specific directions for use and **MUST** be read and understood prior to use.

1080

As 1080 poison is a Schedule 7 Dangerous Poison, its use **MUST** be consistent with the directions for the use of 1080 pest animal bait products in Victoria[37]. 1080 bait products have high potential to cause harm at low exposure levels and require special precautions during manufacture, handling or use. Special regulations restrict their availability, possession, storage and use. 1080 pest animal bait products **MUST** only be purchased and used by operators holding a current Agricultural Chemical User Permit (ACUP)[38] with a 1080 endorsement.

[37] http://new.dpi.vic.gov.au/agriculture/farming-management/chemical-use/agricultural-chemical-use/bait-system/directions

[38] http://new.dpi.vic.gov.au/agriculture/farming-management/chemical-use/?a=27304

Pindone

Pindone concentrate is a restricted chemical product rated as an S6 poison; only to be supplied to or used by an authorised person holding a current ACUP.

Pindone **MUST** be used according to instructions on approved labels and relevant State guidelines.

Warren fumigation

Applicability

Advantages and disadvantages of warren fumigation are provided in Table 11.2.

Table 11.2 – Warren Fumigation: advantages and disadvantages

Advantages	Disadvantages
• Suitable follow up/retreatment for ripped sites • Useful in inaccessible places e.g. steep slopes • Suitable near settled areas • Indicator smoke often locates unseen entrances, especially in long grass (particularly pressure fumigation) • Little equipment needed (diffusion fumigation only) • Suitable for impromptu treatment of isolated or re-opened warrens (diffusion fumigation only) • involves minimal disturbance to bushland areas	• Effectiveness depends on the skill of the operator • Treated warrens are readily recolonised if not destroyed • Can kill non-target native species that utilise warrens for shelter • Labour-intensive and slow • Expensive • Not suitable for large areas • Uncomfortable and tiring for operators • Equipment can be heavy and cumbersome, although lighter fumigators are available (pressure fumigation only)

Table adapted from Williams et al (1995) and Platt and Temby (1999).

Technique

Fumigation of rabbits in burrows is an important part of rabbit control. Fumigation usually takes place after ripping, which is about three to four weeks after poisoning. Fumigation is an essential follow up technique to ripping and poisoning (Bloomfield 1999).

There are two types of fumigation:

- Pressure fumigation, in which fumigant gases or vapours are generated outside the warren and forced into the warren under pressure, usually from a pump (Williams et al 1995, Platt and Temby 1999). However, this technique is considered inhumane (Sharp and Saunders 2004a) and **SHOULD** NOT be used
- Diffusion fumigation, where tablets are placed in active burrows and the gas generated is allowed to diffuse through the warren (Williams et al 1995, Platt and Temby 1999). Phosphine is currently the preferred toxin for diffusion fumigation until more humane methods are developed. Chloropicrin (trichloronitromethane) is considered to be highly inhumane and **MUST** NOT be used (Sharp and Saunders 2004b).

Timing

Fumigation **SHOULD** be undertaken in Autumn/Winter then followed by warren destruction (Platt and Temby 1999).

When fumigating with aluminium phosphide tablets damp soil conditions give the best results (Bloomfield 1999).

Licences/permits

The Australian Pesticides and Veterinary Medicines Authority allows registration of a number of products that are suitable for fumigating rabbit warrens as part of a control program. The relevant product label provides specific directions for use and **MUST** be read and understood prior to use.

Some chemicals require the user to possess an ACUP and in some cases further endorsements on that permit. In Victoria, an ACUP is required to use agricultural chemical products that are restricted use chemicals. These are chemicals that have a potentially higher risk of adversely affecting the user's health, the environment and trade.

Warren destruction

Applicability

Warren destruction is a key follow-up action in a control program to prevent rabbits from re-infesting a project site.

Advantages and disadvantages of warren destruction by mechanical ripping are provided in Table 11.3.

Table 11.3 – Warren destruction: advantages and disadvantages

Advantages	Disadvantages
• Ripping targets the key in the rabbits defence – its ability to rebound and recolonise • The most long-lasting of the prescribed techniques • The most cost-effective of the standard techniques in the long term • Compatible with prior poisoning and fumigation, as well as follow-up fumigation • Suitable for large-scale operations	• Unsuitable for steep slopes and very rocky land • Requires heavy equipment • Can damage/disturb native understory and ground flora • May facilitate weed invasion amongst native vegetation • Can impact habitat for some native animals e.g. carpet python, southern brown bandicoot, stripped legless lizard • Can damage/disturb cultural heritage sites • Where rabbits are high in number may require poisoning to precede this option • May require planning, waterway or cultural assessments to be conducted prior to implementation

Table adapted from Williams et al (1995), Department of Sustainability and Environment (2009) and Platt and Temby (1999).

Technique

The most common technique for warren destruction is ripping.

Where broad scale ripping is appropriate (such as on open and cleared land) it **SHOULD** start at least four metres out from the outermost warren opening. The distance between rip lines **SHOULD** be no more than 50cm. Interline ripping between the rip lines after the first pass, will help destroy the warren structure (Bloomfield and Cummings 2003).

Cross ripping may be necessary in some areas. Cross ripping is to rip in one direction and then to rip again at an angle of 90 degrees to the original ripping (Bloomfield and Cummings 2003).

Depth of riplines

The warren **SHOULD** be ripped to a depth of 1.5m or more if possible. The deeper the ripping the greater the destruction of the warren system (Bloomfield and Cummings 2003).

Soil erosion

Ripped warrens **SHOULD** be track rolled to reduce the risk of rabbits burrowing in on the rip line caused by the dozer. Track rolling will also help compact the soil surface and reduce the risk of erosion (Bloomfield and Cummings 2003).

The site **SHOULD** be revegetated with appropriate vegetation as soon as possible (Bloomfield and Cummings 2003).

Native fauna habitat

If warrens are providing a refuge for native fauna species, consideration **MUST** be given to eradicating the rabbits by other methods e.g. by erecting rabbit proof fencing around the warren (Bloomfield and Cummings 2003).

Timing

Ripping **SHOULD** typically be carried out two to three days after fumigation (Platt and Temby 1999).

Licences/permits

High impact activities in culturally sensitive landscapes (e.g. warren destruction within 200m of a named waterway) can cause significant harm to Aboriginal cultural heritage.

In these situations the Aboriginal Heritage Act 2006 may require the project manager to prepare a Cultural Heritage Management Plan or obtain a cultural heritage permit or enter into a cultural heritage agreement with the relevant Registered Aboriginal Party.

If ripping is proposed within a culturally sensitive landscape, the project manager **MUST** determine if a Cultural Heritage Management Plan or cultural heritage permit is required. Specific information on considering Aboriginal cultural heritage needs can be sourced here[39].

[39] http://www.dpcd.vic.gov.au/indigenous/aboriginal-cultural-heritage/information-for-planners-and-developers

Shooting

Applicability

Advantages and disadvantages of shooting are provided in Table 11.4.

Table 11.4 – Shooting: advantages and disadvantages

Advantages	Disadvantages
• Directly targets the problem • Effective method for targeting the remaining individuals following baiting, harbour removal and/or warren destruction.	• Only effective when rabbits are at extremely low population levels and is relatively ineffective at any other time (Department of Primary Industries 2007) • Only appropriate as part of an integrated program • Cannot be used in semi urban or urban areas • Requires firearm licence

Technique

Shooting can be a humane method of destroying rabbits when:

- It is carried out by experienced, skilled and responsible shooters
- The animal can be clearly seen and is within range
- The correct firearm, ammunition and shot placement are used (Sharp and Saunders 2004a).

Achieving a humane kill with a single shot can be difficult as rabbits are a small target. Wounded rabbits **MUST** be located and dispatched as quickly and humanely as possible (Sharp and Saunders 2004a).

Timing

Where appropriate, shooting can be undertaken at anytime.

Licences/permits

Users of firearms **MUST** adhere to relevant laws and restrictions.

All firearm users **MUST** be appropriately licensed and hold current accreditations. The use of firearms for the humane destruction of pest animals on crown land is also subject to conditions. Firearms **MUST NOT** be carried or discharged in national parks, state parks and a range of reserves without appropriate authorisation.

Fencing

Applicability

Soundly constructed and well maintained rabbit-proof netting fences are the only reliable and long term barriers to rabbit movement (Department of Primary Industries 2007) especially where there is a high risk of rabbit invasion from areas adjoining the site (Department of Sustainability and Environment 2009a).

Advantages and disadvantages of rabbit-proof fencing are provided in Table 11.5.

Table 11.5

Table 11.5 – Fencing: advantages and disadvantages

Advantages	Disadvantages
• Can be designed to enable effective pest animal control irrespective of lack of control on adjacent land • Enables sequential control operations on large management units • Eradication may be possible within enclosures • High-value, functional and capital asset • Better management of pastures • Functions also as a stock fence • Facilitates poisoning operations	• High cost • Requires high maintenance e.g. rabbits are able to gain access through even a small hole in the fence • May require additional water points for stock • Can restrict wildlife movement • Susceptible to flood damage

Table adapted from Williams et al (1995) and Platt and Temby (1999).

Technique

Rabbit-proof fences **MUST** be a minimum of 1,050mm width, 30mm hexagonal netting (Moseby and Read 2006, Department of Sustainability and Environment 2009a).

Netting **SHOULD** be fixed so that it reaches at least 900mm above the ground and is either buried (to 150mm depth) or laid down to a width of 30 cm along the ground facing outwards and secured with pegs, rocks or timber (Moseby and Read 2006, Department of Sustainability and Environment 2009a).

Netting **SHOULD** be attached to an appropriate stock fence (refer to the *Stock Fencing* standard for details).

Harbour removal

Applicability

Harbour can include both rubbish dumped on site and weeds (e.g. Blackberries, Gorse) (Department of Sustainability and Environment 2009a).

Advantages and disadvantages of harbour removal are provided in Table 11.6.

Table 11.6 – Harbour Removal: advantages and disadvantages

Advantages	Disadvantages
• Increases efficiency of control programs • Opens up warrens and dens for treatment • Retards recolonisation • Assists in on-site management of weed species	• May reduce habitat for native animal species • May require local government planning permits regarding disturbance of native vegetation • May require CMA authorised waterway permits

Table adapted from Williams et al (1995).

Technique

Refer to the *Woody Weed Control* standard for details.

Where woody weeds are providing habitat for native animals, project managers **MUST** ensure that either:

- Alternative habitats are established prior to woody weed removal (e.g. replanting of comparable indigenous vegetation); or
- Woody weed removal is staged such that an acceptable level of habitat is maintained throughout the project transition.

Where native vegetation is providing harbour, all available control options (e.g. erection of rabbit-proof fence around vegetation and removal of rabbits by shooting) **MUST** be attempted before harbour removal is considered.

Licences/permits

Clause 52.17 of the Victorian Planning Provisions requires a permit to remove, destroy or lop native vegetation.

If harbour removal involves the removal of native vegetation, a planning permit from the relevant local council **MUST** be obtained (unless the removal is exempt under the planning scheme).

A permit may also be required for native vegetation removal under a planning scheme overlay such as the Environmental Significance Overlay, Vegetation Protection Overlay, Significant Landscape Overlay, Heritage Overlay, Salinity Management Overlay, Erosion Management Overlay or Public Acquisition Overlay.

Guarding

Applicability

Whilst tree guards are effective in stopping rabbits from destroying young plants, they do not provide adequate plant protection from browsing of plant tops (Greening Australia 2008, Corr 2003). This is especially true for tree guards using milk cartons and plastic sleeves.

As such, all alternative control options **MUST** be considered before deciding to individually guard plants (Anderson 2003).

Advantages and disadvantages of tree guards are provided in Table 11.7.

Table 11.7 – Guarding: advantages and disadvantages

Advantages	Disadvantages

• Protects seedlings from rabbits and hares
• Reduces potential impacts to plants from:
  o Hot and cold winds
  o Insect damage (e.g. wingless grasshoppers)
  o Frost (particularly when planting in Autumn in frost prone areas)
  o Spray drift from herbicides.
• Can stimulate plant growth by:
  o Creating a warm and moist micro-climate
  o Funnelling rainwater to the roots of plant
	• Does not provide adequate plant protection from browsing of plant tops
	• Can lead to development of non sturdy 'leggy' stems and weaker roots by over-sheltering from wind
	• Guards that restrict light penetration (e.g. milk cartons) may also lead to weak or 'leggy' growth of short seedlings
	• Milk cartons also provide no significant protection from browsing/grazing animals
	• Very expensive (often costing more than the trees) (Anderson 2003)*
	• More labour is required to guard all trees planted
	• Can create litter/waste if follow-up removal is not undertaken (particularly plastic tree guards)

* When planting large areas, it may be more cost effective to rabbit-proof fence the whole site and remove all rabbits inside the fenced area prior to planting (Department of Primary Industries 2007).

Technique

Refer to the *Plant Establishment* standard for details.

Tree guards **MUST NOT** be used as a substitute for adequate pest control (Corr 2003).

Habitat manipulation

Applicability

Heavy planting of trees and shrubs can reduce available grass for rabbits and reduce the carrying capacity of some sites for rabbits. This technique may be particularly suited to sites that were cleared and can be managed as revegetated sites (Department of Primary Industries 2007).

This technique is inappropriate for grasslands or grassy woodlands and therefore **MUST NOT** be used in these vegetation communities.

Technique

Refer to the *Planting Density, Diversity and Placement* standard for details.

11.3.2 Hares

Unlike rabbits, hares do not build warrens, resting instead in a shallow depression called a 'form', and are solitary animals. Hares prefer grassland and open woodland habitats (Platt and Temby 1999).

A limited number of control options are available for the management of hares, namely:

- Shooting
- Fencing
- Guarding
- Habitat manipulation.

These control options are presented in the following sections with integrated control options (decision trees) provided in Appendix B. The decision trees **SHOULD** be used to guide the development of hare control programs.

Shooting

Refer to Rabbits section.

Fencing

Refer to Rabbits section.

Guarding

Refer to Rabbits section.

Habitat manipulation

Refer to Rabbits section.

11.3.3 Pigs

Feral pigs are found across Victoria, mainly on public land and to a limited extent on private land. There is evidence that feral pigs, through habitat degradation and predatory feeding, are threatening biodiversity and agricultural values.

The main control options used to manage feral pigs are:

- Shooting
- Fencing
- Baiting
- Trapping.

These control options are detailed in the following sections with integrated control options (decision trees) provided in Appendix C. The decision trees **SHOULD** be used to guide the development of pig control programs.

Regardless of which control option (or options) is used, any feral pig management program **MUST** be appropriately planned and coordinated using the most effective, safe and humane methods available - refer to the *Model Code of Practice for the Humane Control of Feral Pigs* (Sharp and Saunders 2004c)[40] for details.

Shooting

Applicability

Shooting has been long established as a control technique for feral pigs. Until about 1980, shooting was a ground based operation undertaken by recreational hunters and landholders. Since 1980, shooting from helicopters has become a more frequent form of control (Choquenot *et al* 1996).

Ground shooting

The feral pig is commonly taken from the ground by either:

- Landholders (generally on an opportunistic basis)
- Hunters (with trained pig dogs) (Choquenot et al 1996).

It is generally considered that ground shooting plays an insignificant role in feral pig control except where it is intensively conducted on small populations (Choquenot *et al* 1996).

Advantages and disadvantages of ground shooting are provided in Table 11.8.

Table 11.8 – Shooting from the ground: advantages and disadvantages

Advantages	Disadvantages
• Can remove individual pigs in a disease outbreak • Species-specific	• Rarely effective for damage control • Can disperse pigs • Costs increase greatly as pig numbers decrease • Requires skilled operators • Not long-lasting or effective for large-scale control

Table adapted from Choquenot *et al* (1996).

[40] http://www.environment.gov.au/biodiversity/invasive/publications/pubs/cop-feral-pigs.pdf

Shooting from the air

Shooting from the air using helicopters is perceived to be a more effective technique for feral pig control than ground shooting because it reduces the effects of immigration. However, it is not effective for reducing pigs to very low densities because costs of finding and shooting remaining pigs increase greatly as numbers decline (Choquenot *et al* 1996).

Advantages and disadvantages of shooting from the air are provided in Table 11.9.

Table 11.9 – Shooting from the air: advantages and disadvantages

Advantages	Disadvantages
• Ideal for rapid population knockdown over a number of properties • Takes up little landholder time • Species-specific • Allows control in inaccessible terrain • Unaffected by seasonal conditions	• Can disperse animals • Costs increase greatly as pig numbers decrease • Annual shoots ineffective for keeping pig numbers low • Ineffective in woodland and forest

Table adapted from Choquenot *et al* (1996).

Timing

Where appropriate, shooting can be undertaken at anytime.

Licences/permits

Users of firearms **MUST** adhere to relevant laws and restrictions.

All firearm users **MUST** be appropriately licensed and hold current accreditations. The use of firearms for the humane destruction of pest animals on crown land is also subject to conditions. Firearms **MUST NOT** be carried or discharged in national parks, state parks and a range of reserves without appropriate authorisation.

Trapping

Applicability

Trapping is best used where poisoning is impractical or as a follow-up control measure after poisoning (Agriculture Protection Board 1991 cited in Choquenot *et al* 1996).

Advantages and disadvantages of trapping are provided in Table 11.10.

Table 11.10 – Trapping: advantages and disadvantages

Advantages	Disadvantages
• Can be incorporated into existing management practices • Pig numbers can be monitored • Traps can be re-used • Landholders can offset trap costs by selling trapped pigs • Does not affect normal pig behaviour • More humane than other methods	• Must be checked regularly • Labour intensive; best used as follow-up control • Not practical for large-scale control

Table adapted from Choquenot *et al* (1996).

Technique

Landholders often permanently locate traps in areas of feral pig activity and activate the traps when pig signs become evident or on a strategic basis to protect a susceptible enterprise (Choquenot *et al* 1996).

Hone *et al* (1980 cited in Choquenot *et al* 1996) list the following points that **SHOULD** be considered when trapping for feral pigs:

- Type of trap to use
- Number of traps to use
- Where to put traps
- Number of nights each trap is used
- Type and amount of bait to use
- Amount and duration of free-feeding.

Various trap designs exist and the choice revolves around the experience, knowledge and resources available to the trapper (Choquenot *et al* 1996).

Baiting

Applicability

Although shooting and trapping can be used as control techniques, baiting using 1080 is the most effective option for controlling feral pigs (Twigg *et al* 2006).

Advantages and disadvantages of baiting are provided in Table 11.11.

Table 11.11 – Baiting: advantages and disadvantages

Advantages	Disadvantages
• Proven method • Widely accepted in rural community • Fast and effective initial knockdown • Relatively cheap	• Non-target risks • Animal welfare implications • Requires registration • May cause vomiting and result in bait-shy pigs or development of resistance • Usually requires prior free-feeding

Table adapted from Choquenot *et al* (1996).

Technique

Types of bait

The Australian Pesticides and Veterinary Medicines Authority have registered 1080 as a lethal poison for the control of feral pigs.

Baiting technique

Feral pig bait products **MUST** be used in accordance to the directions for use and the product label.

Timing

Feral pigs will often travel along defined tracks, creating pads similar to those of sheep and cattle. Evidence of feral pigs is usually most pronounced at the end of autumn and early winter when food supply is more limited, and pigs need to travel further to find food.

Therefore baiting **SHOULD** occur between the end of autumn and early winter (Twigg *et al* 2006).

Licences/permits

All pest animal bait products are dangerous and care **MUST** be taken to ensure they are used safely and in accordance with the directions for use and the product label.

The Australian Pesticides and Veterinary Medicines Authority allows registration of a number of products that are suitable for poisoning pigs as part of a control program. The relevant product label for the prepared bait or poison concentrate provides specific directions for use and **MUST** be read and understood prior to use.

1080

As 1080 poison is a Schedule 7 Dangerous Poison, its use **MUST** be consistent with the directions for the use of 1080 pest animal bait products in Victoria[41]. 1080 bait products have high potential to cause harm at low exposure levels and require special precautions during manufacture, handling or use. Special regulations restrict their availability, possession, storage and use. 1080 pest animal bait products **MUST** only be purchased and used by operators holding a current Agricultural Chemical User Permit (ACUP)[42] with a 1080 endorsement.

Fencing

Applicability

Fencing is not a popular control technique for feral pigs except to protect valuable enterprises in relatively small areas

Advantages and disadvantages of fencing are provided in Table 11.12.

Table 11.12 – Fencing: advantages and disadvantages

Advantages	Disadvantages
• Effective protection for lambing paddocks or small high-value resource areas • More humane than other control methods	• Can be expensive and requires a high level of maintenance • Fences will eventually be breached • Not practical for large-scale control

Table adapted from Choquenot *et al* (1996).

[41] http://new.dpi.vic.gov.au/agriculture/farming-management/chemical-use/agricultural-chemical-use/bait-system/directions

[42] http://new.dpi.vic.gov.au/agriculture/farming-management/chemical-use/?a=27304

Technique

The minimum wire specifications that **MUST** be applied for feral pig fencing projects are detailed in Table 11.13.

Table 11.13 – Minimum wire specifications by stock type

Fence Type	Feral Pigs
Mesh	Standard 8/80/15 ring lock and plain wire
Electric	6 strand plain wire with at least 3 electrified strands ensuring that the bottom wire is earthed* To reduce fence damage and breaches, installation of two electric trip wires **SHOULD** be included (Trip wire 1 - 375mm off the ground and 200mm in front of the fence. Trip wire 2 - 200mm off the ground and 350mm in front of the fence). Trip wires supported by posts spaced at 10-15m intervals.

* Note: long grass may short-out fence, hence site will require regular maintenance.

Table adapted from Choquenot *et al* (1996).

11.3.4 Goats

Goats are generalist herbivores, eating a wide variety of plant foods with the highest quality food available often selected. The feral goat is a major environmental and agricultural pest that has a significant impact on native vegetation. As selective feeders, feral goats can reduce the diversity of plant species, preventing regeneration of some trees and shrubs and leaving only unpalatable plants or those resistant to browsing (Department of Employment, Economic Development and Innovation 2010).

Feral goats also compete with native fauna for food, shelter and water, particularly in semi-arid areas (Department of Employment, Economic Development and Innovation 2010).

The main control options used to manage feral goats are:

- Shooting
- Trapping
- Mustering
- Fencing.

Regardless of which control option is used, any feral goat management program **MUST** be appropriately planned and coordinated using the most effective, safe and humane methods available - refer to the *Model Code of Practice for the Humane Control of Feral Goats* (Sharp and Saunders 2004d)[43] for details.

Shooting

Applicability

Controlling feral goats by shooting can be undertaken from the ground or from the air.

Ground shooting

Ground shooting is labour intensive but can produce good results if control programs are well planned and the effort is maintained (Department of Employment, Economic Development and Innovation 2010).

[43] http://www.environment.gov.au/biodiversity/invasive/publications/pubs/cop-feral-goats.pdf

It is often employed in areas of high cover e.g. within forested areas.

Shooting from the air

Helicopter shooting is extremely effective and can result in a rapid and substantial reduction in goat numbers when there is no extensive cover in the form of dense scrub, caves, or rock piles. However, helicopter shooting is expensive and is used only when the need for a reduction in feral goat numbers is great and when cheaper alternatives are not available (Department of Employment, Economic Development and Innovation 2010).

Advantages and disadvantages of shooting (from both ground and air) are provided in Table 11.14.

Table 11.14 – Shooting: advantages and disadvantages

Advantages	Disadvantages
• Proven method • Can target particular goats	• Requires skilled shooters to ensure humane kills

Table adapted from Parkes *et al* (1996).

Judas goat

In areas where it is difficult to find goats (e.g. moderate to dense vegetation, hilly terrain), the 'Judas goat' technique can be used.

This technique involves fitting a feral goat with a radio transmitter and releasing it in a known feral goat area to join the herd. The radio collared 'Judas' goat is then tracked and local feral goats are shot. The 'Judas' goat can then be allowed to escape and the process repeated (Department of Employment, Economic Development and Innovation 2010).

Timing

Where appropriate, shooting can be undertaken at anytime.

Licences/permits

Users of firearms **MUST** adhere to relevant laws and restrictions.

All firearm users **MUST** be appropriately licensed and hold current accreditations. The use of firearms for the humane destruction of pest animals on crown land is also subject to conditions. Firearms **MUST NOT** be carried or discharged in national parks, state parks and a range of reserves without appropriate authorisation.

Trapping

Applicability

A critical weak-point in the feral goat's normal resilience to management is their reliance on water. During dry times, feral goats can be trapped when they concentrate around water (Parkes *et al* 1996).

Advantages and disadvantages of trapping are provided in Table 11.15.

Table 11.15 – Trapping: advantages and disadvantages

Advantages	Disadvantages
• Sale of goats can offset costs of building and maintaining traps • Can be done by landowners • The traps can also be used to muster sheep	• Has several welfare problems (e.g. irregular checking of traps can lead to stress or starvation of animals) • Can only be used during dry times • Ineffective where extensive bodies of permanent water are present

Table adapted from Parkes *et al* (1996).

Technique

Traps consist of a goat-proof fence surrounding a water point that is entered through one-way gates or ramps. There are a variety of designs for these gates or ramps, which permit the goats to enter, but not to exit (Department of Employment, Economic Development and Innovation 2010).

Maintenance

Traps **MUST** be cleared regularly to avoid starvation and stress, and operated only during the daytime to avoid catching macropods (Parkes *et al* 1996).

Mustering

Applicability

Mustering reduces goat populations and has the additional advantage that costs can be offset from the sale of captured goats. However, mustering may not always be as effective as it has been perceived (Parkes *et al* 1996).

Advantages and disadvantages of mustering are provided in **Table 11.16**.

Table 11.16 – Mustering: advantages and disadvantages

Advantages	Disadvantages
• Sale of goats can offset costs of control • Can be done by landowners	• Has several welfare problems (e.g. irregular checking of traps can lead to stress or starvation) • Only economic and efficient at high goat densities

Table adapted from Parkes *et al* (1996).

Technique

Two general methods are used to herd goats into yards:

- Mustering by helicopters or light aircraft (to flush goats out of rough country or move animals closer to the yards)
- Mustering by people on horses or on motorbikes usually with the aid of one or more dogs (Parkes *et al* 1996).

Fencing

Applicability

Fences can be utilised in a number of ways to manage feral goats, for example:

- To limit the dispersal of feral goats or to break up large land areas into manageable blocks
- To exclude feral goats from some water points to concentrate them at others where they can be trapped (refer to Trapping section directly above)
- To constrain captured feral goats (Parkes *et al* 1996).

Advantages and disadvantages of fencing are provided in **Table 11.17**.

Table 11.17 – Fencing: advantages and disadvantages

Advantages	Disadvantages
• Can limit dispersal • Useful during control campaigns to compartmentalise larger areas • Can be used to exclude goats from some water supplies and force them to drink at sites where they can be trapped	• Fences will always be breached eventually, thus they are tactical, not strategic • Effective fences are very expensive

Table adapted from Parkes *et al* (1996).

Technique

The minimum wire specifications that **MUST** be applied for feral goat fencing projects are detailed in **Table 11.18**.

Table 11.18 – Minimum wire specifications by stock type

Fence Type	Feral Goats
Mesh	Standard 7/90/30 or 8/90/30 ring lock and plain wire
Electric	6 strand plain wire with at least 3 electrified strands ensuring that the bottom wire is earthed*

* Note - long grass may short-out fence, hence site will require regular maintenance.

Table adapted from Parkes *et al* (1996)

Whilst no two fence designs will be exactly the same, the following standards (adapted from Parks and Wildlife Service Tasmania 2003) **MUST** be applied:

- Goats can escape by climbing diagonal braces/stays. Therefore stays **MUST** be enclosed and either:
    - Situated on the outside of the wire (if possible)
    - Constructed of 40 mm or narrower galvanised pipe (goats can't climb up this).
- Goat fencing **MUST** be a minimum height of 900mm but preferably 1200mm.
- The bottom wire **MUST** be no more than 50mm above the ground. On uneven terrain, consideration should be given to reducing the interval between posts to maintain this maximum gap.

11.3.5 Deer

Deer will graze and browse young plants, disturb soil, create large wallows around water holes and depressions (opening up the soil for weed invasion) and damage the bark of trees by rubbing their antlers on tree trunks, particularly in autumn. Deer activity can impede natural and planned revegetation and can often result in the establishment of weeds. This occurs as a result of deer browsing young plants and damaging the ground cover with their hooves. Consequently the reduction in ground cover can often lead to a decline in soil stability, water quality, habitat for ground dwelling animals, foraging habitat and reduced biodiversity (Molonglo Catchment Group no date).

Deer control can be difficult and is generally limited to shooting and fencing.

Shooting

Licences/permits

In Victoria, a license **MUST** be acquired for recreation game hunting of the following deer species:

- Sambar deer
- Hog deer
- Red deer
- Fallow deer.

Users of firearms **MUST** adhere to relevant laws and restrictions.

All firearm users **MUST** be appropriately licensed and hold current accreditations. The use of firearms for the humane destruction of pest animals on crown land is also subject to conditions. Firearms **MUST NOT** be carried or discharged in national parks, state parks and a range of reserves without appropriate authorisation.

For further information, refer to DSE's Game Hunting[44] web page.

Seasons

Open season for recreational game hunting of these species are as follows:

- Sambar deer by stalking. There is a year-long open season for stalking and a restricted period from the second Saturday after Easter Sunday to the last day in November each year for using scent-trailing hounds
- Hog deer. The open season is restricted to a single month from April 1 to the April 30 each year
- Red deer. The open season is restricted to the months of June and July each year
- Fallow deer. There is a year-long open season for hunting Fallow Deer, with hunting permitted in State Forest and other areas of unoccupied Crown Land where the carriage and use of firearms is permitted. Hunting can also be carried out on private property with the permission of the land owner/manager. Fallow deer cannot be hunted in National Parks, reserves or other sanctuaries

The year-long open season for Fallow deer is designed to assist private land owners to significantly reduce or eliminate Fallow deer, particularly herds that are causing problems for landowners or having a detrimental effect on conservation values.

[44] http://www.dse.vic.gov.au/recreation-and-tourism/game-hunting-home

Hunting locations

Game Hunting in Victoria (Department of Sustainability and Environment 2005) lists the following locations as available for hunting:

- State forest and other unoccupied Crown land. Game species may be hunted during the open season only.
- State Game Reserves. Game species may be hunted, but only during the open season. Six State Game Reserves are available for Hog deer hunting.
- National Parks, State Parks, Coastal Parks, Wilderness Parks. Generally, hunting of any type is not permitted at any time; however, there are some exceptions.
- Leased Crown land. Game species may be hunted during the open season but and only with the permission of the lessee.
- Licensed Crown land. Game species may be hunted during the open season only unless the land is licensed under the Land Act 1958.
- Private land. Game species may be hunted during the open season but only with the permission of the land owner/manager.

Fencing

Technique

Mesh exclusion fencing **MUST** be sturdy and high (at least 2m), and can be constructed from star pickets and wire netting.

11.3.6 Native herbivores

In some areas, wallabies and kangaroos may cause damage to revegetation projects through damage to fences and browsing of plants (Corangamite Seed Supply and Revegetation Network 2006, Corr 2003). For example:

- Wallabies enjoy a varied diet, which includes the leaves of young seedlings with a preference for browsing overstorey species such as Eucalypts, She-oaks and Acacias (Deppeler 2007, Temby 2003)
- Kangaroos can cause significant damage to some revegetation sites by camping and grazing in the areas that have been planted (Deppeler 2007).

The most common methods used to minimise wallaby and kangaroo impact are:

- Fencing
- Guarding
- Plant selection
- Repellents
- shooting.

These control options are detailed in the following sections with integrated control options (decision trees) provided in Appendix D. The decision trees **SHOULD** be used to guide the development of wallaby and kangaroo control programs.

Fencing

Applicability

Where native animals are damaging seedlings, exclusion fencing may be an option (Corr 2003).

However, large scale fencing to exclude wildlife may be inappropriate and **SHOULD** consider the movement needs of wildlife (Corangamite Seed Supply and Revegetation Network 2006).

Technique

Constructing fencing that gives 100 per cent protection from kangaroo browsing is difficult and very expensive (Deppeler 2007). This is because kangaroos generally push through fences, as well as jumping over them (Temby 2003).

Electric fence configurations are now available that will keep most kangaroos out most of the time. An electric fence design gaining increasing acceptance is a 45 degree, 12-wire sloping electric fence which leans into the paddock. The second, fourth, sixth and eighth wires are live, with the next three carrying an induced current. This design is capable of excluding kangaroos as well as foxes and other species (Temby 2003).

Guarding

Applicability

Very tall tree guards of rigid plastic mesh or heavy-duty weld mesh **can** be used to prevent kangaroo or wallaby browsing in some areas (Greening Australia 2008).

These individual tree guards are suitable for growing isolated trees but are considered a costly method of revegetation. However, in some locations they may be the only option to get some species represented (Deppeler 2007).

Traditional guards, such as plastic sleeves or milk cartons, **MUST NOT** be used to protect plants from wallaby grazing (Deppeler 2007).

Plant selection

Applicability

The use of locally indigenous prickly or less palatable species as companion plants to more palatable species can be another effective deterrent to browsing animals (Corr 2003, Corangamite Seed Supply and Revegetation Network 2006, Deppeler 2007). For example, the planting of prickly Hedge Wattle (*Acacia paradoxa*) in niches with palatable She-oaks (*Allocasuarina* spp.).

This technique **MUST** be used with caution as plant selection should be based on locally native (indigenous) species.

Technique

Where the impact of browsing animals is assumed to be significant, the most common techniques employed are:

- Exclude palatable species in the first few years of planting
- Increase the proportion of prickly or less palatable species when developing plant order.

Repellents

One effective, short-term repellent for wallabies is a three-part product applied to certain seedling trees to help reduce browsing damage. The distributors state that the repellent will deter browsing of certain tree seedlings by:

- Bennett's Wallaby (*Macropus rufogriseus rufogriseus*)
- Swamp Wallaby or Black Wallaby (*Wallabia bicolor*)
- Red-necked Wallaby (*Macropus rufogriseus*)
- Pretty-faced Wallaby (*Macropus parryi*)
- European Rabbit (*Oryctolagus cuniculus*)
- Tasmanian Pademelon (*Thylogale billardierii*).

Applicability

The protection given by the repellent is limited to six to eight weeks (Corr 2003). Therefore, it is important to inspect plants for evidence of grazing/browsing pressure during and immediately after this timeframe and apply appropriate management if required e.g. guarding.

Technique

The repellent is applied to seedlings as follows:

1. Part A (whole egg solids) and Part B (acrylic polymer adhesive) are mixed together with water and sprayed onto foliage of the trees
2. Then, before the mixture dries, Part C (silicon carbide grit) is sprinkled onto the foliage.

Browsing behaviour is reduced when animals associate the odour of the liquid with the unpalatable texture of the grit.

Timing

The repellent **SHOULD** be applied as a single application 1 to 7 days prior to, or after, planting.

Shooting

As presented above, many problems can be resolved using non-lethal measures that may provide more effective solutions than simply resorting to killing wildlife. In general, appropriate non-lethal wildlife management options **MUST** be attempted and documented before the Department of Sustainability and Environment will consider issuing an Authority to Control Wildlife under the *Wildlife Act 1975*.

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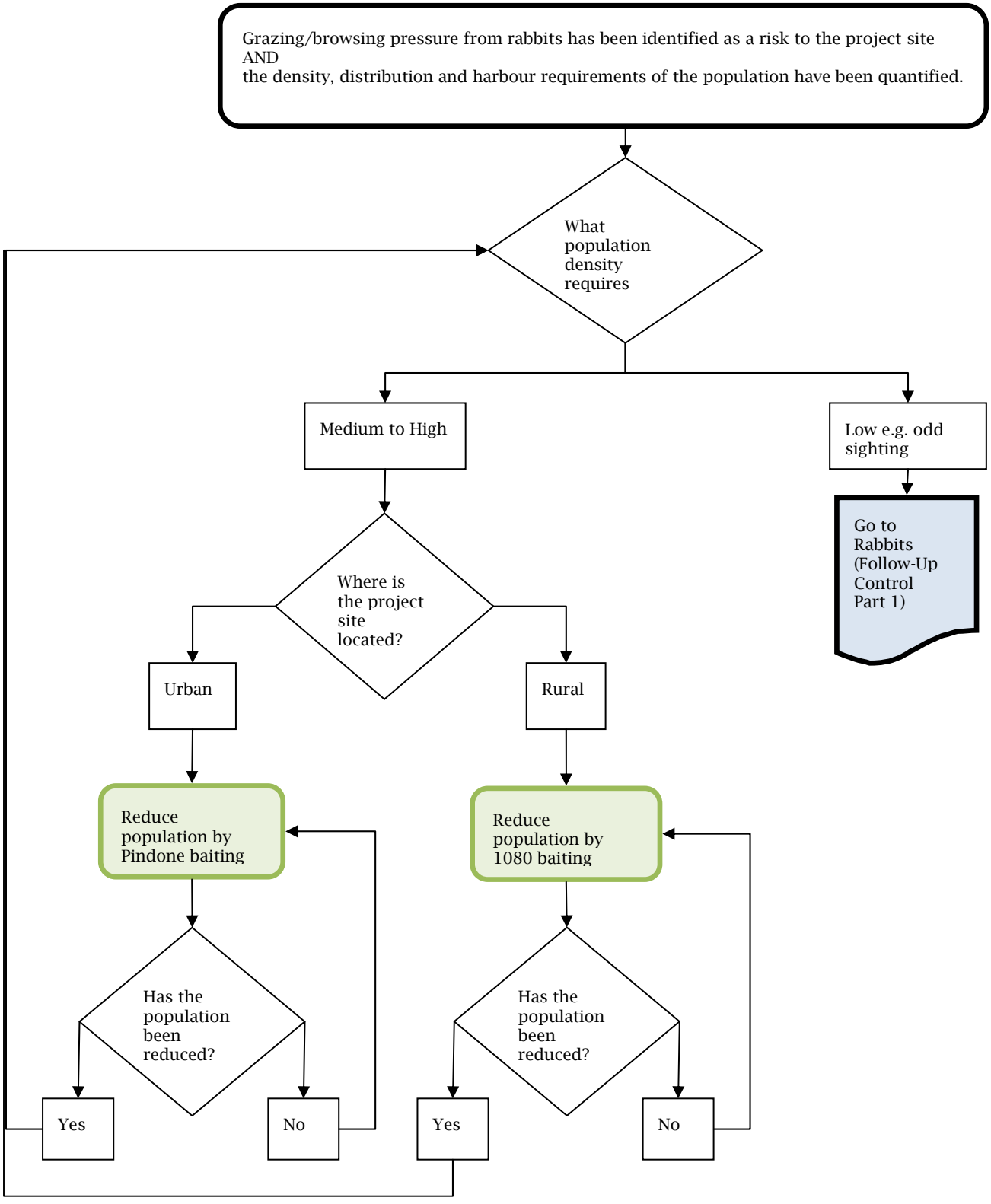
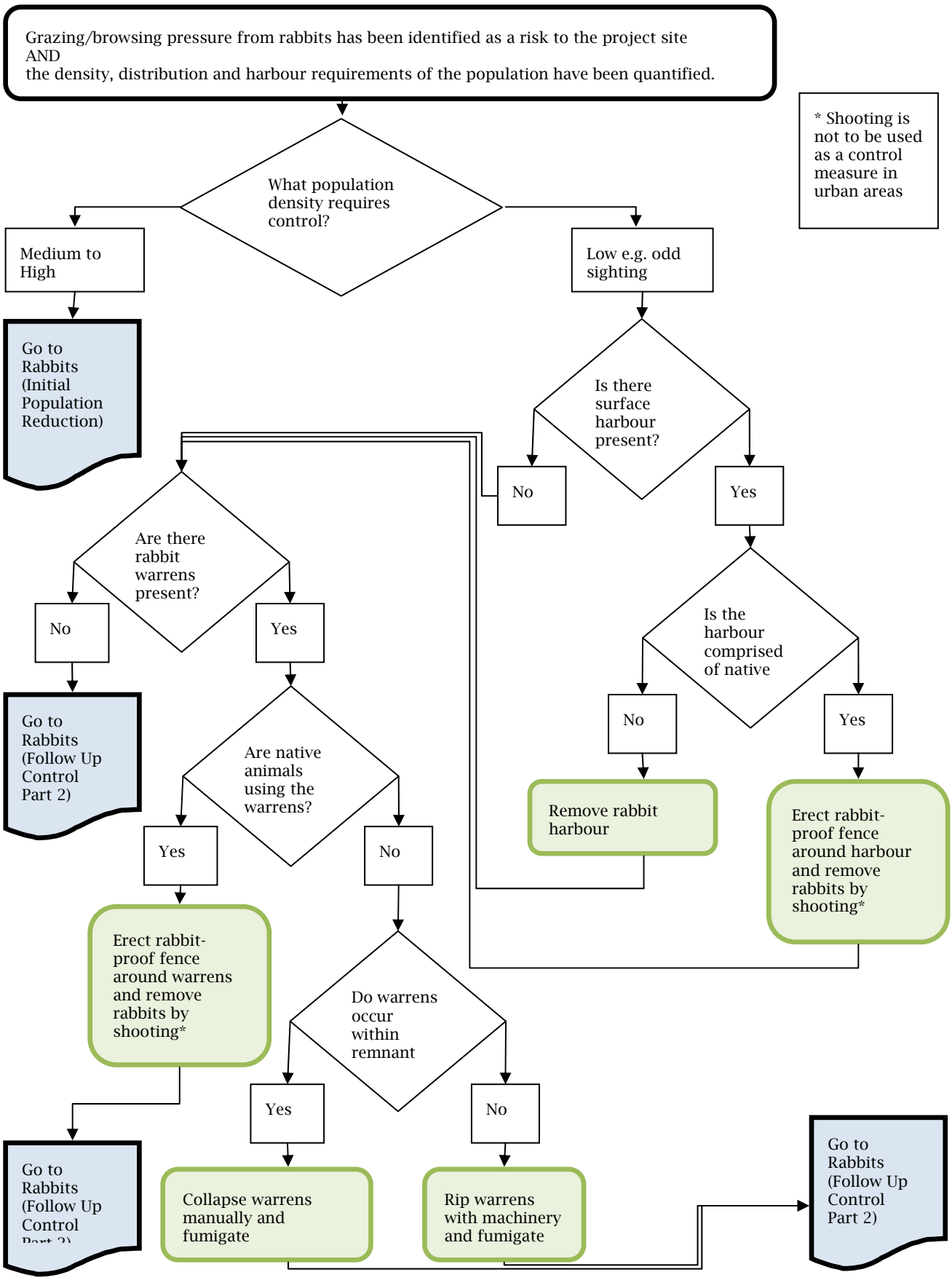
11.5 Appendix A – Decision trees for rabbit Control

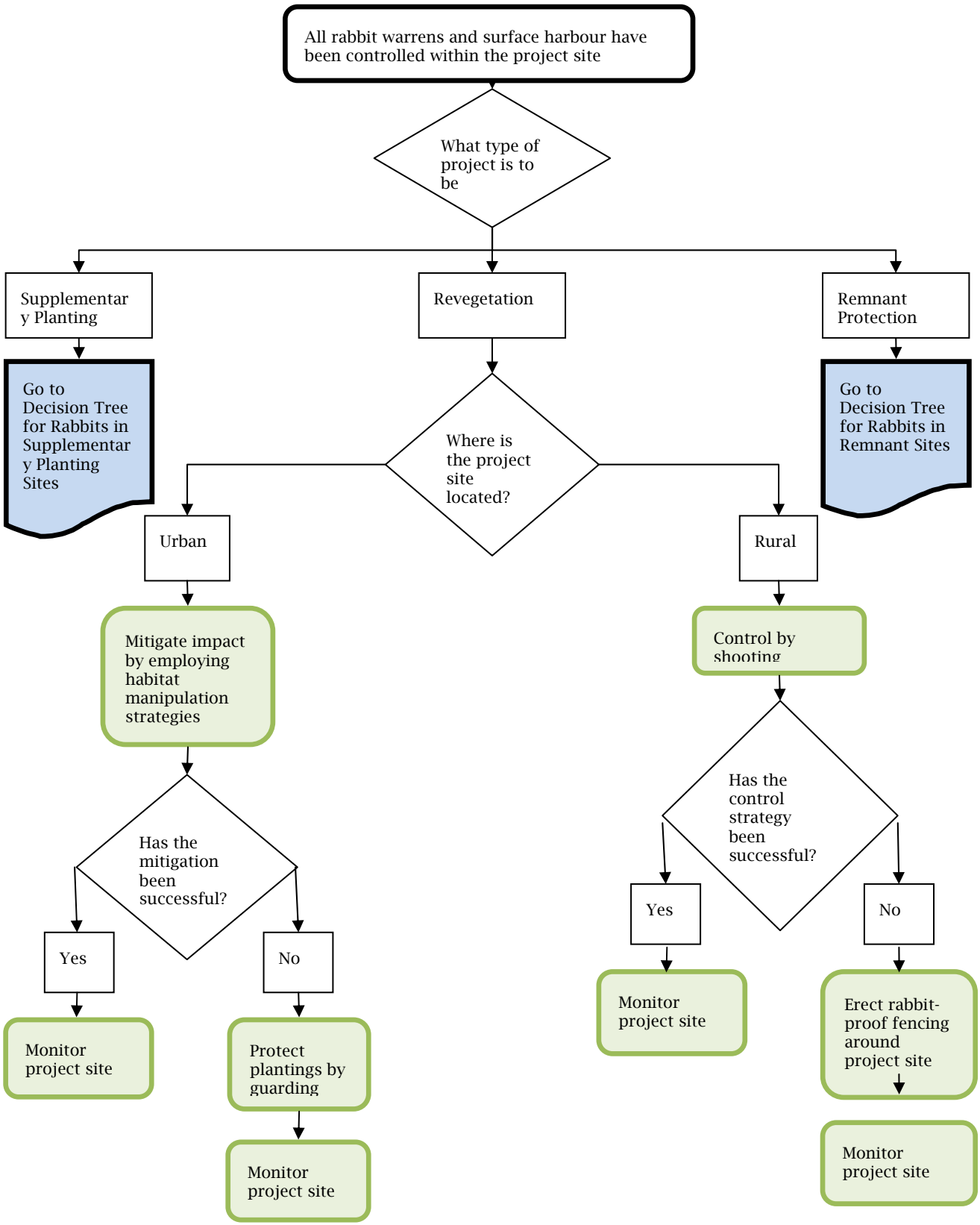
11.5.1 Pest animal management – rabbits (initial population reduction)



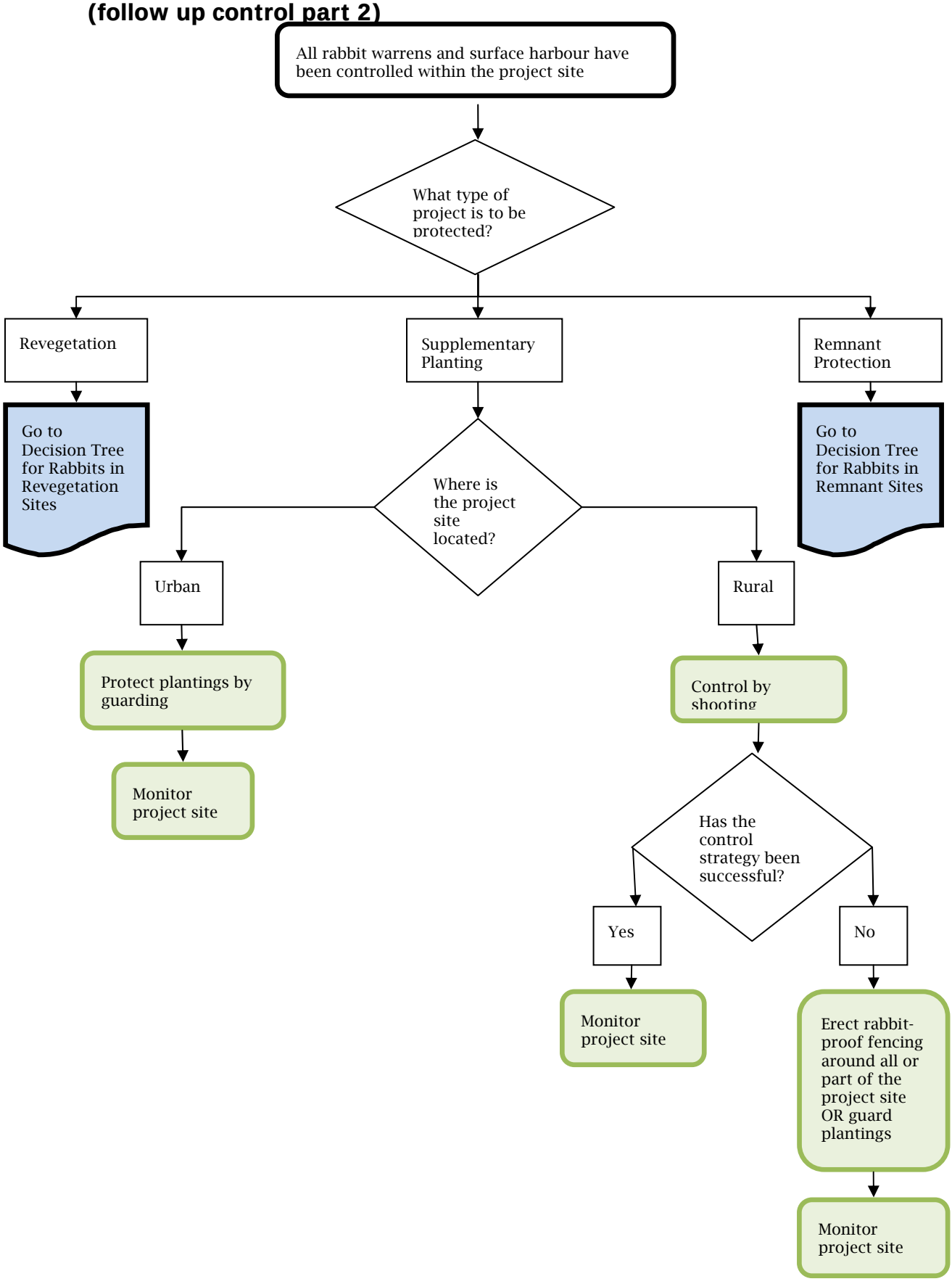
11.5.2 Pest animal management – rabbits (follow up control part 1)



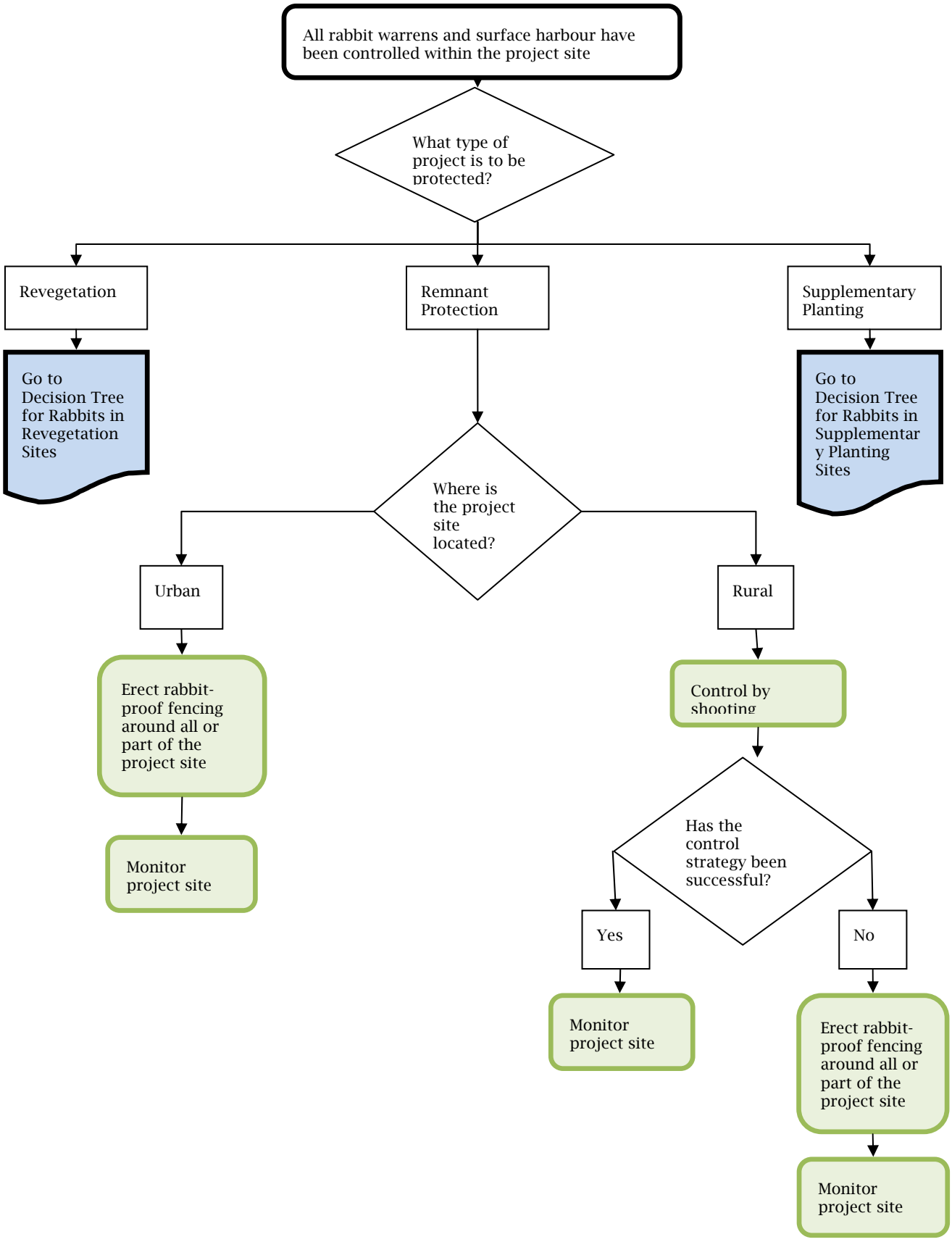
11.5.3 Pest animal management – rabbits in revegetation sites (follow up control part 2)



11.5.4 Pest animal management – rabbits in supplementary planting sites (follow up control part 2)

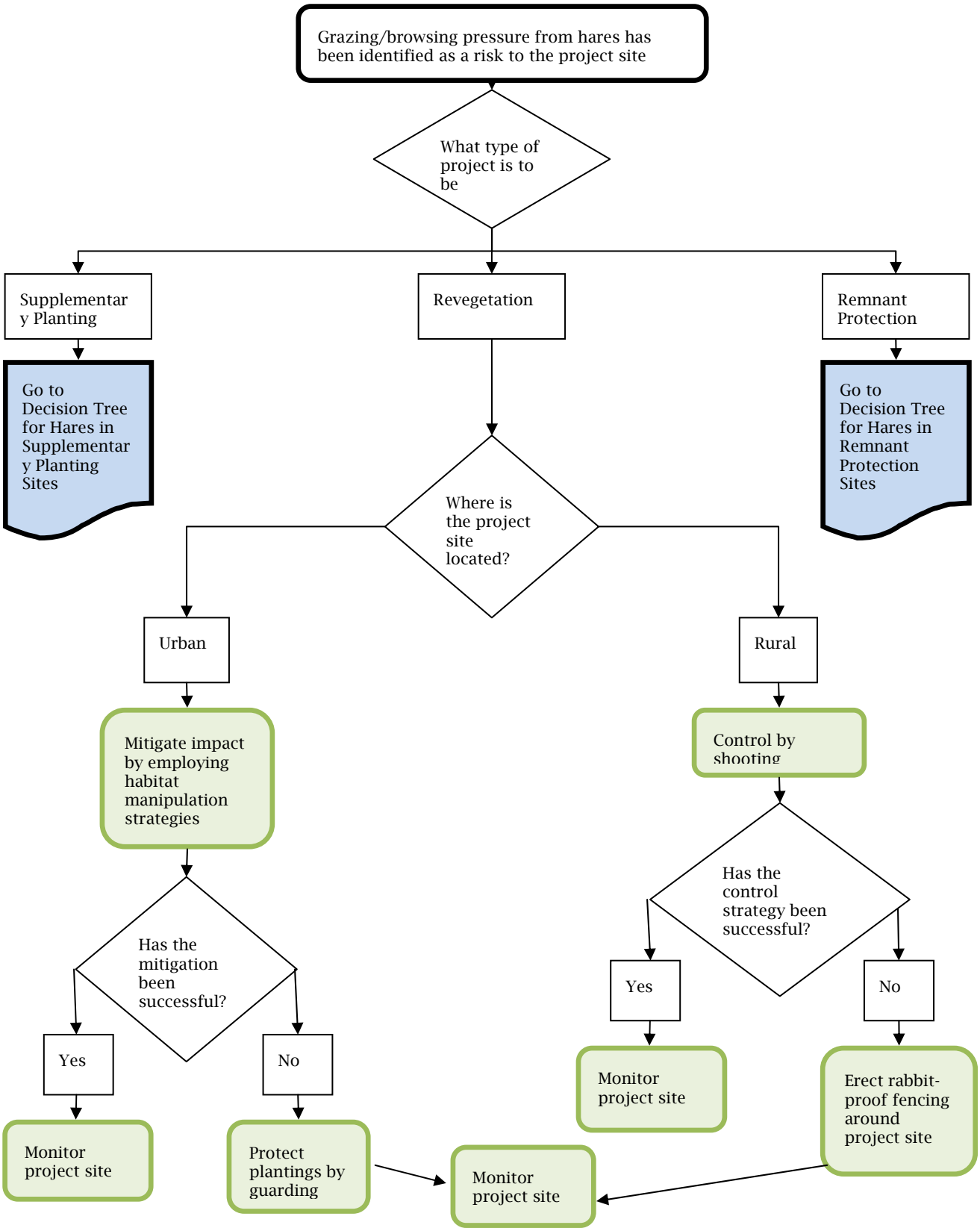


11.5.5 Pest animal management – rabbits in remnant protection sites (follow up control part 2)

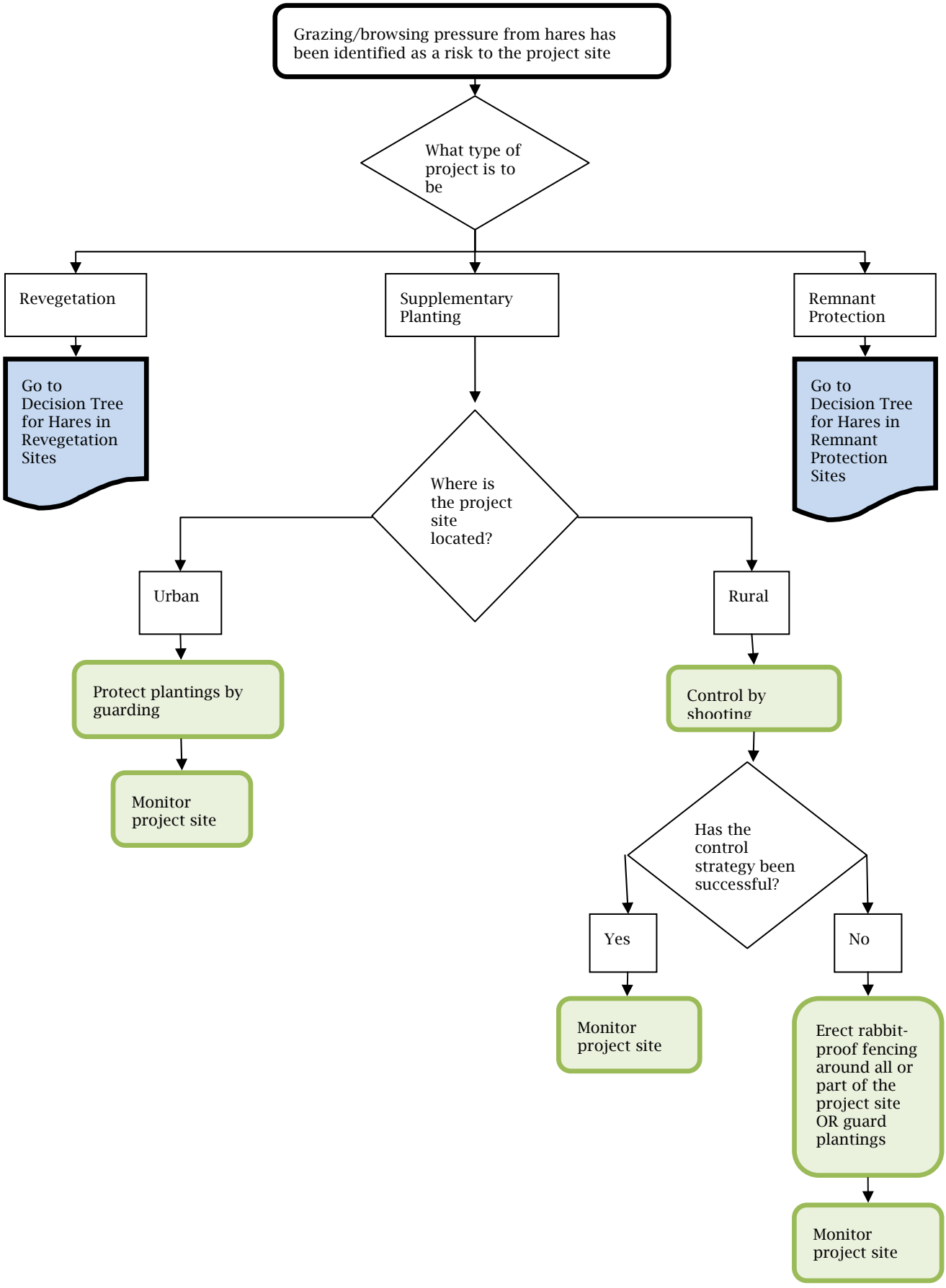


11.6 Appendix B – Decision trees for hare control

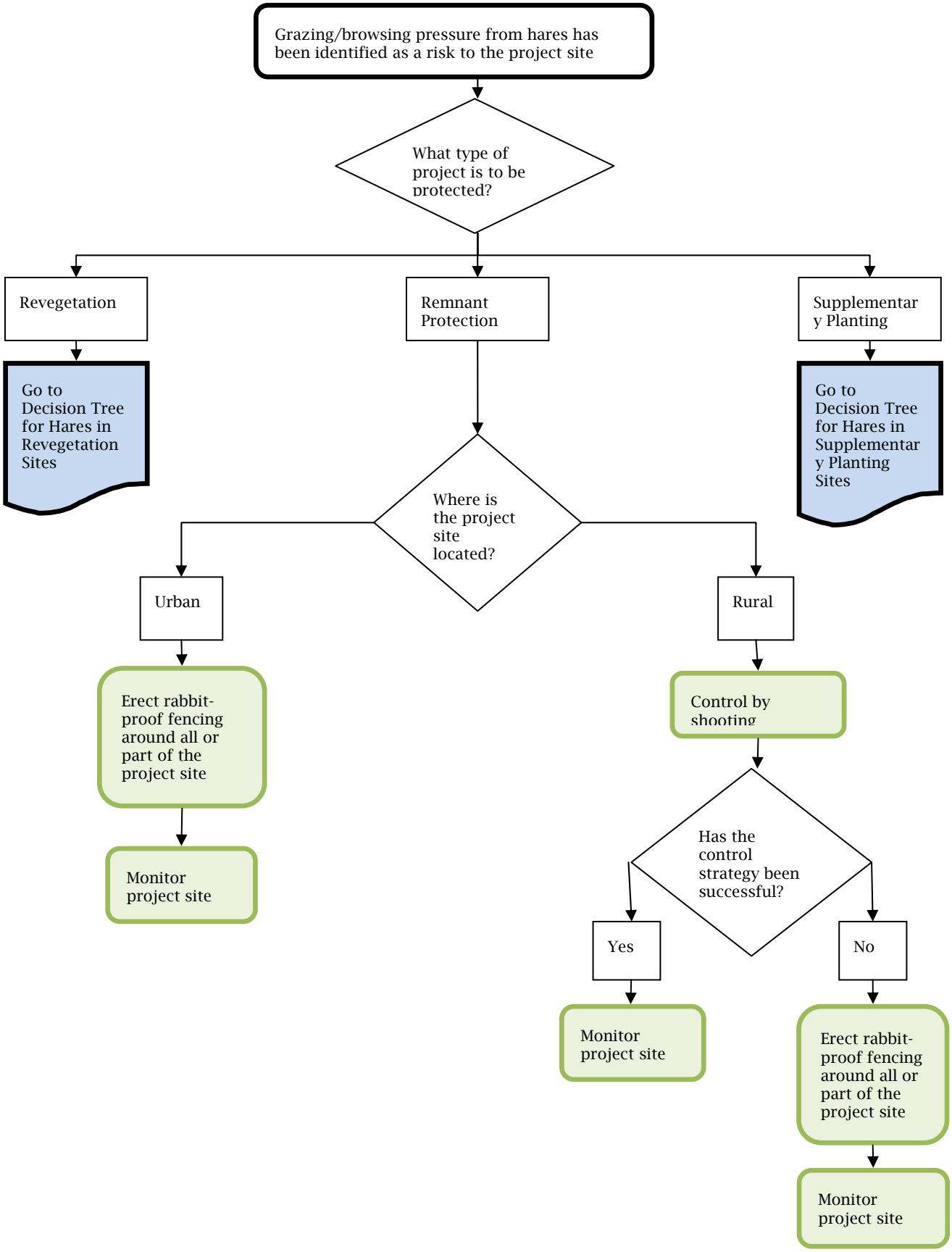
11.6.1 Pest animal management – hares in revegetation sites



11.6.2 Pest animal management – hares in supplementary planting sites

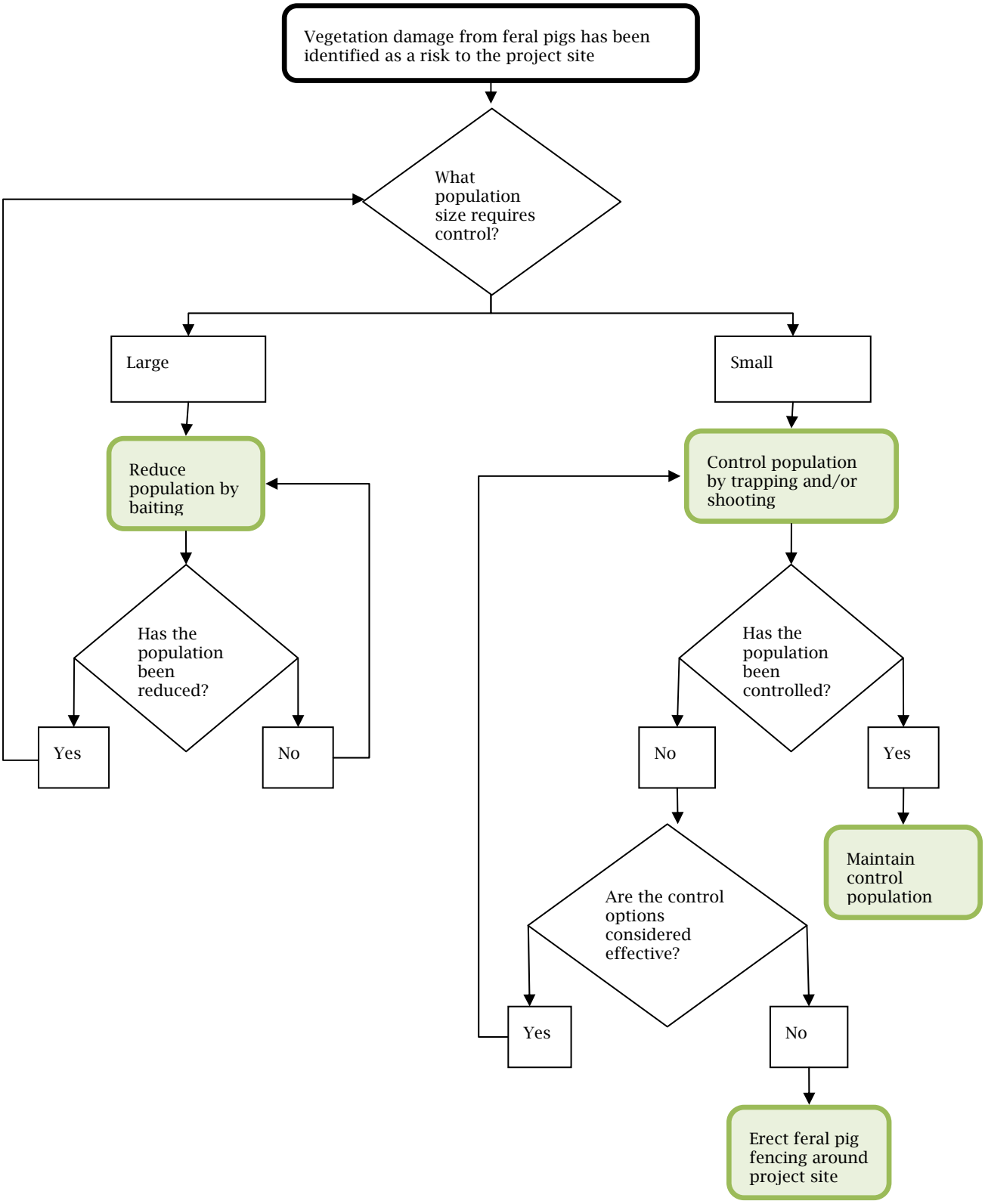


11.6.3 Pest animal management – hares in remnant protection sites



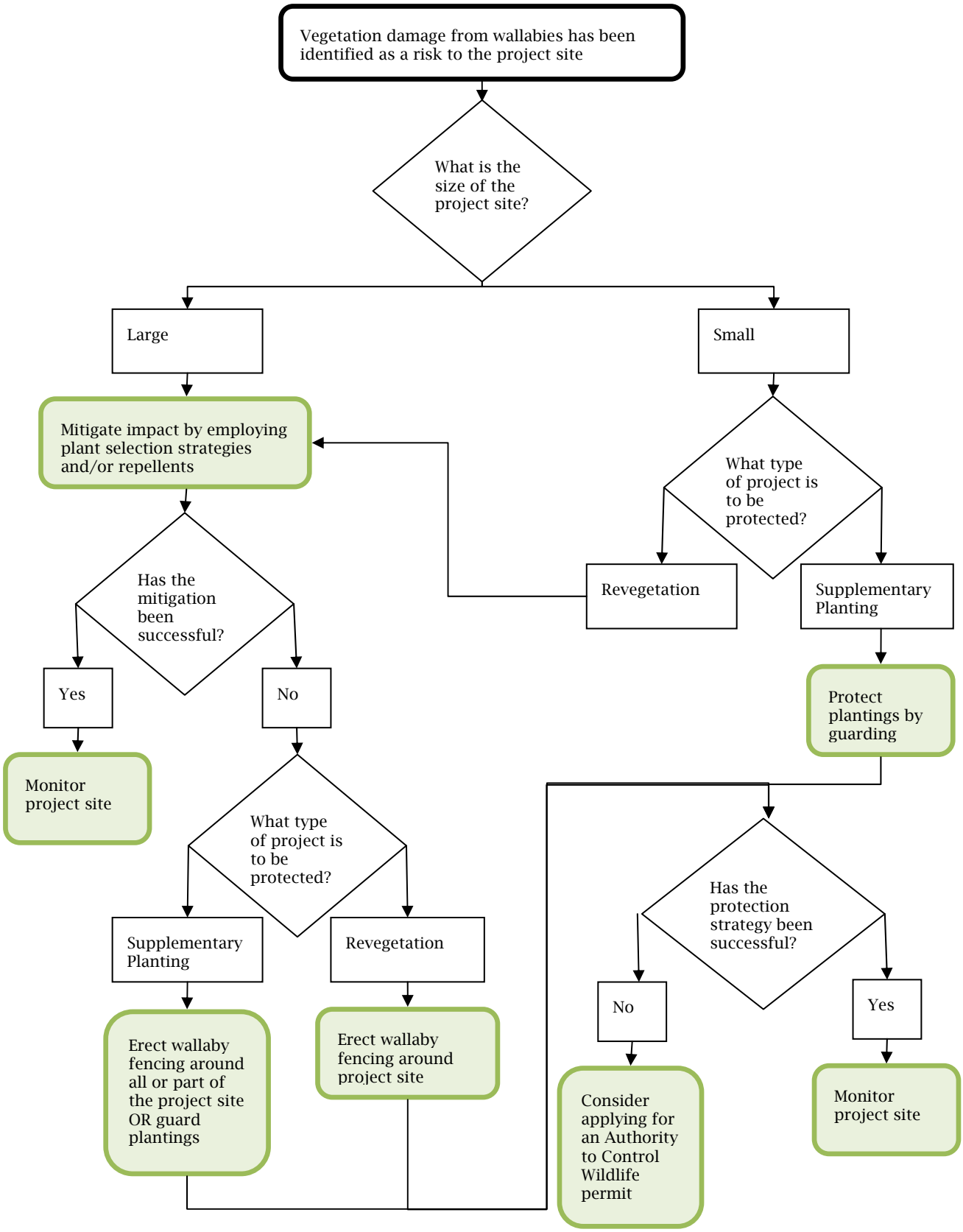
11.7 Appendix C – Decision tree for feral pig control

11.7.1 Pest animal management - pigs



11.8 Appendix D – Decision tree for wallaby control

11.8.1 Pest animal management - wallabies



12 Woody weed control

This standard forms part of a set of state-wide standards for the delivery of vegetation management activities through Victorian Investment Framework (VIF) projects at the landholder scale.

Where woody weed control is to be undertaken as part of a VIF project, this standard **MUST** be applied.

Determining whether woody weed control is an appropriate activity for a particular vegetation management project is the responsibility of the project manager and will be dependent on a number of factors, including:

- The project goal
- The relevant ecological vegetation class (EVC) for the project site
- The condition and extent of remnant vegetation at the project site, which in turn determines whether the project will focus on:
    - Protection of remnant vegetation
    - Establishment of overstorey and/or understorey plants within a remnant patch i.e. supplementary planting
    - Establishment of native vegetation in formerly cleared areas outside of a remnant patch i.e. revegetation.
- Specific site conditions e.g. soil type, slope
- The type and severity of threats present.

Therefore, this standard should not be read in isolation, but rather sequenced and applied with other relevant standards as appropriate.

12.1 Scope

This standard provides technical information for a range of chemical, mechanical and manual methods to control woody weeds[45].

This standard does not provide advice on:

- Assessing the problem (e.g. weeds present, modes of spread, etc)
- Undertaking risk assessments (e.g. plant densities/distributions) to determine if particular control methods are required/appropriate.

12.2 Background

Woody weeds can pose a serious threat to biodiversity and primary production. They contribute to land and water degradation, losses in productivity, and they can significantly impact native flora and fauna populations (Department of Sustainability and Environment 2009). Some woody weeds can also provide suitable harbour for pest animals (e.g. blackberry for rabbits).

12.3 Method

The recommended approach for developing and implementing a woody weed control program involves:

1. Describing the desired vegetation community (i.e. the vision or goal).

[45] Woody weeds include trees, shrubs, scramblers, climbers and vines.

2. Assessing the problem46.
3. Considering the control options/methods and determining:
    - Their effectiveness in treating the problem
    - Their practicality in treating the problem
    - Potential risks of application to both on-site and off-site values. This needs to also consider the risks around the control options
4. Developing a weed control and maintenance program.
5. Implementing the program.
6. Maintaining a monitoring and review program.

However, as problem assessment and control option considerations are dependent on site specific values, conditions and weed species, the scope of this standard is limited to the most common techniques[47] to control woody weeds, namely:

- Chemical control
- Mechanical control
- Manual control
- Burning
- Grazing.

These techniques are presented in the following sections[48].

12.3.1 Chemical control

Applicability

A number of chemical control options are available for the management of woody weeds. The most common employed are:

- Stem injection
- Cut and paint
- Foliar spray
- Stem scrape.

Table 12.1 assesses the suitability of these chemical control options for a range of woody weed life forms. This table **SHOULD** be used to determine which chemical control option (or range of options) is most appropriate for a particular project site.

Recommended chemical control methods that **SHOULD** be applied for specific woody weeds are detailed in Appendix B.

[46] This assessment should also identify the presence of indigenous vegetation that must be protected from any control activities as well as any biodiversity values (e.g. bird habitat) associated with the woody weeds.

[47] Biological control of woody weeds (e.g. gorse spider-mite or blackberry rust fungus) has not been included in this standard as it is seldom applied directly by CMAs/MW. However, its use should still be considered as part of an integrated program with specialist advice sought from the Department of Primary Industry's Bioscience Division.

[48] Useful links to specific control options for some woody weeds (i.e. Weeds of National Significance and/or Victorian Declared Noxious Weeds) can be found in Appendix A.

Table 12.1 - Chemical control options based on woody weed lifeform

Woody weed lifeform	Chemical control option			
	Stem injection	Stem injection	Stem injection	Stem injection
Seedling (small root system and simple stem)	× Stems too small	× Too laborious	✓	×
Small woody weed (< 0.5m tall with extensive fine stems)	× Stems too small	× ** Stems too thin and too many	✓	×
Woody weed (> 0.5m tall)	✓ * Stems or trunks greater than 5 cm in diameter	✓ Preferred method for saplings too small to be stem injected	✓ If practical	✓ If bark tissue is thin and relatively soft
Single or multi-stemmed woody weed tree	✓ * Stems or trunks greater than 5 cm in diameter	✓	× Not cost-effective	×
Regrowth (following mechanical clearing or poor cut stump treatment)	× Stems too small	✓ If practical	✓ Where regrowth has sufficient leaf area	×
Scramblers and climbers at ground storey and mid storey	× Stems too small	✓ Appropriate method to protect remnant vegetation values	✓ Preferred method for large infestations	✓
Scrambler and climbers entering over storey	✓ Appropriate on for very large climbers	✓ Preferred method for the majority of large climbers	× Foliage is out of reach	✓

✓ - control option recommended × - control option not recommended

* Stem injection methods kill the woody weed where it stands. Therefore, this treatment **SHOULD** only be used where either the woody weed can be safely left to die and rot in situ or be felled and removed at a later date (Ensbey and Johnson 2007).

** However, the cut and paint technique may be more appropriate than foliar spraying for some small woody weeds (e.g. ash).

Table adapted from (Dow AgroSciences 2009).

Technique

The following sections detail the key standards that apply to the use of the three most common chemical control options for woody weeds. In particular:

- The recommended technique for each control option; and
- The type of herbicide applicable to the particular woody weed.

Herbicide application techniques

Stem injection

This technique involves drilling or cutting through the bark into the sapwood tissue in the trunks of woody weeds. The aim is to reach the sapwood layer just under the bark (the cambium growth layer), which will transport the chemical throughout the plant (Ensbey and Johnson 2007).

Stem injection is particularly suitable for large climbers, shrub and tree species where you want to kill the plant but do not wish to immediately remove it from the landscape (e.g. you may wish for it to remain in place for its habitat and soil stabilisation functions until other species establish or removal is considered too costly, risky or impractical).

Recommended techniques that **SHOULD** be followed when applying the stem injection method are detailed in Table 12.2.

Table 12.2 – Stem injection: recommended techniques

Method	Recommended Technique
Drill and fill **(also referred to as 'tree injection' or 'stem injection')**	1. Use a battery-powered drill to make a downward-angled hole into the cambium layer of the trunk (i.e. the thin layer of generative tissue lying between the bark and the wood[49]), **as close to the ground as possible** 2. **Immediately apply herbicide**[50] (within 10 seconds of drilling) into the hole using a backpack reservoir and syringe that can deliver measured doses of herbicide solution 3. Continue drilling and filling holes at regular spacings (refer to the herbicide product label for recommended spacings)
Cut and fill **(also referred to as 'frilling and killing' or 'flaring and filling')**	1. Use an axe, chainsaw, tomahawk or hammer and chisel to make horizontal cuts into the cambium layer of the trunk **as close to the ground as possible** 2. While still in the cut, lean the axe, chainsaw, tomahawk or chisel out to make a downward angled pocket and **immediately apply herbicide**[4] (within 3 seconds) 3. Continue cutting and filling around the circumference of the trunk at regular spacings (refer to the herbicide product label for recommended spacings). It is important not to entirely ringbark the trunk, as this will decrease the uptake of the herbicide into the plant 4. Where low branches are encountered place a cut immediately below the branch

Table adapted from Dow AgroSciences (2009) and Ensbey and Johnson (2007).

[49] More specifically, depth of drilling should be limited to the phloem layer and not into the xylem layer (refer to the following link for details).

[50] Prompt herbicide application is necessary because the plant can seal the cut quickly, thus barring the chemical penetrating into the cambium layer.

Cut and paint

This technique involves cutting the plant as close to the ground as possible and then immediately painting the stump with a suitable herbicide.

It is used mainly for large scramblers/climbers, trees and woody weeds (Ensbey and Johnson 2007) and is particularly useful in sensitive environments e.g. areas of remnant vegetation or near waterways (CRC for Australian Weed Management 2003). However, caution **SHOULD** be exercised in using this technique as some species can sucker if treated this way e.g. poplar species (Ensbey and Johnson 2007). In these circumstances, the 'drill and fill' technique **SHOULD** be employed.

The recommended technique that **SHOULD** be followed when applying the cut and paint method is detailed in Table 12.3.

Table 12.3 – Cut paint: recommended technique

Method	Recommended Technique
Cut and paint (also referred to as 'cut stump')	1. Use a chainsaw, brush-cutter, loppers or secateurs (depending on the thickness of the stem/trunk) to completely cut off the plant at its base 2. Stems/trunks should be cut **as close to the ground as possible** 3. **Immediately** spray or paint the herbicide solution on to the exposed surface of the cut stump (a delay of more than 10 seconds for water-based herbicides and 1 minute for diesel soluble herbicides between cutting and applying the chemical will give poor results) 4. Use a brightly coloured dye in the solution to mark the stumps that have been treated. 5. For trees with large circumferences, it is only necessary to place the solution around the edge of the stump (as the objective is again to target the cambium layer inside the bark). The stump circumference should be bruised with the back of an axe and each successive blow treated with herbicide

Table adapted from Dow AgroSciences (2009), Ensbey and Johnson (2007) and Department of the Environment, Water, Heritage and the Arts (2007).

Foliar spray

This technique involves spraying the foliage of a plant to the point of runoff.

Foliar spraying can be done a number of ways, depending on the size of the weed plant and/or the infestation. The main methods are:

- Blanket spraying. Blanket spraying using a boom spray from a tractor or 4WD vehicle can be used to treat large areas completely infested with weeds, especially with selective herbicides, e.g. extensive blackberry infestations that occupy a high cover abundance on a specified site
- Targeted spraying. For large infestations that need targeted applications of herbicide, a hose and handgun can be used to spray solution from a herbicide rig with tank and pump carried by a tractor or vehicle. Smaller infestations can be sprayed using a backpack/knapsack spray unit
- Spot spraying. Spot spraying is used to treat individual weed plants or areas that have only small clumps of weed infestations (Ensbey and Johnson 2007).

Regardless of which method is chosen, the technique detailed in

Table 12.4 **SHOULD** be followed.

Table 12.4 – Foliar spray: recommended technique

Method	Recommended Technique
Foliar spray	1. Dilute herbicide with water or diesel at a specified rate 2. Spray herbicide solution over the foliage to the point of runoff (i.e. until every leaf is wetted, but not dripping) 3. Ensure the entire leaf area of the plant is treated 4. Ensure very accurate application so that no native plants near the target plant are sprayed.

Table adapted from Ensbey and Johnson (2007).

It should be noted that whilst foliar spraying may be a quick and economical method of chemical control, it has the potential for spray drift and off-target damage (Ensbey and Johnson 2007). Hence its use **SHOULD** be avoided (or limited) when there is potential for adverse impacts e.g. in close proximity to waterways or native vegetation.

Stem scrape

This technique involves scraping a very thin layer of bark from a section of stem then immediately applying herbicide to the exposed soft underlying green tissue.

It is mainly used for the control of vines (and some woody weeds where the surface bark can be peeled away easily).

The recommended technique that **SHOULD** be followed when applying the stem scrape method is detailed in Table 12.5.

Table 12.5 – Stem scrape: recommended technique

Method	Recommended Technique
Stem scrape	1. Using a knife or chisel, scrape away 10cm of the bark on one side of the vine to expose the sap wood (be careful not to cut through the vine) 2. **Immediately** (within 10 seconds) apply herbicide with a paint brush to the scraped surface on the stem.

Types of herbicide

There are a number of herbicides registered for the control of woody weeds under various conditions.

Any herbicide selected for use to control woody weeds **MUST** be registered for that particular weed problem and situation (refer to licenses/permits section below).

Timing

Chemical control methods work best when applied to actively growing plants that are not showing signs of stress.

Woody weeds **SHOULD** be treated with herbicide when they are actively growing (usually from Spring to early Autumn, depending on the particular species). If the season preceding treatment has been dry, treatment **SHOULD** be delayed until sufficient rainfall has occurred.

Herbicides **SHOULD NOT** be applied by foliar spray when plants are in full flower or when bees are active.

Recommended herbicide application times that **SHOULD** be considered for the control of specific woody weeds are detailed in Appendix B.

Licences/permits

Herbicide

Before using any herbicide, users **MUST**:

- Ensure that it is registered for the particular weed problem and situation51
- Read the product label and follow all label instructions carefully.

Legal use of some chemicals requires the user to possess an Agricultural Chemical User Permit (ACUP). In Victoria, an ACUP is required to use agricultural chemical products that are 'restricted use' chemicals. These are chemicals that have a potentially higher risk of adversely affecting the user's health, the environment and trade and include ester formulations of MCPA, 2,4-D, 2,4-DB or triclopyr, which are particularly relevant for woody weed control. A full list of restricted use chemicals can be found on the DPI website here[52].

Other restrictions on chemical use apply within Chemical Control Areas (CCAs). Nine CCAs have been established in Victoria to protect high value herbicide sensitive crops. These areas can be found on the DPI website here[53].

Vegetation removal

In some situations, the removal of woody weeds (including the removal of some non-indigenous native species) may require a local government planning permit. For example:

- Species such as poplars, pines and holly (above a certain size) may be included within tree protection local laws in some municipalities
- Vegetation may be protected under a Significant Landscape Overlay.

For woody weed control projects occurring in or adjacent to a designated waterway[54], a Works on Waterways permit (or written authorisation from the responsible CMA or Melbourne Water) **MUST** be obtained prior to any vegetation removal.

Maintenance

Woody weed control programs may require several years of follow-up treatment (dependent on species, degree of infestation and site conditions). At a minimum, all treated woody weeds **MUST** be appropriately maintained over a 24 month period after herbicide application and any regrowth treated.

At least 50cm of regrowth **SHOULD** be present before treatment. However, annual treatment of regrowth may be important in some situations (rather than waiting for plants to reach a required height).

[51] Using herbicides other than as strictly described on the label will often require a permit; consult DPI for details.

[52] http://new.dpi.vic.gov.au/agriculture/farming-management/chemical-use/restricted-use

[53] http://new.dpi.vic.gov.au/agriculture/farming-management/chemical-use/agricultural-chemical-use/control-areas

[54] Waterways gazetted to be a designated waterway under the *Water Act 1989*.

12.3.2 Mechanical control

Applicability

For some species, and in certain circumstances, mechanical clearing with heavy earth moving equipment (e.g. bulldozers or groomers) can form an effective part of integrated weed management, particularly for severe infestations of larger woody weeds (CRC for Australian Weed Management 2004).

Advantages and disadvantages of mechanical clearing are provided in

Table **12.6**.

Table 12.6 – Mechanical clearing: advantages and disadvantages

Advantages	Disadvantages
• Can be quick • Can be cost effective for extensive infestations (prickle bushes) • Removes pest animal harbour	• Significant disturbance of soil and native vegetation (which may reactivate previously dormant weed species) • Can only be conducted when ground is dry • Vehicle hygiene risks • Expensive for small infestations • Root systems may be left intact to regrow, hence comprehensive follow-up may be required • Removes native fauna habitat • Can impact cultural heritage values through soil disturbance • Underground assets need to be identified prior to starting or planning works which may impact on costs

Adapted from CRC for Australian Weed Management (2004).

Technique

The key machinery used for mechanical clearing of woody weeds are:

- Excavators
- Bulldozers.

Excavators

Techniques to clear woody weeds using excavators include:

- Grooming. Excavators fitted with groomers (a rotating drum fitted with free swinging blades) can be very effective in controlling large infestations of woody weeds in hard to reach places e.g. riparian zones. The groomer shreds plant material down to ground level, reducing biomass (and subsequent follow-up herbicide volume) and leaving a surface mulch which helps suppress the growth of new (and existing) weeds
- Tree removal. Excavators fitted with a log grab or claw are ideal for lifting and stockpiling tree limbs that have been cut down using chainsaws. Some machines are fitted with a specialised chainsaw head.

Bulldozers

Techniques to clear woody weeds using bulldozers include:

- Blade ploughing. This technique uses a large plough device attached to the bulldozer which cuts off trees below the soil surface and below the zone from which they can

rebud. This is best done when trees are young and easier to cut through (CRC for Australian Weed Management 2004)

- Dozer pushing. This technique cuts off established plants near the soil surface using the blade of the dozer. It is favoured in situations where minimal soil disturbance and subsequent weed seed germination is desired (CRC for Australian Weed Management 2004)
- Chain pulling. This technique knocks plants to the ground and involves two bulldozers dragging a heavy chain through dense infestations (CRC for Australian Weed Management 2004).

Bulldozers **MUST NOT** be used in the following environments:

- Riparian and wetland areas (due to the high level of disturbance and soil compaction)
- Sites that require selective weed control (e.g. sites within remnant vegetation).

Timing

Mechanical clearing **MUST** only occur if the ground is dry and **SHOULD** be undertaken after weed flowering but prior to seed set i.e. over spring and summer.

Where woody weeds are providing habitat for native animals, project managers **MUST** ensure that either:

- Alternative habitats are established prior to woody weed removal (e.g. replanting of comparable indigenous vegetation)
- Woody weed removal is staged such that an acceptable level of habitat is maintained throughout the project transition.

Licences/permits

Aboriginal Cultural Heritage

High impact activities in culturally sensitive landscapes can cause significant harm to Aboriginal cultural heritage. In these situations the Aboriginal Heritage Act 2006 may require the project manager to prepare a Cultural Heritage Management Plan or obtain a cultural heritage permit or enter into a cultural heritage agreement with the relevant Registered Aboriginal Party.

If mechanical clearing is proposed within a culturally sensitive landscape, the project manager **MUST** determine if a Cultural Heritage Management Plan or cultural heritage permit is required. Specific information on considering Aboriginal cultural heritage needs can be sourced here[55].

Local government

In some situations, the removal of woody weeds (including the removal of some non-indigenous native species) may require a local government planning permit.

Other permits

For woody weed control projects occurring in or adjacent to a designated waterway[56], a Works on Waterways permit (or written authorisation from the responsible CMA or Melbourne Water) **MUST** be obtained prior to any vegetation removal.

A 'Dial before you Dig' assessment may also be required to establish if underground assets are within the area planned for mechanical control.

[55] http://www.dpcd.vic.gov.au/indigenous/

[56] Waterways gazetted to be a designated waterway under the *Water Act 1989*.

Maintenance

Mechanical clearing can cause major disturbance to vegetation and soil and **SHOULD** only be contemplated where resources exist to carry out necessary follow-up work. This includes restoration of the site with desirable vegetation (CRC for Australian Weed Management 2004).

12.3.3 Manual control - slashing

Applicability

Where smaller woody weed infestations occur or where access issues exclude the use of heavy machinery, slashing with brush-cutters may be an acceptable approach.

Advantages and disadvantages of slashing are provided in Table 12.7.

Table 12.7 – Slashing: advantages and disadvantages

Advantages	Disadvantages
• Minimises soil disturbances • Minimises risks to local flora • Can prevent seeding and spread • Removes excess foliage (for follow-up treatments) • Supplements other methods • Helps to weaken plants, making them susceptible to other forms of control • Inexpensive on small projects	• Usually doesn't eradicate weeds if the infestation is large • Can prevent seeding by local flora • Can introduce / spread weed propagules • Can encourage weed growth • Can increase fuel loads over the short term (dried material) • Labour intensive

Adapted from CRC for Australian Weed Management (2004).

Timing

The use of brush- cutters will not eradicate weeds but can prevent or greatly reduce weed seed production if timed appropriately i.e. after weed flowering but prior to seed set.

Manual control - hand removal or chipping

Applicability

Pulling out weeds by hand or digging them out with a hoe is a simple and effective method best suited to small scale projects (Corr 2003). However, it does not prevent growth of new weed seedlings (Horlock 1998 in Corr 2003).

Technique

When removing weeds by hand, care should be taken to:

- Create minimal disturbance
- Avoid disturbing the roots of any remnant, sown or planted seedlings
- Remove all plant parts capable of re-growth (Corr 2003).

Timing

This technique **SHOULD** be undertaken prior to weeds flowering and producing seed (Horlock 1998 in Corr 2003).

12.3.4 Burning

Applicability

As part of an integrated control program, fire can assist in the control of some woody weed species by reducing weed biomass and stimulating seed germination, enabling more efficient and effective control (CRC for Australian Weed Management 2003).

However, the use of fire is not an appropriate strategy for all vegetation types.

Advantages and disadvantages of burning to control woody weeds are provided in Table 12.8.

Table 12.8 – Burning: advantages and disadvantages

Advantages	Disadvantages
• Removes rank and excessive foliage (for follow-up spray treatments) • Supplements other methods • Encourages local flora regeneration • Encourages germination of soil-stored weed seedbank for some species (for follow-up treatments)* • Relatively inexpensive • Kills weed seedbanks of some weed species*	• Usually does not eradicate weeds • Inappropriate for non-fire adapted ecosystems • Seasonal and timing limitations • Encourages weed growth/germination of some weed species* • Altered nutrient-moisture availability can favour weeds • Potential for run-off/erosion • Fauna, people, health, property risks • Can be costly if establishment of fire breaks, spelling of pasture and personnel required to control fire are involved • Specialist knowledge required • Creation of fire breaks can damage native vegetation

* Burning can affect different weed species in different ways. For example, fire encourages germination of some species (e.g. Gorse) and destroys the seedbanks of other species (e.g. Sweet Pittosporum). Therefore its use must be specific to the weed species identified for control.

Adapted from CRC for Australian Weed Management (2004).

Technique

Pre burn

Prior to undertaking a burn, the following attributes **MUST** be assessed and appropriate protection/replacement strategies developed:

- The extent, proximity, conservation status and fire-dependence of any native vegetation types within the proposed burn area
- The extent, conservation status and habitat requirements of any rare or threatened species occurring within the proposed burn area
- Any other specific values within the proposed burn area e.g. habitat features (such as hollows, shrubby cover, leaf litter), sites of cultural significance, recreation areas (Fire Ecology Working Group 2004).

Burn

The best fire strategy for woody weeds is a prescribed burn that aims to burn only the weedy area, using firebreaks and back-burning techniques (Ensbey and Johnson 2007).

The success of a prescribed burn depends on a number of factors, most notably:

- The response of the weed to burning. Some weeds do not burn well whilst alive (CRC for Australian Weed Management 2004) and may require prior chemical control
- The fire regime employed. The factors which govern the impact of a fire on woody weeds include the amount of fuel, the speed and intensity of the fire, and the time of year that burning takes place (Ensbey and Johnson 2007).

Timing

Burning is best undertaken in the first year of a woody weed control program to reduce biomass to a more manageable level. It **SHOULD** be timed to allow plants to regrow to at least one metre before starting a herbicide treatment.

Spring is the optimum time to reduce woody weed biomass. However, autumn burning **SHOULD** be considered to reduce the impact on native fauna that may utilise woody weeds for habitat.

For large areas of woody weeds, the site **SHOULD** be burnt in patches over a number of years rather than conducting a prescribed burn across an entire site at the same time. This approach will provide refuge areas for native animals to escape from the fire and maintain habitat during the transition from woody weeds to native vegetation.

Licences/Permits

During the fire season, project managers **MUST** apply for a permit from the relevant local government before undertaking a prescribed burn. In addition, some local governments may have other burning restrictions. Therefore, project managers **SHOULD** discuss a proposed burn with the relevant local government regardless of the time of year that the burn will take place (Department of Sustainability and Environment 2010).

Even if a local government permit is not required, the following steps **MUST** be followed (adapted from Department of Sustainability and Environment (2010):

- Burn plan. Depending on the size of the intended burn area, develop a burn plan that takes into account issues such as aspect ,slope, fuel load , humidity, isolations, exposures, ignition points, public and private assets, evacuation tracks, staging areas, etc
- Fire breaks. Clear at least 3 metres around the area to be burned to stop fires spreading (taking care to avoid/minimise impacts to native vegetation). Slashing or raking fire breaks is recommended rather than using mechanical or chemical methods. Ploughing or spraying a fire break will remove competition by native plants and encourage germination of weeds, creating a strip of weedy vegetation (Eddy 2002)
- Notification. Notify all neighbours when a burn date has been set and at least two hours prior to burning, including Country Fire Authority and the Department of Sustainability and Environment, to avoid confusion from visible smoke
- Weather. Before burning - check weather conditions for the next 48 hours. Only burn if forecasts indicate low temperatures and weak breezes. Windy conditions increase the chance of fire spreading
- Supervision. Most fires escape when no one is present as fuels can smoulder without being obvious. Supervise your burn off
- Be prepared. Accidents do occur. Have fire fighting equipment and a good water supply nearby.

In addition, burning adjacent to a designated waterway will require a Works on Waterways permit or written authorisation from the responsible CMA or Melbourne Water.

Maintenance

Whilst fire can be useful in reducing dense thickets of woody weeds to ground level, it does not necessarily kill the plant. Moreover, fire can stimulate weed-seed germination. For example burning gorse stimulates seed growth but also destroys much of the grass beneath the bush, creating an ideal environment for re-establishment.

Therefore, follow-up weed control (chemical, manual or both) **MUST** be planned and implemented for the period following the fire.

12.3.5 Grazing

Applicability

Grazing by livestock (in particular sheep and goats) can be a useful contributor to woody weed control. For example:

- Goats eat a number of woody weed species dependent on the palatability of the weed (highly palatable weeds include blackberry, sweet briar and scotch broom) (Ensbey and Johnson 2007); and
- Sheep can be moderately effective in controlling gorse seedlings before spines are formed however high stocking rates are needed to force sheep to graze on gorse rather than other species (CRC for Australian Weed Management 2003).

Advantages and disadvantages of grazing to control woody weeds are provided in Table 12.9.

Table 12.9 –Grazing: advantages and disadvantages

Advantages	Disadvantages
• Selective (depending on grazing animal and weed species being targeted) • Can remove excess foliage (for follow-up treatments) • Can reduce flowering and seed dispersal • Can stress weed plants • Supplements other controls • Inexpensive	• Timing limitations • Disturbs soils • Can introduce/spread weed propagules • Encourages weed growth • Damages or destroys native vegetation and prevents natural recruitment • Inappropriate for many ecosystems • Can elevate nutrient levels • Potential for erosion/run-off • Site rehabilitation required • On-going management required • Danger to stock if weed toxic

Adapted from CRC for Australian Weed Management (2004).

Technique

<u>Goats</u>

To control localised woody weed infestations, the area **MUST** be isolated from other parts of the project site with fencing. This will protect adjoining vegetation from goat browsing and reduce the number of goats required to control the weed (Holst and Simmonds 2000).

In dense infestations of woody weeds (e.g. blackberry, gorse), it is that paths **SHOULD** be slashed through the infestation to allow greater access for goats (Holst and Simmonds 2000).

Sheep

Sheep are generally used as a maintenance/follow-up tool to control woody weed regrowth following the implementation of other woody weed control methods. For example, the use of sheep to control gorse seedlings after a dense gorse infestation has been removed.

Timing

The best time to implement grazing is when the weeds are most palatable (generally spring). However, this timing coincides with the critical life stages of native plants which tend to flower and set seed during late spring and early summer.

Therefore, in combination with appropriate fencing to protect adjacent native vegetation, grazing for woody weed control **SHOULD** only occur in autumn and late winter/early spring.

Site conditions

Irrespective of the time of year, livestock **MUST NOT** be used to control woody weeds when:

- Soil moisture levels are high. Grazing at such times will lead to pugging and compaction (Staton and O'Sullivan 2006, Water Technology 2009)
- Soil is very dry e.g. during a drought. At such times, the ground layer may be too sparse, leading to over-grazing and soil erosion (Staton and O'Sullivan 2006, Water Technology 2009).

12.4 References

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Holst, P. and Simmonds, H. (2000). *Weed Control Using Goats*. Australian Cashmere Growers Association. Retrieved from http://www.acga.org.au/goatnotes/J001.php

12.5 Appendix A - Links to specific control options for some woody weeds

Common name	Botanical name	Weeds of national significance	Victorian declared noxious weeds
Boneseed	*Chrysanthemoides monilera*	http://www.weeds.org.au/WoNS/bitoubush/	http://www.dpi.vic.gov.au/agriculture/pests-diseases-and-weeds/weeds/other-declared-weeds/boneseed
Blackberry	*Rubus fruticosus*	http://www.weeds.org.au/WoNS/blackberry/	http://www.dpi.vic.gov.au/agriculture/pests-diseases-and-weeds/weeds/invasive-plant-management/biological-control-of-weeds/blackberry/lc0188-blackberry-identification
Briar Rose	*Rosa rubiginosa*		http://www.dpi.vic.gov.au/agriculture/pests-diseases-and-weeds/weeds/other-declared-weeds/sweet-briar
Bridal Creeper	*Asparagus asparagoides*	http://www.weeds.org.au/WoNS/bridalcreeper/	http://www.dpi.vic.gov.au/agriculture/pests-diseases-and-weeds/weeds/other-declared-weeds/bridal-creeper
Cape Ivy	*Deleria odorata*		http://www.dpi.vic.gov.au/agriculture/pests-diseases-and-weeds/weeds/non-declared-weeds/cap-ivy
English Broom	*Cytisus scoparius*		http://www.dpi.vic.gov.au/agriculture/pests-diseases-and-weeds/weeds/other-declared-weeds/english-broom
Gorse	*Ulex europaeus*	http://www.weeds.org.au/WoNS/gorse/	http://www.dpi.vic.gov.au/agriculture/pests-diseases-and-weeds/weeds/other-declared-weeds/gorse
Mesquite	*Prosopis sp.*	http://www.weeds.org.au/WoNS/mesquite/	http://www.dpi.vic.gov.au/agriculture/pests-diseases-and-weeds/weeds/state-prohibited-weeds/mesquite
Montpellier Broom	*Genista monspessulana*		http://www.dpi.vic.gov.au/agriculture/pests-diseases-and-weeds/weeds/other-declared-weeds/cape-broom
Willow species	*Salix sp*	http://www.weeds.org.au/WoNS/willows/	

12.6 Appendix B – Recommended chemical control methods and timing for specific woody

Figure 12.1 Chemical control methods for trees

Common name	Botanical name	Chemical control method			Timing
		Stem injection	Stem injection	Stem injection	
TREES					
Black Willow	*Salix nigra*	✓	✓		Late Spring/Summer
Box Elder	*Acer negundo*	✓	✓		Winter/Spring
Cherry Plum	*Prunus cerasifera*	✓	✓		Autumn/Winter
Desert Ash	*Fraxinus angustifolia*	✓	✓	✓	Winter/Spring
Elm	*Ulmus sp.*	✓	✓	✓* seedlings	Spring/Summer
Fig	*Ficus spp*	✓	✓		Winter/Spring
Hawthorn	*Crataegus spp*	✓	✓	✓ seedlings	Spring/Summer
Mesquite	*Prosopis sp.*		✓	✓	Spring/Summer/ early Autumn
Olive Tree	*Olea europaea*	✓	✓	✓	Spring/Summer
Peppercorn	*Schinus molle*	✓	✓	✓	Spring/Summer
Poplar	*Populus spp*	✓			Winter to Summer
Privet	*Ligustrum spp*	✓	✓	✓ seedlings	Winter/Spring
Pussy Willow	*Salix cinerea*	✓	✓	✓ seedlings	Winter/Spring
Sweet Pittosporum**	*Pittosporum undulatum*	✓	✓	✓	Summer
Tree of Heaven	*Ailanthus altissima*	✓	✓	✓ seedlings	Winter/Spring/ Summer
Tree Tobacco, Madeira Winter Cheery.	*Solanum spp*	✓	✓	✓ seedlings	All Year
Willow species	*Salix sp*	✓	✓	✓ seedlings	All Year

* Ensure elm 'seedlings' are not in fact juvenile suckers (as spraying suckers can impact the non-target parent tree).

** *Pittosporum undulatum* is native to parts of Victoria but poses a threat in other areas., therefore a permit to remove native vegetation may apply to its control.

Figure 12.2 Chemical control methods for shrubs

Common Name	Botanical Name	Chemical Control Method			Timing
		Stem Injection	Cut and Paint	Foliar Spray	
SHRUBS					
African Boxthorn	*Lycium ferocissimum*	✓	✓	✓ seedlings	Spring/Summer
Boneseed	*Chrysanthemoides monilera*		✓	✓	Autumn/Winter
Briar Rose	*Rosa rubiginosa*		✓	✓	Spring/Summer
Cotoneaster	*Cotoneaster spp*	✓	✓	✓ seedlings	Winter/Spring
English Broom	*Cytisus scoparius*		✓	✓	Winter/Spring
Gorse	*Ulex europaeus*		✓	✓	Autumn/Winter
Montpellier Broom	*Genista monspessulana*		✓	✓	Summer

Figure 12.3 Chemical control methods for scramblers and climbers

Common name	Botanical name	Chemical control method				Timing
		Stem injection	Cut and paint	Foliar spray	Stem scrape	
SCRAMBLERS AND CLIMBERS						
Asparagus Ferns	*Asparagus sp*			✓		
Banana Passionfruit	*Passiflora mollissima*		✓		✓	
Blackberry	*Rubus fruticosus**		✓	✓		Spring/early Summer
Blue Periwinkle	*Vinca major*			✓		Spring/early Summer
Bridal Creeper	*Asparagus asparagoides*			✓		Autumn just prior to flowering
Cape Ivy	*Deleria odorata*			✓		Autumn/Spring/early Summer
English Ivy	*Hedera helix*	✓	✓	✓	✓	Spring/early Summer
Japanese Honeysuckle	*Lonicera japonica*		✓	✓	✓	Autumn/Spring/early Summer
Moth Plant	*Araujia sericifera*		✓	✓	✓	Spring/ Summer
Old Mans Beard	*Clematis aristata*		✓	✓		Spring/ Summer
Rambling Dock	*Acetosa sagittata*		✓	✓	✓	Spring/ Summer
Tradescantia	*Tradescantia fluminensis*			✓		Autumn/Spring/ Summer

* Variable habit, could be classed as a shrub