



Government of **Western Australia**  
Department of **Water and Environmental Regulation**

# A Guide to Preparing Revegetation Plans for Clearing Permits

under Part V of the *Environmental Protection Act 1986*

Department of Water and Environmental Regulation

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## Definitions<sup>1</sup>

**CEO** means the Chief Executive Officer of the Department of Water and Environmental Regulation

**density** means the number of individual plants of a defined group that are present in a given area at a particular time, for example stems per unit area.

**dieback survey** means an onsite survey undertaken by an environmental specialist to: (a) verify desktop study information; (b) identify indicator species; and (c) carry out soil sampling in areas significantly affected by dieback.

**direct seeding** means a method of re-establishing vegetation through the establishment of a seed bed and the introduction of seeds of the desired plant species.

**disease** means organisms (pathogens) that cause adverse outcomes (symptoms) in another organism (host). Dieback of native plants caused by *Phytophthora* species is an example of a serious plant disease that is a major problem in Western Australia (Environmental Protection Authority 2006).

**dominant species** means the tallest and/or most common plant in the overstorey or each layer.

**environmental specialist** means a person who holds a tertiary qualification in environmental science or equivalent, and has experience relevant to the type of environmental advice that an environmental specialist is required to provide, or is approved by the CEO as a suitable environmental specialist.

**local provenance** means native vegetation, seeds and propagating material from natural sources geographically similar and within as close proximity as practicably possible. Local provenance in higher diversity bioregions, such as the Swan Coastal Plain, can be within less than 50 kilometres, while in areas with homogenous diversity, such as the Central Kimberley, it may be within 200 kilometres.

**mulching** means the use of organic matter, wood chips or rocks to slow the movement of water across the soil surface and to reduce evaporation.

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<sup>1</sup> The definitions of terms in individual clearing permits, where inconsistent with this Guide, take precedence for the time that the permit is valid.

**optimal time** means the specified period for the activity in a particular area of the State as follows:

Area	Optimal time for direct seeding	Optimal time to undertake planting
Gascoyne	May in south or November–December in north	no planting without irrigation
Goldfields Esperance	April–May	no planting without irrigation
Great Southern	April–May	May–June
Kimberley	October–December	no planting without irrigation
Metropolitan	April–June	May–July
Midwest	April–May or November–December in extreme north	May–June
Pilbara	November–December	no planting without irrigation
South West	April–June	May–June
Wheatbelt northern	May–June	June–July
Wheatbelt southern	April–June	May–June

**permit holder** means the holder of a clearing permit granted and in force under Part V Division 2 of the *Environmental Protection Act 1986*.

**planting** means the re-establishment of vegetation by creating favourable soil conditions and planting seedlings of the desired species.

**quadrat** means a sample plot established for the purpose of data collection and monitoring vegetation characteristics, for example species composition, structure, density and condition.

**qualified disease interpreter** means a person who holds a tertiary qualification in environmental science or equivalent, and has a minimum of two years' work experience in plant disease identification and remediation techniques.

**reference site** means a site used to provide baseline data for planning a revegetation project. Measurements from fixed reference points or plots where biodiversity components are measured are used to set measurable completion criteria for revegetation projects.

**regenerate/ion** means the re-establishment of vegetation from in-situ seed banks and propagating material (such as lignotubers, bulbs, rhizomes) contained either within the topsoil or seed-bearing mulch.

**rehabilitation** means actively managing an area containing native vegetation in order to improve the ecological function of that area.

**remedial action** means any activity that is required to ensure successful re-establishment of vegetation to its pre-clearing composition, structure and density, and may include a combination of soil treatments and revegetation.

**revegetate/ion** means the re-establishment of a cover of local provenance native vegetation in an area using methods such as natural regeneration, direct seeding and/or planting, so that the species composition, structure and density is similar to pre-clearing vegetation types in that area.

**revegetation plan** means a plan prepared by the permit holder, or an appropriate environmental specialist delegated by the permit holder, for the revegetation and rehabilitation of a site in accordance with a permit condition.

**site preparation** means management of existing site topsoil and preparation of the finished soil surface, for example by ripping or tilling the soil surface and re-spreading site topsoil and chipped native vegetation.

**species richness** means the number of species that are present in a habitat or ecosystem.

**vegetation condition** means the rating given to native vegetation which refers to the impact of disturbance on each of the layers and the ability of the community to regenerate (Keighery 1994). The Keighery scale (1994) is used for the South West and Interzone Botanical Province, and Trudgen (1991) is used for the Eremaean and Northern Botanical Provinces (see Appendices C and D).

**vegetation unit** means any group of plants or a plant community, regardless of vegetation category or level.

# 1 Purpose

This guide sets out the Department of Water and Environmental Regulation's (DWER) recommended approach to preparing a revegetation plan, where land revegetation is proposed as an offset or required, as a condition of a clearing permit granted under the *Environmental Protection Act 1986* (EP Act). It provides general guidance to key stakeholders including landowners, consultants, local government authorities and state government agencies, regarding the information that should be provided to DWER to ensure that an assessment of the adequacy of a revegetation plan can be made.

# 2 Introduction

Revegetation is the intentional establishment and management of native vegetation to recreate or improve the environmental values of a site to achieve a species composition, structure and diversity similar to that which existed prior to disturbance.

Depending on the purpose of the revegetation, it may be necessary to revegetate land within the clearing impact area (onsite) or at a separate location (environmental offset). Revegetation will generally be in accordance with an approved revegetation plan as a condition to a clearing permit.

Onsite revegetation (onsite mitigation) may be conducted when some or all of the land cleared is no longer required for the purpose for which it was cleared. Restoring the clearing footprint to a self-sustaining state, or as close to its pre-clearing state as possible, aims to reduce long-term environmental impacts of the clearing.

Offsite revegetation (environmental offset) may be required when clearing results in a significant residual environmental impact. DWER's Chief Executive Officer (CEO) may require a permit holder to offset the loss of native vegetation by undertaking offsite revegetation, whether on the same or another property.

Successful revegetation requires appropriate planning and preparation to establish objectives and completion criteria, and identify tasks and resources to ensure the success of the revegetation. It is important for revegetation projects to be guided by a revegetation plan appropriate to the specific conditions and requirements of the revegetation site.

The revegetation plan should be prepared by, or in consultation with, an environmental specialist with appropriate expertise in revegetation techniques, and demonstrated revegetation experience specific to Western Australian native vegetation and environmental conditions.

To facilitate the consideration and approval of revegetation plans, checklists of the recommended contents of a revegetation plan and monitoring report are provided in Appendices A and B of this guide.

This guide provides a recommended approach for preparing a revegetation plan and is not intended to detail revegetation techniques. Sections 7 and 8 references some other publications that provide detailed guidance on revegetation techniques.

## 3 Legislation

The clearing of native vegetation in Western Australia is regulated under Part V Division 2 of the EP Act and the *Environmental Protection (Clearing of Native Vegetation) Regulations 2004* (Clearing Regulations). Clearing of native vegetation is an offence unless a clearing permit has been granted, or an exemption applies.

A clearing permit may be granted subject to conditions that the CEO considers necessary or convenient for mitigating environmental harm or offsetting the loss of cleared vegetation (section 51H). Such conditions may include requirements relating to the revegetation of an area (whether onsite or offsite). This includes the preparation of a revegetation plan for the establishment and maintenance of vegetation on land (other than land cleared under the permit to offset the loss of the cleared vegetation).

The CEO has delegated the clearing provisions of the EP Act to the Department of Mines, Industry Regulation and Safety for clearing regulated under the *Mining Act 1978*, various petroleum legislation and under state agreements administered by the Department of Jobs, Tourism, Science and Innovation.

## 4 Reporting Requirements

Under section 51I(2)(d) of the EP Act, a permit holder may be required to monitor operations and environmental harm, conduct analysis of monitoring data, and provide reports of monitoring data and analysis to the CEO.

The completion criteria for revegetation must be measurable so that the effectiveness of the revegetation can be monitored, reported and assessed. Monitoring reports and the evaluation of monitoring data must be provided to the CEO before the date specified on the clearing permit.

Reporting must continue until the expiry of the clearing permit or until the CEO or delegate agrees that the conditions of the clearing permit and the revegetation completion criteria are met (provided that this is prior to the expiry of the permit).

## 5 Revegetation Plan

The revegetation plan must include an outline of the permit holder's revegetation commitments; background information about the impact site prior to clearing and, if offsite revegetation is proposed, the revegetation site; relevant information collected from reference sites; and completion criteria. The revegetation plan should also outline a monitoring and management program.

Appendix A contains a checklist of the recommended content of a revegetation plan. The revegetation plan checklist must be completed and attached to the revegetation plan upon submission to DWER. If revegetation is required as a condition of a clearing permit, typically an applicant will be requested to provide a revegetation plan to DWER for review, prior to the granting of the permit. DWER may require the permit holder to amend the revegetation plan where it is insufficient. This checklist can be modified to meet specific circumstances as required.

## 5.1 Revegetation Commitments

The permit holder's overall objectives for the revegetation project should be outlined in the revegetation plan.

The Environmental Protection Authority's (EPA) *Guidance Statement No. 6 – Rehabilitation of Terrestrial Ecosystems* (2006) provides information on setting effective objectives for rehabilitation and revegetation. The vision and objectives of a revegetation plan should be consistent with the SMART (specific, measurable, achievable, relevant, time-bound) principles.

Examples of a revegetation project objective are to ensure the:

- ecosystem has the capacity to become self-sustaining or become sustainable with minimal management; and
- revegetation is representative of the original vegetation unit.

## 5.2 Background Information

The revegetation plan should include the following information about the impact site prior to clearing and, if offsite revegetation is proposed, the revegetation site:

- ownership, vesting and zoning of the land;
- description of the site's physical and biological features (such as soil type, landform, topography, hydrology/drainage, vegetation type and fauna);
- description of the site's history, including historical disturbance such as grazing and logging;
- description of disturbances and threats potentially exacerbated by clearing such as erosion and weeds;
- existing site conditions that require remediation such as soil compaction, erosion, surface water diversion, weeds, feral animals and plant pathogens;
- evidence of any agreements necessary to access the site for the purpose of undertaking revegetation; and
- maps, photographs and spatial datasets relating to the site.

### Maps and shapefiles

Maps, spatial datasets and other information referred to in the revegetation plan are to be provided to DWER electronically. Spatial datasets provided should be as Environmental Systems Research Institute (ESRI) shapefiles with the following properties:

- geometry type: polygon shape;
- coordinate system: GDA 1994 (Geographic latitude/longitude); and
- datum: GDA 1994 (Geocentric Datum of Australia 1994).

Aerial photographs or maps should be used to show features of a site, for example, the boundaries of the clearing footprint, the revegetation site/s, the reference site/s and vegetation unit boundaries.

## 5.3 Reference Sites

Reference sites enable the collection of baseline data that assist in determining the completion criteria to be developed in sufficient detail.

### Selecting reference sites

Reference sites are an important source of information on the type of vegetation, for example species composition and structure, that is proposed to be revegetated.

Baseline floristic data can be collected from the following types of reference sites:

- floristic surveys of the pre-disturbance vegetation that is in 'excellent condition' (Keighery, 1994) or 'very good condition' (Trudgen 1991) or better;
- in consultation with DWER, adjacent vegetation of the same vegetation unit/s and is in 'excellent condition' (Keighery 1994) or 'very good condition' (Trudgen, 1991) or better, and occurs on the same soil type; or
- in consultation with DWER, vegetation located in close proximity that has the same vegetation unit/s and is in 'excellent condition' (Keighery 1994) or 'very good condition' (Trudgen 1991) or better, and occurs on the same soil type.

Where it can be demonstrated that a suitable reference site meeting the above criteria is not available, DWER may consider and approve an alternative reference site (e.g. occurring on a different soil type).

Existing datasets can be used to supplement reference site data.

### Data to collect

Collecting baseline data using quadrats for the overall site is necessary to develop the completion criteria. Other information such as existing datasets may be used in some circumstances. Baseline data should be collected for each relevant component, for example, each vegetation type impacted or proposed to be revegetated, and the completion criteria developed for each of these. Compilation of baseline floristic and associated data from reference site surveys also assists in the development of species lists for revegetation.

Table 1 outlines example data and methods of collection that may be used to develop the completion criteria (see Section 5.4) and monitoring reports (see Section 6). The methods of collection outlined should be based on site characteristics and justification provided.

Table 1: Example data and methods of collection

Scale	Data	Method
Quadrat-level	Species richness	Number of species within quadrats.
	Species list (includes weeds)	List in order of dominance and grouped by structural component (for example trees and shrubs). Dominance is determined by ranking species based on density. Density is described below.
	Density of trees and large shrubs using stems/ha (includes weeds)	For trees and large shrubs use stems/ha as quadrat based counts may be inaccurate where trees and large shrubs are not numerous.
	Density of small shrubs and herbs using plants/quadrat (includes weeds)	For small shrubs such as herbs, conversion between stems/ha and count/quadrat is possible, as long as the quadrat size is known.
	Vegetation structure	ESCAVI (2003), Muir (1977) or similar.
	Vegetation condition	Use Keighery (1994) or Trudgen (1991) depending on botanical province (Appendices C and D respectively).
	% Bare ground	Visual estimate for quadrats or site (if small). Bare ground includes soil and/or rock.
	Photos (photo monitoring points)	Taken at each quadrat for future reference.
Site level	Species richness	The number of species found at the site.
	Species list (includes weeds)	List in order of dominance and grouped by structural component (for example trees and shrubs. Dominance is determined by ranking species based on their density. Use density as described above.
	Vegetation condition site mapping	Use Keighery (1994) or Trudgen (1991) depending on botanical province (Appendices C and D respectively).
	Weed mapping	Use polygons and % cover classes.
	Disease mapping	To be completed by a qualified disease interpreter.

### When to survey

Floristic surveys should be conducted close to the peak flowering period for the majority of species in the vegetation unit. Site type, latitude and conditions specific to the season, such as late or early rains, should be considered (Department of Biodiversity, Conservation and Attractions 2017).

[www.dpaw.wa.gov.au/images/documents/plants-animals/monitoring/forms/threatened-priority-flora-field-manual.pdf](http://www.dpaw.wa.gov.au/images/documents/plants-animals/monitoring/forms/threatened-priority-flora-field-manual.pdf)).

Where Threatened or Priority flora species are present, or are likely to be present, specific consideration should be given to the peak flowering period for these species. ([www.dpaw.wa.gov.au/plants-and-animals/threatened-species-and-communities](http://www.dpaw.wa.gov.au/plants-and-animals/threatened-species-and-communities)).

Further information on optimal survey times can be found in the [EPA's Technical Guidance – Flora and Vegetation Surveys for Environmental Impact Assessment \(2016\)](#). Province and bioregion maps can be viewed on the FloraBase website, <https://florabase.dpaw.wa.gov.au/help/ibra>.

## Quadrat quantity, placement and size

The number of quadrats required will vary depending on the size of the site being surveyed. Sufficient replication is required to ensure that physical and biological variation within the site is adequately sampled (Harding and Williams 2010). The revegetation plan should demonstrate that appropriate sampling techniques were used to determine the optimum number of quadrats.

Appropriate quadrat placement is important in the establishment of suitable and realistic completion criteria:

- quadrats must be placed in vegetation that is in 'excellent condition' (Keighery, 1994) or 'very good condition' (Trudgen 1991) to ensure that completion criteria reflect the vegetation type that is compositionally and structurally intact (for example, placed 50–100 metres from the edge of a site to avoid edge effects). If this is not possible, contact DWER for advice;
- the placement of quadrats should avoid ecotones (transitional vegetation areas) to ensure data is representative of a unique vegetation unit; and
- quadrats must include common or dominant species, and species representative of and endemic to the ecosystem (Department of Environment and Conservation 2009).

Quadrat locations must be reported to DWER at the time of the clearing permit application assessment.

The selection of quadrat size is dependent on the spatial scale of ecological and floristic variation within the bioregion. Bioregions of higher diversity, such as the Geraldton Sandplains and Swan Coastal Plain, may require smaller quadrats than those located within the more homogenous Central Kimberley bioregions.

Further information on sampling design and intensity can be found in the [EPA's Technical Guidance – Flora and Vegetation Surveys for Environmental Impact Assessment \(2016\)](#).

## Vegetation condition

The condition of vegetation at a reference site is to be determined by assessing the impact of disturbance on the vegetation structure and its capacity to regenerate. Appendices C and D list vegetation condition scales for different Western Australian botanical provinces.

Vegetation condition maps are to be included in the revegetation plan.

## Weeds and diseases

Recording the species, extent and density of weeds or diseases present in a reference site assists in determining the appropriate techniques to manage weeds and diseases within the revegetation site.

## Use of existing datasets

A substantial volume of ‘grey’ literature (that is, academic literature that has not been formally published) exists, which may be useful in the development or refinement of completion criteria.

Existing floristic datasets can be used to supplement data collected from reference sites. If a reference site is missing key structural components due to disturbance, previously collected relevant data (especially from regional baseline surveys) may provide relevant information on the site’s likely vegetation prior to disturbance.

The revegetation plan should clearly differentiate between data obtained through surveys undertaken by (or on behalf of) the permit holder, and data obtained from existing datasets. If existing floristic datasets are used, the currency of species names should be checked. Existing floristic datasets must be referenced.

## 5.4 Completion Criteria

Revegetation plans should include quantitative completion criteria. Each completion criterion must be defined by a measurable outcome so that the effectiveness of the revegetation action(s) can be assessed over time. The measurable outcomes of a revegetation project that are to be regularly monitored and reported, should be included in the revegetation plan. DWER may assist permit holders with the development of appropriate completion criteria.

Completion criteria must be designed to allow effective reporting and auditing for the duration of the clearing permit. Floristic data from reference sites are useful in setting the completion criteria for the revegetation site. Revegetation is generally considered complete once the completion criteria have been met. DWER will ensure that an approved revegetation plan and the clearing permit conditions are consistent. If approved completion criteria have not been met towards the end of the permit, the permit holder or DWER may seek an extension of the permit.

### Developing completion criteria

Completion criteria are developed based on data collected from a reference site (where possible) and must be consistent with the SMART principles (see Section 5.1). Completion criteria will depend on the revegetation purpose and objectives.

Table 2 outlines a typical framework for the completion criteria of a revegetation project to increase biodiversity. Other criteria may be proposed, provided there is sufficient evidence to justify use. DWER may discuss specific criteria with the permit holder during the assessment.

**Table 2: Example framework for the completion criteria of a revegetation project aimed at improving biodiversity**

Criterion		Measure	Units
A	Species richness	i. Total species richness (site)	species count
		ii. Quadrat species richness (average across quadrats)	species count
		iii. Tree species richness	species count
		iv. Shrub species richness	species count
B	Species density	i. Tree density (for each dominant species)	stems/ha
		ii. Shrub density	stems/ha (large shrubs) or count/quadrat (small shrubs)
C	<b>Herbs, sedges, grasses</b>		count and/or percentage cover per quadrat
D	Weed cover	i. Minor, non-competitive species	percentage cover or count
		ii. Major competitive weeds	percentage cover or count
		iii. Declared weeds	percentage cover or count
E	<b>Bare ground</b>		percentage
F	<b>Vegetation structure</b>		refer Table 1
G	<b>Other measures as required</b>		

Table 3 outlines an example of completion criteria developed, based on baseline data collected from a fictional reference site, *Banksia woodland X*, which is to be cleared, and the completion targets. In this example, the completion criteria include ‘duplicate criteria’ for the number of stems per hectare to be achieved at the revegetation site (see criteria B and F), for example, criteria B is attained by achieving criteria F. DWER will accept ‘duplicate criteria’ that are complementary, but will not accept criteria that are in conflict with other completion criteria, for example targeted outcomes which contradict each other.

**Table 3: Example completion targets and criteria developed for *Banksia woodland X***  
(Note: Criterion C - Herbs, sedges and grasses is not a significant measure for this revegetation.)

The vegetation unit to be revegetated is identified as <i>Banksia woodland X</i> . As it is to be cleared, <i>Banksia woodland X</i> is used as the reference site, upon which completion criteria will be developed.			
Criterion	Baseline floristic data	Completion targets	Completion criteria
<b>A(i)</b>	Site species richness is 55 (native sp. only).	Minimum of 60% of native species returned, based on reference sites.	The revegetation site needs to achieve a minimum species richness of 33 native species, as recorded at the reference sites.
<b>A(ii)</b>	Species richness of the 10m x 10m quadrats were 30, 35, 32, 25 and 36. Therefore, the average number of species/quadrat is 32.	Minimum of 60% of native species returned, based on reference sites.	The revegetation site needs a minimum of 19 native species per quadrat, as recorded at the reference sites.
<b>A(iii)</b>	There are four dominant tree species.	Return dominant tree species present at reference sites.	The revegetation site needs to have the four dominant tree species ( <i>Banksia attenuata</i> , <i>B. menziesii</i> , <i>B. ilicifolia</i> and <i>Eucalyptus marginata</i> ) recorded at the reference sites.

<b>A(iv)</b>	Shrub species richness is 20.	Minimum of 60% of native species returned, based on reference sites.	The revegetation site needs a minimum of 12 shrub species, as recorded at the reference site.
<b>B(i)</b>	Common tree species by dominance are <i>Banksia attenuata</i> 200 stems/ha; <i>B. menziesii</i> 150 stems/ha; <i>B. ilicifolia</i> 50 stems/ha; <i>Eucalyptus marginata</i> 25 stems/ha	Minimum of 60% of stems/ha for dominant tree species returned, based on reference sites.	The revegetation site needs a minimum of stems/ha for: <i>Banksia attenuata</i> 120 stems/ha; <i>B. menziesii</i> 90 stems/ha; <i>B. ilicifolia</i> 30 stems/ha; <i>Eucalyptus marginata</i> 15 stems/ha, as recorded at the reference site.
<b>B(ii)</b>	Shrub species by dominance are <i>Bossiaea eriocarpa</i> 500 stems/ha; <i>Acacia pulchella</i> 50 stems/ha; <i>Adenanthos cygnorum</i> 20 stems/ha; <i>Leucopogon conostephioides</i> 300 stems/ha; <i>Scholtzia involucrata</i> 400 stems/ha	Minimum of 60% of stems/ha for dominant shrub species returned, based on reference sites.	The revegetation site needs a minimum of stems/ha for: <i>Bossiaea eriocarpa</i> 300 stems/ha; <i>Acacia pulchella</i> 30 stems/ha; <i>Adenanthos cygnorum</i> 12 stems/ha; <i>Scholtzia involucrata</i> 240 stems/ha; as recorded at the reference site.
<b>D(i)</b>	Weed cover at the site is 15% (minor non-competitive species).	Weed cover is no greater than in the reference sites.	The revegetation site should have a maximum of 15% weed cover, as recorded at the reference site.
<b>D(ii)</b>	5% cover of major competitive weeds.	Absent from the revegetation site.	The revegetation site needs to have major competitive weeds absent from the site.
<b>D(iii)</b>	No declared weeds are present.	Managed as required by the <i>Biosecurity and Agriculture Management Regulations 2013</i> .	Absent.
<b>E</b>	Bare ground is 15%.	No more than 5% greater than in the reference sites.	The revegetation site average for bare ground is to be no more than 15%, as recorded at the reference site.
<b>F(i)</b>	Clearing will result in loss of Carnaby's habitat.	The site must be fully revegetated to at least 75% cover or density of the reference sites using native food plants for Black Cockatoos, and high to medium priority food species.	The revegetation site needs to have a minimum of stems/ha for: <i>Banksia attenuata</i> 150 stems/ha; <i>B. menziesii</i> 110 stems/ha; <i>B. ilicifolia</i> 35 stems/ha.
<b>F(ii)</b>	Survival rate to be achieved.	If after 5 years of planting a survival rate of at least 80% is not achieved, all planted trees that have not survived must be replanted within 12 months and monitored for a further 2 years.	The revegetation site needs to ensure a survival rate for trees of at least 80% is achieved after five years, and replant any trees within 12 months of dying.

## 5.5 Methodology

The revegetation plan should include the revegetation methodology. Some common methods of site preparation and revegetation establishment are discussed below. Information on revegetation techniques in this guide are of a general nature only and must be considered on a site-by-site basis. Other techniques may be considered, depending on the site's characteristics. Permit holders undertaking revegetation activities are advised to consult an environmental specialist.

Advice on correct site preparation should be sought from an environmental specialist to minimise maintenance after vegetation establishment, and enhance progress towards completion criteria.

Species for revegetation should be selected to replicate dominant species at the reference site. Reasonable attempts should be made to obtain diverse relevant species for revegetation. Where it is not possible to obtain a particular species, consultation with an environmental specialist is required to determine if there are any suitable substitute species.

### Revegetation techniques

Effective revegetation techniques differ across local soil and climatic conditions. In arid regions, topsoil management with some direct seeding may be the most effective method of vegetation establishment. In higher rainfall regions of the south-west, planting and seeding may be the most effective.

Seeds and seedlings should be obtained from disease-free sources to ensure that plant pathogens are not introduced to the revegetation site.

### Dieback mapping and site hygiene

*Phytophthora* sp. dieback is a soil-borne plant pathogen that is spread through wet soil, water and root-to-root contact between plants in areas that receive 400 millimetres of rainfall per year or more (e.g. the south-west of Western Australia).

If *Phytophthora* sp. dieback is suspected at a site, a dieback survey undertaken by an environmental specialist will be required prior to the commencement of site works to prevent accidental spread. The mapping can be used as a baseline for ongoing dieback monitoring, management and reporting to DWER. Sites may require a site hygiene protocol to reduce the spread of dieback at already infected sites and prevent the spread of dieback to uninfected sites.

### Ripping

Some revegetation sites may need to be ripped prior to establishment to promote the best chance of survival for seeds and plantings in the first year. Ripping has a number of advantages, including breaking up soil compaction to allow root and water penetration, promoting better root development, and lifting roots and rocks that may interfere with vegetation establishment.

### Pre-vegetation establishment weed control

Pre-vegetation establishment weed control is important to ensure that competition for resources between weeds and the native plants or seeds is minimised. Where necessary, weed control should commence at least 12 months prior to vegetation establishment. An environmental specialist should be consulted to develop a site-specific weed management plan. Alternatively, the revegetation plan may refer to an existing weed management plan if appropriate for the revegetation site, a copy of which must be provided to DWER.

## Fencing

Consideration should be given to fencing as part of site preparation ahead of revegetation, where sheep and other livestock may otherwise have access to the site. Temporary fencing may be required to deter kangaroos and rabbits from grazing establishing plants. Fencing also assists in reducing unauthorised access by people to the site, either by foot or in off-road vehicles.

## Tubestock and direct seeding

A program of works should avoid weather that is detrimental to vegetation establishment. This may include strong winds, heavy rain, very dry conditions or temperature extremes. Vegetation establishment should occur at the optimal time of year for that bioregion, or as otherwise specified in the clearing permit. Local or seasonal conditions that could influence the optimal timing for seeding or planting should be detailed in the revegetation plan.

Tubestock will need to be sourced in advance of any planned revegetation activities to ensure required species are available for planting and direct seeding. Seed obtained for revegetation must comply with any definition of local provenance in the clearing permit. Collection of seed from Crown land requires a 'Scientific or Other Prescribed Purposes' licence under the *Wildlife Conservation Act 1950*. On private property, the landowner's permission is required.

Depending on species and to allow for seasonal variation, it is suggested that seed collection commences at least two years prior to revegetation. Seed stocks may be supplemented by purchase through a seed supplier from local provenance sources.

## Topsoil

Where a site to be cleared has relatively intact and weed-free vegetation, topsoil (the upper layer within a soil profile, which normally contains organic matter) may contain valuable native plant seeds, organic matter and other nutrients. Topsoil is best used immediately after clearing, however where this is not possible, topsoil can be stockpiled. Stockpiled topsoil must be managed as there is an exponential decrease in seed viability and soil nutrients over time.

## Mulch

Where a site to be cleared contains relatively intact and weed-free vegetation, mulching can provide a good source of seed (especially canopy stored seeds) to be spread over the site. The mulched material can be spread over the top of re-spread topsoil and help to suppress weeds.

## 5.6 Maintenance and Contingency Measures

The revegetation plan should outline maintenance activities that will be undertaken over the life of the revegetation project (for example, weed control and nuisance animal control). Contingency measures should also be included in case monitoring identifies deficiencies in the revegetation, for example if a significant number of plants die during a drought.

## 5.7 Schedule and budget

A schedule of actions, including dates for the start of activities, an estimated budget and funding sources, should be included in a revegetation plan. An example of an indicative schedule is provided in Table 4. Appendix E provides two examples of budgets for revegetation in Western Australian bioregions. Permit holders must take into consideration the requirements of the clearing permit where applicable.

Table 4: Example of a schedule of actions

Stage	Actions	Timing	Responsibility	Year 1	Year 2	Year 3	Year 4 and beyond	Cost and funding source
COMPLETION CRITERIA	Reference site surveys and development of completion criteria	Spring	WA Revegetation Consultants are the lead consultancy and will engage and coordinate specific sub-contractors as required.	X				<i>Insert cost estimate and source of funding for each action</i>
SITE PREPARATION	Dieback mapping and development of hygiene plan	Spring	XYZ dieback interpretive services	X				
	Onsite clearing	February	LMN contractors		X			
	Fencing and ripping	Autumn	LMN contractors		X			
	Weed control	Autumn	EFG weed control contractors	X	X			
VEGETATION ESTABLISHMENT	Seed collection and seed management	Spring	WA Revegetation Consultants	X	X if required			
	Place tubestock orders with nursery	Summer	WA Revegetation Consultants ordering from ABC Native Nursery.	X	Until completion criteria have been met and maintained for two years (within the timeframe of the clearing permit).			
	Plant tubestock and undertake direct seeding	May–July	WA Revegetation Consultants		X	Until completion criteria have been met and maintained for two years (within the timeframe of the clearing permit).		
MONITORING	Vegetation monitoring against completion criteria	Spring	WA Revegetation Consultants		X	Until completion criteria have been met and maintained for two years (within the timeframe of the clearing permit).		

Stage	Actions	Timing	Responsibility	Year 1	Year 2	Year 3	Year 4 and beyond	Cost and funding source
	Weed monitoring	Spring	WA Revegetation Consultants		X	Ongoing annually until completion criteria met and maintained for two years (and as required in the clearing permit)		
	Dieback monitoring	Spring	XYZ dieback interpretive services		X	Ongoing annually		
	Weed control	After winter rains	EFG weed control contractors		X	Ongoing annually until completion criteria met and maintained for two years (and as required in the clearing permit)		
	Remedial planting	May to July	WA Revegetation Consultants			X	Ongoing as indicated by monitoring	
	Dieback treatment	Summer	XYZ dieback interpretive services		As required and indicated by monitoring			
<b>REPORTING</b>	Revegetation plan		WA Revegetation Consultants Includes datasets in their entirety (electronically), data analysis, results, discussion. Includes all from Appendix A checklist including completed checklist. Mapping and GIS shapefiles included	X				
	Annual progress report	June 30 each year	WA Revegetation Consultants Includes all datasets in their entirety (electronically), data analysis, results, discussion. Includes all from Appendix B checklist including completed checklist. Mapping and GIS shapefiles included		X	Ongoing annually until completion criteria met and maintained for two years (and as required in the clearing permit)		

## 6 Revegetation Monitoring Reports

Clearing permit conditions may include a requirement to monitor revegetation and measure the progress of revegetation activities undertaken to determine if maintenance and contingency actions are required. This section provides guidance on monitoring requirements, including information to be included in annual reporting. Appendix B provides a checklist of the recommended content of monitoring reports for submission to DWER.

### 6.1 Monitoring methods

#### Data to collect

The types of data and methods of collection at a reference site apply to data collection for monitoring purposes (refer to Section 5.3).

#### Quadrats

The aim of quadrat-level monitoring is to collect data in a consistent way for use in detecting changes in revegetation over time, in order to determine if revegetation is progressing towards meeting the completion criteria. By using the same data collection methods, the data can be analysed year to year to compare the progress of the revegetation.

Determining the appropriate time to undertake a floristic survey, and the appropriate number, placement and size of quadrats for monitoring revegetation, follows the same principles as those outlined for reference sites (refer to Section 5.3):

- floristic surveys should be conducted close to the peak flowering period for the majority of species in the vegetation unit revegetated, taking into consideration seasonal variations; and
- sufficient replication of quadrats is required to encompass variability in the monitoring area, and quadrat location must be random to ensure this variation is taken into account.

The monitoring report must demonstrate that appropriate sampling techniques were used to determine the optimum number of quadrats for replication, and describe the method for quadrat location randomisation.

If permanent monitoring quadrats are used, these should be established in accordance with the [Standard Operating Procedure Establishing Vegetation Quadrats \(Department of Environment and Conservation 2009\)](#), the [EPA's Technical Guidance – Flora and Vegetation Surveys for Environmental Impact Assessment \(2016\)](#) and the requirements specified in the clearing permit.

#### Photopoint monitoring

Photopoint monitoring provides a visual comparison of changes to vegetation over time. This requires photographs to be taken from the same location at set intervals

(for example, in January, April, July and October each year for three years), and using the same method (such as camera settings). Images must be provided to DWER in accordance with records and reporting conditions on the clearing permit.

### Weeds and disease

Monitoring can be useful to identify whether weed control methods have been effective. This includes whether the composition and density of native species are responding positively to weed control, and whether modification to the control methods is required, for example, planting trees closer together to shade out weeds.

If disease is present within a revegetation site, hygiene management must be implemented to prevent the spread of the disease within or outside the affected area. Ongoing investigation by an environmental specialist is also recommended to ensure that disease is not being inadvertently spread through the revegetation site and to evaluate the effectiveness of hygiene protocols.

## 6.2 Monitoring Schedule

The frequency and duration of monitoring and documentation of changes in revegetation over time are outlined in Table 5.

Table 5: Example monitoring requirements

Scale	Monitoring type	Output	Frequency	Duration
Quadrat-level	Quadrat floristics	Floristic survey data, analysis (ordinations), discussion, list of coordinates and site map with quadrats.	Annual	Until completion criteria have been met (within the timeframe of the clearing permit).
	Vegetation structure	Data, analysis and discussion.	Annual	
	Photopoint monitoring	Images, list of coordinates, map of photopoints.	Annual	
Site-level	Vegetation condition	Data and map.	Annual	
	Weed monitoring and mapping	Data and map.	Annual	
	Disease monitoring and mapping	Data, map, name and qualifications of dieback interpreter.	Annually or as required	

## 6.3 Detecting Change through Data Analysis

Both multivariate (multiple variable) and univariate (single variable) analysis are used to monitor change in vegetation over time. Multivariate analysis identifies changes in the vegetation unit as a whole (that is, change in multiple species from year to year in a single test), whereas univariate analysis identifies change in one feature (for example, the change in *Banksia attenuata* stems/ha from year to year). Analysis by an experienced statistical analyst who is familiar with botanical data is recommended.

Multivariate analysis can assist in providing an indication of how revegetation is progressing towards the completion criteria. As a minimum, analyses should be completed to compare the species' richness (presence/absence) and species density (plants/ha or stems/ha) between the revegetation site and reference sites.

For transparency, an outline and justification of data treatment and analysis must be included in the monitoring report. Data pre-treatment may be required and logarithmic, square root or other transformations should also be considered.

## 6.4 Maintenance and Contingency Measures

Results from the monitoring data may trigger corrective or contingency measures where revegetation is compromised by weeds, feral or stock animals, human activities, fire and drought. Maintenance and contingency measures should include:

- post-planting weed control, for example spot-spraying, hand weeding and mulch;
- remedial planting or seeding requirements (dependent on establishment and ongoing success);
- disease treatment (if required);
- inspection and maintenance of fencing (if required);
- erosion (causes and remedial actions); and
- other maintenance actions.

Timing and methods of these measures should be documented.

# 7 Useful Resources

## 7.1 General

Australian and New Zealand Minerals and Energy Council and Minerals Council of Australia 2000, *Strategic framework for mine closure*, ANZMEC and MCA, Canberra.

Department of the Environment and Energy n.d., *Australia's bioregions – maps*, Australian Government. [www.environment.gov.au/land/nrs/science/ibra/australias-bioregions-maps](http://www.environment.gov.au/land/nrs/science/ibra/australias-bioregions-maps).

Casson, N, Downes, S and Harris, A 2009, *Native vegetation condition assessment and monitoring manual for Western Australia*, Department of Environment and Conservation, Western Australia. [www.dbca.wa.gov.au](http://www.dbca.wa.gov.au).

Environmental Protection Authority 2006, *Guidance for the assessment of environmental factors: rehabilitation of terrestrial ecosystems*, guidance no. 6, EPA, Western Australia. [www.epa.wa.gov.au](http://www.epa.wa.gov.au)

Hussey, BMJ and Wallace, KJ 1993, *Managing your bushland*, Department of Conservation and Land Management, Western Australia.

## 7.2 Photo monitoring

Hussey, BMJ 2001, 'Photographic monitoring of vegetation', *Wildlife Notes*, no. 9, Department of Conservation and Land Management, Western Australia.

[www.dbca.wa.gov.au](http://www.dbca.wa.gov.au).

## 7.3 Plants and seeds

Apace WA n.d., *Revegetation catalogues*. <http://apacewa.org.au/revegetation-catalogues/>.

Bradby, K and Morris, V 1997. 'Seed collection from native plants', *Wildlife Notes*, no. 4, Department of Conservation and Land Management, Western Australia.

[www.dbca.wa.gov.au](http://www.dbca.wa.gov.au).

Department of Biodiversity, Conservation and Attractions n.d., *FloraBase*, Government of Western Australia. <https://florabase.dpaw.wa.gov.au/>.

Department of Biodiversity, Conservation and Attractions 2014, *Plants for Carnaby's search application*, Government of Western Australia.

[www.dpaw.wa.gov.au/apps/plantsforcarnabys/index.html](http://www.dpaw.wa.gov.au/apps/plantsforcarnabys/index.html).

Department of Biodiversity, Conservation and Attractions n.d., *Threatened species and communities*, Government of Western Australia. [www.dpaw.wa.gov.au/plants-and-animals/threatened-species-and-communities](http://www.dpaw.wa.gov.au/plants-and-animals/threatened-species-and-communities).

Department of Biodiversity, Conservation and Attractions 2013, *Seed notes for Western Australia*, Government of Western Australia. [www.dpaw.wa.gov.au/about-us/science-and-research/publications-resources/114-seed-notes-for-western-australia](http://www.dpaw.wa.gov.au/about-us/science-and-research/publications-resources/114-seed-notes-for-western-australia).

Greening Australia and Commonwealth Scientific and Industrial Research Organisation n.d., *Species navigator – a Florabank decision support tool*.

[www.florabank.org.au](http://www.florabank.org.au).

Kings Park and Botanic Gardens 1999, *Smoke to sow and grow*, Kings Park and Botanic Gardens, Western Australia. Email: [scienceadmin@bgpa.wa.gov.au](mailto:scienceadmin@bgpa.wa.gov.au)

Ralph, M 2003, *Growing native trees from seed*, CSIRO Publishing.

## 7.4 Vertebrate pests, weeds and disease

Brown, K and Brooks, K 2002, *Bushland weeds: a practical guide to their management with case studies from the Swan Coastal Plain and beyond*, Environmental Weeds Action Network, Greenwood.

Brown, KL and Bettink, KA (2009-), *Swan weeds: management notes*, FloraBase — The Western Australian Flora, Department of Biodiversity, Conservation and Attractions. <https://florabase.dpaw.wa.gov.au/weeds/swanweeds/>.

Department of Biodiversity, Conservation and Attractions. Forest Ecosystem Management Division. Email: [enquiries@dbca.wa.gov.au](mailto:enquiries@dbca.wa.gov.au) Phone: (08) 9219 9000.

Department of Biodiversity, Conservation and Attractions 2014, *Rabbits*, Government of Western Australia. [www.dpaw.wa.gov.au/management/pests-diseases/181-rabbits](http://www.dpaw.wa.gov.au/management/pests-diseases/181-rabbits)

Department Primary Industries and Regional Development n.d., *Rabbit control in urban and semi-urban areas*, Government of Western Australia. [www.agric.wa.gov.au/](http://www.agric.wa.gov.au/)

Dieback Working Group n.d., *Expert directory*. [www.dwg.org.au/expert-directory](http://www.dwg.org.au/expert-directory).

Dieback Working Group n.d., *Publications*. [www.dwg.org.au/publications](http://www.dwg.org.au/publications).

Hussey, BMJ, Keighery, GJ, Dodd, J, Lloyd, SG and Cousens, RD 2007, *Western weeds: a guide to the weeds of Western Australia*, 2nd Edition, The Plant Protection Society of Western Australia, Victoria Park.

## 7.5 Restoration/Rehabilitation

Clewell, A, Reiger, J and Munro, J 2005, *Guidelines for developing and managing ecological restoration projects*, Society for Ecological Restoration International. [www.ser.org](http://www.ser.org).

Davidson, N and Freudenberger, D 2012, *A revegetation guide for eucalypt woodlands*, Greening Australia, Canberra. [www.greeningaustralia.org.au](http://www.greeningaustralia.org.au).

Botanic Gardens and Parks Authority n.d., *Science staff*, Department of Biodiversity Conservation and Attractions. [www.bgpa.wa.gov.au/about-us/conservation/research/science-staff#content](http://www.bgpa.wa.gov.au/about-us/conservation/research/science-staff#content).

Department of Biodiversity, Conservation and Attractions n.d, *Land for wildlife publications - wildlife notes*, Government of Western Australia. [www.dpaw.wa.gov.au/management/off-reserve-conservation/land-for-wildlife/187-publications](http://www.dpaw.wa.gov.au/management/off-reserve-conservation/land-for-wildlife/187-publications).

Department of Mines and Petroleum and the Environmental Protection Authority 2015, *Guidelines for preparing mine closure plans*, Government of Western Australia. [www.dmp.wa.gov.au/Documents/Environment/ENV-MEB-121.pdf](http://www.dmp.wa.gov.au/Documents/Environment/ENV-MEB-121.pdf).

McGregor, J, Gardner J and Robinson, J 2012, *A revegetation guide for mallee woodlands*. Greening Australia, Canberra.

Schirmer, J. and Field, J 2000, *The cost of revegetation: final report*, Greening Australia Limited and Australian National University, Canberra.

Standards Reference Group Society for Ecological Restoration Australasia 2017, *National standards for the practice of ecological restoration in Australia*, SERA. [www.seraustralasia.com](http://www.seraustralasia.com).

Stevens, JC, Rockich, DP, Newton, VJ, Barrett, RL and Dixon, KW 2016, *Banksia woodlands: a restoration guide for the Swan Coastal Plain*, University of Western Australia Publishing, Perth.

## 7.6 Western Australian vegetation reference data

Gibson, N, Keighery, B, Keighery, G, Burbidge, A and Lyons, M 1994. *A floristic survey of the southern Swan Coastal Plain*, Department of Conservation and Land Management and Western Australian Conservation Council, Western Australia. <https://library.dbca.wa.gov.au/static/FullTextFiles/916249.e.pdf>.

Harvey, JM and Keighery, GJ 2012, *Benchmarking Wheatbelt vegetation communities, classification and description of eucalypt woodlands*, Wheatbelt Baseline Project, Wheatbelt Natural Resource Management Region and Department of Environment and Conservation, Perth. [www.dbca.wa.gov.au](http://www.dbca.wa.gov.au).

Perth Region Plant Biodiversity Project n.d., *Bush Forever reference sites*, Western Australian Local Government Association, Department of Environment and Department of Conservation and Land Management. <http://pbp.walga.asn.au/ProjectPrograms/PerthRegionPlantBiodiversityProject.html>

## 8 References

Department of Environment and Conservation 2009, *Standard operating procedure, establishing vegetation quadrats*, Government of Western Australia.

[www.dbca.wa.gov.au](http://www.dbca.wa.gov.au).

Department of Biodiversity, Conservation and Attractions 2017, *Threatened and Priority Flora Report Form – Field Manual*, Government of Western Australia.

[www.dbca.wa.gov.au](http://www.dbca.wa.gov.au)

Environmental Protection Authority 2006, *Guidance for the assessment of environmental factors: rehabilitation of terrestrial ecosystems*, guidance no. 6, Government of Western Australia. [www.epa.wa.gov.au](http://www.epa.wa.gov.au).

Environmental Protection Authority 2016, *Technical guidance, flora and vegetation surveys for environmental impact assessment*, Government of Western Australia.

[www.epa.wa.gov.au](http://www.epa.wa.gov.au).

Executive Steering Committee for Australian Vegetation Information 2003, *Australian vegetation attribute manual: National Vegetation Information System*, Version 6.0, Department of Environment and Heritage, Canberra. [www.environment.gov.au](http://www.environment.gov.au).

Harding C and Williams M 2010, *Designing a monitoring project for significant native flora*, Department of Environment and Conservation, Perth. [www.dbca.wa.gov.au](http://www.dbca.wa.gov.au).

Keighery, B 1994, *Bushland plant survey: a guide to plant community survey for the community*, Wildflower Society of Western Australia (Inc.), Nedlands.

Muir, B 1977, *Biological survey of the Western Australian Wheatbelt, Part 2: Vegetation and habitat of Bendering Reserve*. Records of the Western Australian Museum, Supplement No. 3, Western Australian Museum, Perth.

<http://museum.wa.gov.au/research/records-supplements/records/biological-survey-western-australian-wheatbelt>

Trudgen, ME 1991, 'Vegetation condition scale', in National Trust (WA) 1993 *Urban Bushland Policy*. National Trust of Australia (WA), Wildflower Society of WA (Inc.), and the Tree Society (Inc.), Perth.

## Appendices

### Appendix A: Recommended Content for a Revegetation Plan

PERMIT HOLDER MUST COMPLETE THIS CHECKLIST AND SUBMIT TO DEPARTMENT OF WATER AND ENVIRONMENTAL REGULATION (DWER) TOGETHER WITH THE REVEGETATION PLAN.

Relevant boxes should be ticked to demonstrate that the information has been provided within the submitted revegetation plan.

- Title which clearly outlines the name of the revegetation project and its location.
- Table of contents. Suggested headings include:
  - Introduction
  - Reporting requirements
  - Background of revegetation site
  - Current disturbances and threats
  - Reference site floristic data collection
  - Revegetation commitments and completion criteria
  - Site preparation
  - Vegetation establishment
  - Proposed monitoring plan
  - Maintenance and contingency measures
  - Schedule and budget
  - References and appendices

#### **Introduction**

This section should contain the following information on the background of the site and include, but is not limited to:

- Purpose of the plan.
- Section explaining how the proposed revegetation addresses the impacts of the clearing.
- Clearing permit number (CPS xxx/x) that the revegetation plan relates to.
- Key contacts and details of person who developed the plan.
- Level of qualification and experience of person who developed the plan.
- Location of clearing, property details, clearing size and purpose.
- Location of revegetation site, property details and size of revegetation site.
- Map outlining the boundary of the clearing area, the revegetation site, aerial photography, cadastral boundaries, roads and other relevant factors. Include area in hectares.
- Associated spatial data for the clearing area is provided in approved format (for example, shapefile).
- Name and qualifications of company providing expertise on completion criteria development and onsite revegetation techniques.

#### **Background of revegetation site**

This section should contain information on the existing environment and land details of the revegetation site and include:

- Details of ownership, vesting and zoning of the land (current and/or proposed).

- Details of agreement with landowner to access and carry out revegetation (if not the owner of the revegetation site).
- Details on how the long-term security of the revegetation site will be ensured, including any existing or proposed management arrangements (for example, a conservation covenant).
- Map outlining the existing vegetation unit/s, summary structure and condition. When mapping each vegetation unit and vegetation condition across the site, include area in hectares.
- Map outlining the existing soil types, landforms and topography. Include area in hectares.
- Associated spatial data for the revegetation site (vegetation units, soil types, landforms and topography) is provided in Geographic Information Systems (GIS) format (for example shapefile).
- Existing hydrology and drainage.
- Existing evidence of fauna.
- Photos of the existing environment should be provided.

### **Current disturbance and threats**

This section should contain the current disturbances and threats to the revegetation site:

- Site history (for example, grazing or logging).
- Existing land use disturbances that need to be addressed such as grazing, rubbish dumping, four wheel drive access and fire.
- Existing physical site factors that need to be addressed or repaired such as soil compaction, erosion and surface water diversion.
- Existing biological site conditions that need to be repaired such as weed invasion, disease, lack of fauna habitat, feral animals and low floristic diversity.

### **Revegetation commitments**

This section should contain the overall vision of the plan as well as objectives for the revegetation project.

- Vision: an overarching statement of the intent of the plan and its ultimate goal.
- Objectives: set the main goals of the revegetation (for example, safe and stable landforms and soils, establishment of natural hydrology, resilient and self-sustaining vegetation, reaching agreed numeric targets for revegetation recovery and to provide fauna habitat).

### **Reference site floristic data collection**

If more than one vegetation unit is being revegetated, reference site data for each vegetation unit is required. Species lists from different vegetation units are not to be combined.

- Identify each unique vegetation unit to be revegetated (if there are many vegetation units, contact DWER to discuss).
- Describe and justify chosen reference site/s in the context of developing completion criteria.
- Provide map showing reference site location, tenure and size; boundaries of vegetation units; aerial photograph; and quadrat locations, size and number. Also include site vegetation condition mapping, site weed mapping and site disease mapping (include area in hectares).
- Associated spatial data for the reference site/s is provided in GIS format (for example shapefile).
- Provide all reference site data sets as outlined in Section 5.3 in this guide. This includes entire floristics for each quadrat as outlined (electronically). If more than one vegetation unit is being revegetated, separate reference site data is required.

## Targets and completion criteria

If more than one vegetation unit is being revegetated, each will require a set of unique completion criteria. Do not combine different vegetation units into one, unless through prior discussion with DWER.

- Outline targets and completion criteria.
- Describe clearly how each target and completion criterion was developed and how they meet the SMART principles. If existing data sets were used, describe and justify their inclusion.

## Species list compilation and revegetation techniques

This section should include details on how and when vegetation establishment is to occur.

- Species list and amounts from completion criteria. Describe and confirm where these species can be acquired, in the required amounts and at the correct time of year.
- Seed collection (for either direct seeding or seedling propagation). Details on the timing of seed collection and the source and methods used to collect seeds are required. Include provenance.
- Direct seeding. A species list, timing and details on the methods used to direct seed are required as well as the target species composition and sowing rate (kilogram per hectare). Justify species composition and sowing rate (if undertaken).
- Topsoil. A list of expected species and species composition from the topsoil is required, along with the methods and timing of collecting, stockpiling and spreading the topsoil on the revegetation site (if undertaken).
- Mulching. Details on timing and methods are required.
- Confirm that seedlings are obtained from dieback-free sources to prevent introduction or spread of disease.

## Site preparation

This section should contain details on the site preparation required prior to vegetation establishment.

- Describe techniques, timing and methods to be used to undertake site preparation actions. For example, actions may include ripping; grading and contouring; stockpiling of topsoil; mulching or matting; and pre-planting weed control.
- Describe revegetation site protection actions to be undertaken including methods and timing. For example:
  - Protecting the site through fencing and providing protection from grazing. Provide map of current and proposed fencing boundaries.
  - Signage and schedule for installation.
  - Provide dieback mapping and site hygiene plan showing hygiene boundaries to prevent spread of dieback and other plant diseases. Please provide map in report and associated spatial data in GIS format (for example shapefile).
  - Provide weed mapping and hygiene boundaries to prevent spread of dieback and other plant diseases. Please provide map in report and associated spatial data in GIS format (for example shapefile).

## Maintenance and contingency measures

This section should outline the maintenance and contingency measures that will be put in place to ensure revegetation is successful.

- Post-planting weed control (for example, spot-spraying, hand weeding and mulching). Timing and methods used should be documented.
- Remedial planting or seeding requirements (dependent on establishment and ongoing success). Timing and methods used should be documented.

- Dieback treatment if required. Contractor name, timing and methods used should be documented.
- Inspection of fencing. Timing and methods used should be documented.
- Erosion. Cause and remedial action to be used should be documented.
- Other maintenance actions. Timing and methods used should be documented.

### **Schedule and budget**

This section should include a detailed work plan that outlines the timing for each action per year including monitoring and maintenance. It should also outline the costings and source of funding for each revegetation action.

- Schedule of actions (timeline) in table format (see Table 4) showing actions to be undertaken per month/season and per year of the project. This includes specialist environmental consultancy services, materials, site preparation, on ground works, maintenance, monitoring and overheads/administration. A date for the commencement of revegetation should be identified.
- The entity or person responsible to implement each action outlined in the schedule of actions.
- Budget and costings (see examples in Appendix E).
- Source of funding.

### **Monitoring and analysis**

This section should include details on the proposed methods for monitoring and data analysis. Describe monitoring methods to be used:

- Describe monitoring frequency and timing (month / year).
- Outline the statistical analysis to use and the features of the revegetation to analyse.

### **References and appendices**

This section should include references used to create the plan and any appendices.

- References used to create the revegetation plan.
- Aerial photographs.
- Onsite photographs (photopoints) of both reference site/s and revegetation site.
- Required datasets in entirety. Both reference site/s and revegetation site (site floristics, quadrat vegetation structure, quadrat vegetation condition, quadrat per cent bare ground and vegetation. Datasets are to be clearly named with a basic description of each required.
- Maps of fence boundary, dieback mapping, vegetation condition mapping, photopoint locations and monitoring quadrat locations.
- Associated spatial data of the revegetation site features is provided in GIS format (for example shapefile). Shapefiles are to be clearly named to reflect content.
- Copy of written agreement with landowner (if not the owner of the revegetation site).

## Appendix B: Recommended Content for Monitoring

PERMIT HOLDER MUST COMPLETE THIS CHECKLIST AND SUBMIT TO DEPARTMENT OF WATER AND ENVIRONMENTAL REGULATION (DWER) TOGETHER WITH THE MONITORING REPORT.

Relevant boxes should be ticked to demonstrate that the information has been provided within the submitted revegetation annual report.

- Title which clearly outlines the name of the revegetation project and its location
- Table of contents. Suggested headings include:
  - Introduction
  - Summary of revegetation site:
    - background of revegetation site;
    - current disturbances and threats;
    - site preparation; and
    - initial vegetation establishment.
  - Monitoring outcomes
  - Progress against completion criteria:
    - data analysis;
    - results; and
    - discussion.
  - Maintenance and contingency measures
  - Updated schedule and budget
  - References and appendices

### Introduction

The following should be included, but not limited to:

- Purpose of the report.
- Section explaining how the proposed revegetation addresses the impacts of the clearing.
- Clearing permit number (CPS xxx/x) that the revegetation plan relates to.
- Key contacts and details of person who wrote the report.
- Level of qualification and experience of person who wrote the report.
- Location of clearing, property details, clearing size and purpose.
- Location of revegetation site, property details and size of revegetation site.
- Map outlining the boundary of the clearing area, the revegetation site, aerial photography, cadastral boundaries, roads and other relevant factors (include areas in hectares).
- Associated spatial data for the clearing area is provided in GIS format (for example shapefile).

### Summary of revegetation site

This section should include the components below which are from the original revegetation plan:

- The background of the revegetation site.
- Current disturbances and threats.
- Summary of initial site preparation.
- Summary of initial vegetation establishment.
- Revegetation sites and/or activities that have occurred should be illustrated on a detailed site plan and provided in GIS format (for example shapefile).

### Monitoring outcomes

This section should state the monitoring outcomes and include:

- A description of monitoring methods to be used (particularly if changed from what was suggested in the revegetation plan).
- A description of the monitoring frequency and timing (month/year).
- The monitoring data sets (electronically), monitoring summaries, analysis and interpretation of findings for data outlined in table below.
- Records of the weed density or cover. Provide weed map in report and GIS format (for example shapefile).
- A vegetation condition map in the report and in GIS format (for example shapefile).
- Disease mapping (if relevant) in the report and in GIS format (for example shapefile).
- The success of additional actions, for example weed control, fencing and rabbit control.

### **Progress against completion criteria**

This section should comprise data analysis, results and discussion on changes in the revegetation over time. This includes:

- Who completed the analysis?
- The data analysis methods used and justification for their use.
- Why/why not data pretreatment was/was not undertaken.
- The type of pretreatment used.
- Results and discussion.

### **Maintenance and contingency measures**

This section should outline the maintenance and contingency measures that are required based on monitoring results and progress against completion criteria, including:

#### Maintenance measures

- A list of the maintenance measures.
- The trigger for maintenance measures.
- Timing.
- How often these measures will be undertaken.

#### Contingency measures

- A list of the contingency measures
- The trigger for contingency measures.
- Timing.
- How often these measures will be undertaken.

## Updated schedule and budget

This section should include any modifications to the original detailed work plan.

- Schedule of actions (timeline) in table format (see Table 4) showing actions to be undertaken per month/season and per year of the project. Highlight any changes from the original revegetation management plan and provide explanation.
- The entity or person responsible to implement each action outlined in the schedule of actions.
- Budget and costing of actions (see examples in Appendix E).
- Source of funding.

## References and appendices

This section should include references used to create the plan and any appendices.

- References used to create the revegetation plan.
- Aerial photographs.
- Onsite photographs (photopoints).
- Required monitoring datasets in entirety.
- Maps of fence boundary, dieback mapping, vegetation condition mapping, photopoint locations and monitoring quadrat locations.
- Associated spatial data of the revegetation site features is provided in GIS format (for example shapefile). Shapefiles are to be clearly named to reflect content.
- Copy of written agreement with landowner (if not the owner of the revegetation site).

## Appendix C: Measuring Vegetation Condition for the South West and Interzone Botanical Province (Keighery scale)

Vegetation condition is a rating given to a defined area of vegetation to categorise and rank disturbance related to human activities. The rating refers to the degree of change in the vegetation structure, density and species present in relation to undisturbed vegetation of the same type. The degree of disturbance impacts upon the vegetation's ability to regenerate. Disturbance at a site can be a cumulative effect from a number of interacting disturbance types.

Score	Condition	Description	General Management Response
1	Pristine	Pristine or nearly so, with no obvious signs of disturbance.	Monitoring
2	Excellent	Vegetation structure intact, with disturbance affecting individual	Weed control plus above
3	Very good	Vegetation structure altered, with obvious signs of disturbance. For example, disturbance to vegetation structure caused by repeated fires, the presence of some more aggressive weeds, and/or grazing, dieback and logging.	Remedial planting plus above
4	Good	Vegetation structure significantly altered by very obvious signs of multiple disturbances. Retains basic vegetation structure or ability to regenerate it. For example, disturbance to vegetation structure caused by very frequent fires, the presence of some very aggressive weeds at high density, partial clearing, dieback and/or grazing.	Rehabilitation including above
5	Degraded	Basic vegetation structure severely impacted by regeneration but not to a state approaching good condition without disturbance. Scope for regeneration but not to a state approaching good condition without intensive management. For example, disturbance of vegetation structure caused by very frequent fires, the presence of very aggressive weeds, partial clearing, dieback and/or grazing.	Revegetation with scope for rehabilitation but will require intensive, ongoing management.
6	Completely degraded	The structure of the vegetation is no longer intact and the area is completely, or almost completely, without native species. These areas are often described as "parkland cleared" with the flora comprising weed or crop species with isolated native trees or shrubs.	Complete revegetation

Source: Keighery 1994

## Appendix D: Measuring Vegetation Condition for the Eremaean and Northern Botanical Provinces (Trudgen scale)

Condition	Description
E Excellent	Pristine or nearly so, no obvious signs of damage caused by human activities since European settlement.
VG Very Good	Some relatively slight signs of damage caused by human activities since European settlement. For example, some signs of damage to tree trunks caused by repeated fire, the presence of some relatively non-aggressive weeds, or occasional vehicle tracks.
G Good	More obvious signs of damage caused by human activity since European settlement, including some obvious impact on the vegetation structure such as that caused by low levels of grazing or slightly aggressive weeds.
P Poor	Still retains basic vegetation structure or ability to regenerate after very obvious impacts of human activities since European settlement, such as grazing, partial clearing, frequent fires or aggressive weeds.
VP Very Poor	Severely impacted by grazing, very frequent fires, clearing or a combination of these activities. Scope for some regeneration but not to a state approaching good condition without intensive management. Usually with a number of weed species present including very aggressive species.
D Completely Degraded	Areas that are completely or almost completely without native species in the structure of their vegetation, such as areas that are cleared or 'parkland cleared' with flora comprising weed or crop species with isolated native trees or shrubs.

Source: Trudgen 1991

## Appendix E: Examples of Budgets for Revegetation in Two Different Western Australian Landscapes

Note: The costs used in these examples are for illustrative purposes only and should not be considered as recommended costs for these or similar activities.

### Example 1

#### Swan Coastal Plain

Impact: Clearing 1.9 hectares of native vegetation (which included Black Cockatoo foraging habitat).

Revegetation: 4.1 hectares of offsite revegetation.

Background: Most of the revegetation site has been heavily modified or degraded, with numerous weed species dominating most of the area. In addition, the revegetation site is threatened by the dumping of rubbish, edge effects from residential gardens, grazing by kangaroos, and uncontrolled access to remnant vegetation, feral animals and, potentially, dieback.

Stage	Actions	Timing	Commitments / Completion criteria	Estimated unit cost	Total estimated cost (where possible)	Comments
INITIAL DATA COLLECTION AND SURVEY	Control/baseline site selection and data collection to inform target setting.	Year 1		\$14,000	\$14,000	
	Surveys of flora species to be used in revegetation.	Years 1–3		\$500	\$500	

<b>SITE PREPARATION</b>	Secure land tenure.	Immediately		-	-	The site is vested as Crown Land managed by a local government authority.
	Weed control.	<ol style="list-style-type: none"> <li>1. 18 months prior to planting</li> <li>2. Autumn 2015</li> <li>3. Winter 2015</li> <li>4. Year 1</li> </ol>		<ol style="list-style-type: none"> <li>1. \$1,800/ha</li> <li>2. \$1,800/ha</li> <li>3. \$1,800/ha</li> <li>4. \$1,800/ha</li> </ol>	<ol style="list-style-type: none"> <li>1. \$6,408</li> <li>2. \$6,408</li> <li>3. \$6,408</li> <li>4. \$6,408</li> </ol> Total: \$25,632	
	Review existing tracks and determine placement of new access tracks.	Year 1		\$5,000	\$5,000	
	Fencing and gates.	Year 1	To be established prior to planting/seeding.	\$2,500/km \$850/gate	-	
	Signage.	Year 1		\$2,000	\$2,000	
	Fire prevention (management plan and installation of fire break).	Year 1	To be established prior to planting/seeding.	\$5,000	\$5,000	
	Rubbish removal.	Year 1		\$1,000	\$1,000	
	Grading, scalping, ripping and other protection actions.	Year 1		\$85/ha	\$300	
	Apply fertiliser and water crystals.	Year 1–2		\$2,100/ha	-	

<b>VEGETATION ESTABLISHMENT</b>	Seed collection.	Year 1		\$250/kg	-	
	Treatment to break dormancy and mulching for direct seeding.	Years 1–3		\$275/ha	-	
	Purchase and plant seedlings.	Years 1–3		\$2.80/seedling	-	
	Purchase and plant mature shade trees around the perimeter of the revegetation site with 10m spacing.	Years 1–3	Target of 300 trees/ha of native plant species preferred by Black Cockatoos for foraging within 10 years of planting/seeding	\$25/plant	-	
	Replacement planting and seeding, if necessary	Years 2–3	<ul style="list-style-type: none"> <li>• No reduction in areas considered to be in Good or Very Good condition from baseline surveys.</li> <li>• Target density of revegetation within 5 years of 40% of control site coverage/ha of native plant species.</li> <li>• Target density of revegetation within 10 years of 75% of control site coverage/ha of native plant species.</li> <li>• Target species diversity of revegetation within 5 years of 40% of native species diversity at control site.</li> <li>• Target species diversity of revegetation within 10 years of 75% of native species diversity at control site.</li> <li>• Target overstorey, midstorey and understorey ratios of revegetation within 5 years of 40% of ratios at control site.</li> <li>• Target overstorey, midstorey and understorey ratios of revegetation within 10 years of 75% of ratios at control site.</li> </ul>	\$2.80/seedling	-	

<b>MONITORING</b>	Monitoring to be undertaken for a period of 10 years.	Year 1 and ongoing		\$100,000	\$100,000	Examples: vegetation quadrats, photopoint monitoring, fauna habitat assessment, weed monitoring, fences and firebreaks, and threatening processes.
<b>MAINTENANCE</b>	Implement and maintain fire management plan.	Year 1 and ongoing		\$5,000	\$5,000	
	Remove litter/rubbish on a regular basis as required.	Year 1 and ongoing		\$3,000	\$3,000	
	Maintenance of fencing, gates and signage.	Year 2 and ongoing		\$5,000	\$5,000	
	Weed control.	Year 2 and ongoing	Target of less than 20% weed cover of grassy weeds and less than 10% weed cover of herbaceous weeds (consistently) for the first 10 years after planting/seeding.	\$1,800/ha	-	
<b>REPORTING</b>	Annual reporting to DWER.	Annually, ongoing		\$5,000	\$5,000	

## Example 2

### South West

Impact: Clearing of 6.7 hectares of native vegetation with environmental values Priority 4 conservation significant flora, Carnaby's Cockatoo, Forest Red-tailed Black-Cockatoo, Baudin's Black-Cockatoo, Western Ringtail Possum and Rainbow Bee-eater. The site is also in an area of vegetation identified as part of an ecological link.

Revegetation: 4.9 hectares; 3 hectares of offsite revegetation; and 1.9 hectares of onsite revegetation.

Stage	Actions	Timing	Commitments / Completion criteria	Estimated unit costs	Total estimated cost	Comments
INITIAL DATA COLLECTION AND SURVEY	Reference site surveys and development of completion criteria.	Autumn		-	-	
	Dieback survey.	Prior to seed collection		\$1,500	\$1,500	
SITE PREPARATION	Fencing of Management Zone 1.			-	-	
	Weed control.	May	Reduce existing weeds in degraded areas.	\$750-\$1,000	\$750-\$1,000	
	Mulch spreading.	May		-	-	
	Ripping and mounding.	March-May from 2015 onwards		\$3,000	\$3,000	
	Fencing and signage.		Fence the boundary, restrict access and install signage to revegetation sites.	-	-	
	Apply fertiliser and water crystals.			-	-	

<b>VEGETATION ESTABLISHMENT</b>	Seed collection, sorting and treatment.	Spring 2014 and continuing for a minimum of 3 years		\$2,000/year	Minimum of \$6,000	
	Purchase seedlings.			-	-	
	Plant propagation.	June–July	<ul style="list-style-type: none"> <li>• 20% overstorey, 50% midstorey and 30% understorey.</li> </ul>	\$3,000	\$3,000	
	Direct seeding.	June–July	<ul style="list-style-type: none"> <li>• Revegetate with endemic native species identified in the reference site surveys. Plant density should average 500 plants/ha.</li> <li>• Use local provenance seed if available.</li> <li>• No introduction of dieback to the site.</li> <li>• Retain large trees where possible.</li> </ul> <p>1 year (2 years; 3 years; 5 years) after planting:</p> <ul style="list-style-type: none"> <li>• 95% (90%; 90%; 75%) survival of planted seedlings.</li> <li>• 5% (10%; 25%; 50%) native plant cover.</li> <li>• 30% (40%; 40%; 70%) plant diversity.</li> </ul>	-	-	

<b>MONITORING</b>	Vegetation monitoring and overall site inspection.	Autumn and spring of each calendar year for a period of three years after planting. If completion criteria have not been met, monitoring will continue for another 2 years.	If completion criteria have not been met after 5 years, contingency actions and further monitoring will be discussed with the Department of Environment Regulation.	-	-	
<b>MAINTENANCE AND CONTINGENCY</b>	Weed control.	Annually in late spring with a follow-up in Autumn as required, for a minimum of 3 years following cessation of planting (including replacement or infill planting).	No introduction of new weed species or spread of existing species.	\$750-\$1,000 for Year 2	\$750-\$1,000 for Year 2	
	Application of plant guards.	If required.		-	-	
	Remove rubbish.	If required.	Remove all rubbish and debris from the site.	-	-	
	Infill planting.	If required.		-	-	
<b>REPORTING</b>	Monitoring report.	Submit to DWER by 30 June each year.		-	-	