# 2015 COMPLIANCE REPORT FOR EPBC APPROVAL 2008/4250

## AVON RIDGE ESTATE, BRIGADOON

Project Number EP13-041

**Prepared for Peet Ltd.**
**September 2015**

# Document Control

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# Executive Summary

Peet Limited (Peet) received approval pursuant to the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) for the special rural development of Lots 1010 and 1022 Campersic Road in Brigadoon in Western Australia on the 8th October 2009 (EPBC 2008/4250).

The development, known as Avon Ridge Estate, is located approximately 30 km northeast of the Perth Central Business District and is approximately 450 hectares (ha) with approximately 411 ha for Parks and Recreation Reserve (PR Reserve).

Emerge Associates (Emerge) have been appointed by Peet to prepare an annual compliance report (this report) to satisfy Condition 12 of the approval. In addressing Condition 12 of the approval, this document outlines the current level of compliance with all the conditions of EPBC 2008/4250 for the development thus far.

Specifically this document:

- details the actions undertaken within the development from the 2nd September 2014 to 4th July 2015
- demonstrates the level of compliance with the conditions of approval
- identifies any further actions which are required to meet the conditions of the approval.

To date, stages one to four, out of a total of nine stages have been constructed and 82 lots out of a total 214 have been sold. Compliance has been achieved against all conditions throughout the reporting period through the ongoing implementation of Protective Covenants, Notifications on Title, management plans, revegetation and other works as detailed in this report.

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# 1 Proposal and Proponent Details

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|---|---|
| **PROPOSAL TITLE** | Brigadoon Estate (Avon Ridge Estate) Special Rural Development, Brigadoon Western Australia |
| **EPBC REFERENCE NUMBER** | EPBC 2008/4250 |
| **PROPONENT NAME** | Peet Limited |
| **REPORTING PERIOD** | 2nd September– 4th July 2015 |
| **IMPLEMENTATION PHASE(S) DURING REPORTING PERIOD** | Construction |

## 1.1 Proposal Background

Avon Ridge Estate Special Rural Development (the development) is located in Brigadoon, approximately 12 kilometres north of the Midland Regional Centre and 30 kilometres northeast of the Perth Central Business District (CBD). The development is located on the Darling Scarp and is bound to the north by Walyunga National Park. The development is also in close proximity to the Swan River to the west.

The development consists of a special rural subdivision of 214 lots over 450 hectares (ha), with lot sizes ranging from 1.5 ha to 5.1 ha. An additional area of 411 ha area is reserved as "Parks and Recreation" (PR Reserve) under the Metropolitan Region Scheme (MRS).

Peet Limited (Peet) submitted a referral pursuant to the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) for the special rural development of Avon Ridge Estate in May 2008. The proposal was deemed to be a "Controlled Action" development on the 2nd July 2008 and was assessed by "Preliminary Documentation".

Additional information to inform the Preliminary Documentation assessment was prepared by Cardno (WA) Pty Ltd and was released for public comment in November 2008. A number of public comments were received and these were addressed in Response to Submissions: Brigadoon Estate Special Rural Development, Brigadoon Western Australia, EPBC Reference 2008/4250 (Cardno 2009).

The Department of Environment, Water, Heritage and the Arts (DEWHA) (now Department of the Environment (DoE) also referred to as "the Department") issued an environmental approval for the development in October 2009 subject to 16 conditions. In October 2011 and January 2012, variations to approval conditions were approved by the Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC) and the current list of 17 conditions is provided in **Table 1**.

## 1.2 Purpose of Report

This document has been prepared to satisfy the requirements of Condition 12 of the EPBC approval (2008/4250), which states:

*"Within three months of every annual anniversary of commencement of the action, the person taking the action must submit to the Department a report addressing compliance with the conditions of this*

*approval. Annual Reports must be provided until the Minister is satisfied that the proponent has complied with all conditions of the approval."*

The first compliance report was produced in October 2011 (Cardno 2011). Subsequent compliance reports (Cardno 2012, Emerge 2013, Emerge 2014a) were submitted by the 5th October each year.

The submission date was based on Condition 12 (outlined above) which was interpreted that the annual compliance report was required to be submitted within three months on the commencement of construction (5th July 2010), this being the 5th October. The first two reports did not explicitly define a reporting period, which Emerge Associates (Emerge) attempted to rectify in the 2013 Compliance Report suggesting a reporting period of October to September.

Following discussions with the Department in February 2015, the proponent was made aware that the compliance reporting period is intended to reflect the annual anniversary of the commencement of the action and must be submitted within 3 months of this date. The intended reporting period should therefore cover the period of 5th July to 4th of July each year and the report submitted by the 5th October. The 2014 compliance report covered the period of 2nd September 2013 to 1st September 2014. Therefore, this report will cover the period 2nd September 2014 to 4th July 2015 and be submitted to the Department by 5th October 2015. Following from this, future compliance reports will cover the period from 5th July to 4th July and will be submitted to the Department by 5th October.

On behalf of Peet, Emerge has prepared this compliance report to demonstrate the current level of compliance with conditions of approval under the EPBC Act. The objectives of this report are to:

- detail the actions undertaken within the development from 2nd September 2014 to 4th July 2015
- demonstrate compliance with conditions of approval
- identify further actions which are required to meet conditions of approval.

This compliance report covers the 2015 compliance reporting period and focuses on actions undertaken within the development during the reporting period. Previous compliance reports (Cardno 2011, Cardno 2012a, Emerge 2013, Emerge 2014a) provided numerous appendices to demonstrate compliance and in the interest of efficiency, this information has not been repeated, unless it is necessary to demonstrate compliance over the reporting period. This compliance report should be read in conjunction with the Approval Conditions under EPBC 2008/4250.

Details of compliance with each condition under EPBC 2008/4250 is presented in **Table 1** and the definition of compliance status terms used is shown in **Table 2**.

# 2 Approvals under the Environmental Protection and Biodiversity Conservation Act 1999

Peet received approval from the Department pursuant to the *Environment Protection and Biodiversity Conservation Act 1999* for the special rural development of 450 ha of land at Campersic Road in Brigadoon on the 8th October 2009 (EPBC 2008/4250).

The approval was subject to 16 conditions. Two separate variations to the approval conditions have been approved by the Department including amendments to conditions 5, 6, 7 and 9 in October 2011 and amendments to conditions 1 and 2 and the addition of condition 17 in January 2012. There have been no variations to approval conditions during the 2015 Compliance Report period.

## 2.1 Summary of Approval Conditions

Details of compliance with each condition under EPBC Act Approval, EPBC 2008/4250 is presented in **Table 1** and the definition of compliance status terms is shown in **Table 2.**

*Table 1: Audit Table for EPBC 2008/4250 – Avon Ridge Estate*

| CONDITION | REQUIREMENT | HOW | EVIDENCE | TIMEFRAME | STATUS | INFORMATION |
|---|---|---|---|---|---|---|
| 1 | The person taking the action must not clear more than 63 hectares of native vegetation within the project area (Attachment 1) comprising:<br>(a) up to 30 hectares for the purpose of constructing roads;<br>(b) up to 27 hectares of the purpose of constructing boundary firebreaks on individual lots as identified in Attachment 2;<br>(c) up to 6 hectares for the purposes of constructing strategic firebreaks and dams. | Construction Environmental Management Plan (CEMP). | Audit/record keeping of CEMP. | Construction Phase. | C | CEMP approved by the Department (24th June 2010). |
| 2 | The person taking the action must put in place measures to ensure that clearing undertaken by future landowners within the project area (Attachment 1) will not exceed 37.4 hectares of native vegetation comprising:<br>(a) up to 31.4 hectares for the purposes of constructing house sites, infiltration areas and buffers around the house sites; and<br>(b) up to 6 hectare for the purpose of constructing driveways. | Protective Covenants placed on each lot to restrict clearing to permitted areas.<br><br>Local Structure Plan to restrict size of Building Envelopes. | Protective Covenants placed on titles. | During development. | C | Revised version of the Protective Covenants was approved by the Department in August 2014 and was applied to Stage 1 (Release 2) and Stage 2 of the development. Future stages will use Stage 2 Protective Covenant (unless subsequent version approved). |
| 3 | Revegetation and Fire Management Plan<br>The person taking the action must prepare a Revegetation and Fire Management Plan that applies to the 100 ha within the Park and | The 2015 RFMP was approved by DFES (9 July | Approved RFMP. | Prior to construction. | C | The 2015 RFMP is in effect. The 2015 RFMP was |

| CONDITION | REQUIREMENT | HOW | EVIDENCE | TIMEFRAME | STATUS | INFORMATION |
|---|---|---|---|---|---|---|
| | Recreation Reserve and 450 ha for the subdivision (as identified at **Attachment 5**) including all 214 individual lots. The proponent must obtain written approval from FESA prior to submission to the Department for approval. | 2015 and the Department (29 July 2015). | | | | approved by DFES on 9 July 2015 and subsequently approved by the Department on 29 July 2015 (see **Appendix A**). |
| | The person taking the action must not commence clearing or construction within the project area until the Department has approved the Revegetation and Fire Management Plan in writing. Once approved this plan must be implemented. The person taking the action must ensure that the Revegetation and Fire Management Plan includes (but is not restricted to): | | | | | |
| | **a.** fuel reduction measures (including cool burn measures) specifying the timing and frequency of fuel reduction measures to minimise impacts on Black Cockatoo habitat. | Implement RFMP. | Burn prescriptions. Photos of fuel reduction undertaken. | Construction and development phase. | C | Based on the 2015 RFMP, the proposed prescribed burn area for 2014/2015 reporting period was undertaken on 3-6 October 2014. |

| CONDITION | REQUIREMENT | HOW | EVIDENCE | TIMEFRAME | STATUS | INFORMATION |
|---|---|---|---|---|---|---|
| | **b.** Revegetation measure to create additional Black Cockatoo habitat across the project sites, including in Parks and Recreation Reserve, specifically:<br>**i.** revegetation for all condition classes (excluding pristine and excellent classes) and vegetation complexes (including maps)<br>**ii.** mix, numbers and density of species to be planted;<br>**iii.** timing of proposed planting (must be during or following the annual winter rain period and generally between 1 June and 30 November;<br>**iv.** weed management measures;<br>**v.** the survivorship rate of all revegetation measures must be at least 90% after three years. If after three years of the date of the planting, a survival rate of 90% of the planted trees is not achieved, all dead tress must be replaced with other Black Cockatoo habitat species within 12 months and maintained for at least an additional two years;<br>**vi** annual monitoring measures within the project area undertake by an appropriate qualified and experienced ecologist and must commence within 12 months of the completion of revegetation and continue for at least three year after the initial revegetation planting in any particular area (given that revegetation will be staged across the development);<br>**vii.** annual monitoring measures undertaken by an appropriately qualified and experienced specialist must commence in the Parks and Recreation Reserve within 12 months of completion of revegetation and continue for at least three years after the initial revegetation planted in the Parks and Recreation Reserve for the purposes of establishing the survivorship rates and replanting efforts within the project area; | Implement RFMP. | Revegetation biannual monitoring reports including monitoring photographs.<br><br>Documentation of site inspections.<br><br>Aerial photography. | Development Phase. | C | Biannual monitoring reports (**Appendix B**). |

| CONDITION | REQUIREMENT | HOW | EVIDENCE | TIMEFRAME | STATUS | INFORMATION |
|---|---|---|---|---|---|---|
| | **viii.** mapping of all potential Black Cockatoo habitat trees of 500 mm DBH or greater on individual lots and information on how these will be retained for permanent conservation. | Implement RFMP. | Protective Covenants. Trees 500 mm DBH (diameter at breast height) or greater within lots identified by GPS coordinates and marked with flagging tape. | Construction and development phase. | C | |
| 4 | Building Protection Zone.<br>The person taking the action may thin native vegetation within the Building Protection Zone (**Attachment 2**) on each housing lot (**Attachment 3**). The total thinning within the Building Protection Zones of the 214 housing lots (**Attachment 3**) must not exceed 112,350 plants suitable for foraging for Black Cockatoos. The thinning process must be managed under the terms of the approved Revegetation and Fire Management Plan, and be personally supervised (pre and post thinning inspection for individual lots) by a qualified Fire Management Consultant. The person taking the action must obtain written approval from FESA of the first appointed Fire Management Consultant prior to the provision of any Building Protection Zone thinning advice. Any subsequent appointment of Fire Management Consultants will be based on that consultant having similar qualification as the initially appointed consultant.<br><br>The Building Protection Zone must be implemented on each of the 214 housing lots in the dimensions specified in **Attachment 2**. The location of each Building Protection Zone and house site must be chosen in consultation with the Fire Management Consultant for the purpose of maximizing the retention of trees as specified in Condition 4.<br><br>The person undertaking the action must ensure that all native vegetation that provides habitat for Black Cockatoos is retained outside of the Building Protection Zones within 214 housing lots. This excludes | Protective Covenant and use of FMC throughout the lot clearing process. | Protective Covenant and Purchaser Information. | Development phase. | C | Revised version of the Protective Covenants was approved by the Department in August 2014 and was applied to Stage 1 (Release 2) and Stage 2 of the development. Future stages will use Stage 2 Protective Covenant (unless subsequent version approved). |

| CONDITION | REQUIREMENT | HOW | EVIDENCE | TIMEFRAME | STATUS | INFORMATION |
|---|---|---|---|---|---|---|
| | native vegetation that is specifically managed under the Revegetation and Fire management Plan. | | | | | |
| 5 | The person taking the action must ensure that all potential breeding habitat trees for Black Cockatoos (as designated at Attachment 4 and 4A) are protected in perpetuity via a Notification on Title. The person taking the action must ensure that all other trees within the lot area (Attachment 1) with a diameter by breast height (DBH) of 500 mm or greater are retained unless:<br>a. They are located within a house site;<br>b. They are located within the Building Protection Zone;<br>c. they are required to be removed for fire management purposes as advised by a qualified Fire Management Consultant(s). | Notification on Title and Protective Covenants. | Notification on Title and Protective Covenants. | During development. | C | Revised version of the Protective Covenants was approved by the Department in August 2014 and was applied to Stage 1 (Release 2) and Stage 2 of the development. Future stages will use Stage 2 Protective Covenant (unless subsequent version approved). |
| 6 | The person taking the action must ensure at the 411 ha Park and Recreation reserve as highlighted in green at **Attachment 5** be ceded to the WA State Government. The Department must be notified in writing once this has occurred. | Park and Recreation (PR Reserve) ceded to WA State Government. | Deposited Plan and Certificate of Title for PR Reserve. | | CLD | Reported in previous Compliance Report (Cardno 2012a). |
| 7 | The person taking the action must ensure that the following the sale and settlement each individual lot owner will be offered at least 1000 seedlings suitable for foraging and breeding habitat for Black Cockatoos to be permanently planted on their purchased lot. This planting must be undertaken under the direct supervision of a Revegetation Specialist at the proponent's expense. | Protective Covenants. | Protective Covenants. | | C | The 2015 RFMP was approved by DFES and the Department on 9 and 29 July 2015 respectively. |
| | The person taking the action must ensure that any seedlings allocated for individual lots that cannot be planted because of Fire management or other reasons, must be planted in the Parks and Recreation Reserve as identified in Attachment 7. Planting must be undertaken following the | RFMP | Biannual revegetation monitoring reports (see **Appendix B**) | Ongoing through the development. | C | |

| CONDITION | REQUIREMENT | HOW | EVIDENCE | TIMEFRAME | STATUS | INFORMATION |
|---|---|---|---|---|---|---|
| | sale and settlement of the individual lots so that the planting under this condition total at least 214,000 plants on either individual lots or in the Parks and Recreation Reserve. | | detailing plant survival, monthly site inspections and Progress Certificates outline the number and species of seedlings planted. | | | |
| | The person taking the action must ensure that all purchasers of lots within the project area, prior to sale and settlement:<br>a. Are aware of the existence of potential and actual breeding habitat trees on the individual lots, Notifications on Title and the requirements that these must be conserved into perpetuity and not be cleared<br>b. Are aware of the Protective Covenant;<br>c. Are aware of restriction relating to clearing of<br>i. Potential breeding habitat trees over 500 mm DBH<br>ii. Area within and outside of the Building Protection Zone.<br>d. Are aware of the proposed revegetation measures for their individual lot by person(s) as outlined in Condition 3;<br>e. Are provided with species related information on all Black Cockatoos, their presence in the area, ecology, species range and details on habitat. | Notification on Title.<br><br>Protective Covenant.<br><br>Purchaser Information. | Notification on Title.<br><br>Protective Covenant.<br><br>Purchaser Information. | Ongoing through the development. | C | Revised version of the Protective Covenants was approved by the Department in August 2014 and was applied to Stage 1 (Release 2) and Stage 2 of the development. Future stages will use Stage 2 Protective Covenant (unless subsequent version approved). |
| 8 | The person taking the action must provide a final version of the Protective Covenant in writing to the Department for approval prior to the sale and settlement of any lot. The person taking the action must ensure that the approved Protective Covenant is in place for each of the 214 lots. | Protective Covenant. | Letter from DSEWPaC and DoE endorsing Protective Covenant. | Ongoing through the development. | C | Revised version of the Protective Covenants was approved by the Department in August 2014 and was applied to Stage 1 (Release 2) and Stage 2 of the development. |

| CONDITION | REQUIREMENT | HOW | EVIDENCE | TIMEFRAME | STATUS | INFORMATION |
|---|---|---|---|---|---|---|
| | | | | | | Future stages will use Stage 2 Protective Covenant (unless subsequent version approved). |
| 9 | All elements specified in Attachment 6 must be incorporated in either the Structure Plan, approved subdivision conditions or approved Protective Covenants. These must be complied with. The Department must be notified in writing on how all the elements in Attachment 6 have been incorporated and complied with. If any of the elements in Attachment 6 are not incorporated, to the Department's satisfaction, the person taking the action must negotiate an outcome to the Department's satisfaction, prior to commencing construction. | Incorporate all elements in the Structure Plan, Western Australian Planning Commission (WAPC) conditions of subdivision and Protective Covenants. | Structure Plan, WAPC conditions of subdivision and Protective Covenants. | Ongoing through the development. | C | Structure Plan was endorsed by the WAPC on the 27th March 2014. Mechanism to implement Attachment 6 reported in previous Compliance reports (Cardno 2011, Cardno 2012a). |
| 10 | The person taking the action must prepare and implement a Construction Management Plan. This plan must be submitted and approved by the Department prior to any clearing taking place. | CEMP approved by DSEWPaC (24th June 2010). | Approved CEMP. | Prior to clearing. | CLD | |
| | The Construction Management Plan must clearly demonstrate that:<br>**a.** All habitat trees at Attachment 4 and 4A are to be retained in perpetuity; and<br>**b.** All trees to remain that are greater than 300mm DBH within the subdivision area (as at Attachment 3) and within 10 meters of an area to be proposed to be cleared (excluding those in the Building Protection Zone) are clearly marked and retained.<br>**c.** Areas of vegetation that are Black-Cockatoo habitat and not for clearance (including roadside vegetation, streamline vegetation and Public Open Space area) are clearly marked and retained;<br>**d.** If clearing outside of stipulated area occurs by other contract parties, then the person taking the action must notify the Department in writing | Implement CEMP. | Requirements of this condition are outlined in the CEMP. | Ongoing through the development. | C | CEMP approved by the Department (24th June 2010) and implemented for stages 1 to 4. |

| CONDITION | REQUIREMENT | HOW | EVIDENCE | TIMEFRAME | STATUS | INFORMATION |
|---|---|---|---|---|---|---|
| | and will ensure that these areas will be revegetated to the same density (following the annual winter rain period and between 1 October – 30 November); and<br>**e.** All contracted parties will undergo an induction programme prior to commencement of construction and/or clearing. This programme will include information on EPBC listed species and measure employed within the project areas to protect Black cockatoo habitat. | | | | | |
| 11 | Within 30 days of commencement of construction, the person taking the action must advise the Department in writing the actual date of commencement. | Advise DoE. | Letter to DSEWPaC advising date of commencement of construction. | Prior to construction. | CLD | |
| 12 | Within three months of every annual anniversary of commencement of the action, the person taking the action must submit to the Department a report addressing compliance with the condition of this approval. Annual Reports must be provided until the Minister is satisfied that the proponent has complied with all conditions of the approval. | Compliance report demonstrating compliance and providing evidence. | Compliance reports. | Annually through the development. | C | Addressed through 2015 compliance report. |
| 13 | If, at any time five years from the date of this approval, the Minister notified the person taking the action in writing that the Minster is not satisfied that there has been substantial commencement of the construction of the rural residential development at Brigadoon, Western Australia, the action must not thereafter be commenced without the written agreement of the Minister. | Commencement of construction within 5 years from date of approval. | Project has been commenced substantially within 5 years of the project's approval. See Condition 11. | Five years following granting of approval. | CLD | |
| 14 | If the person taking the action wishes to carry out any activity otherwise than in accordance with the plans, reports or strategies referred to in these condition, the person taking the action must submit for the Minister's approval a revised version of any such plan, report or strategy for the Minister's approval. The person taking the action must comply with any such request. The revised approved plan, report or strategy must be implemented in place of the plan, report or strategy originally approved. | Submit for Minister's approval of revised version of plan, report or strategy. | The 2015 RFMP. | Ongoing through the development. | C | The 2015 RFMP was approved by DFES and the Department (see **Appendix A**). |

| CONDITION | REQUIREMENT | HOW | EVIDENCE | TIMEFRAME | STATUS | INFORMATION |
|---|---|---|---|---|---|---|
| 15 | If the Minister believes that it is necessary or desirable for the better protection of threatened species and threatened ecological communities (s18 and s18A) to do so, the Minister may request that the person taking the action make specified revision to the plan, reports or strategies approved pursuant to Condition 2 and submit the revised plan, report or strategy for the Minister's approval. The person taking the action must comply with any such request. The revised approved plan, report or strategy must be implemented in place of the plan, report or strategy originally approved. | Not applicable. | Not applicable. | Ongoing through the development. | NR | |
| 16 | The person taking the action must maintain accurate records of all activities associated with or relevant to the above conditions of the approval, and make them available on request by the Department. Such document may be subject to audit by the Department and used to verify compliance with the condition of approval. Summaries of audits may be posted on the Department website. The results of audits may also be publicised through the general media. | Maintain accurate records of all activities associated with or relevant to the above conditions. | Accurate records of all activities described in this table. | Ongoing through the development. | C | |
| 17 | In order to offset the impact of clearing of Black Cockatoo habitat, before June 30 2012, the person taking the action must:<br>**a.** Provide funds to the Western Australian Department of Environment and Conservation for the acquisition and management of one or more properties that contain at least 150 hectares of high quality foraging habitat for Black Cockatoos to be protected in perpetuity. The offset property must be approved in writing by the Department.<br>**b.** Provide documentary evidence to the Department that funds have been provided to the Western Australian Department of Conservation as required by approval condition 17a. | Transfer of funds to DPaW for an offset site. | Letters from DSEWPaC approving variation to conditions and approving the offset site and regarding Peet's remuneration and clearance of conditions.<br><br>Remittance from Peet to DSEWPaC. | Prior to 30 June 2012. | CLD | |

*Table 2: Definition of Compliance status terms*

| COMPLIANCE STATUS TERMS | ABBREVIATION | DEFINITION | NOTES |
|---|---|---|---|
| Compliant | C | Implementation of the proposal has been carried out in accordance with the requirements of the audit element. | This term applies to audit elements with:<br>• ongoing requirements that have been met during the reporting period; and<br>• requirements with a finite period of application that have been met during the reporting period, but whose status has not yet been classified as 'completed'. |
| Completed | CLD | A requirement with a finite period of application has been satisfactorily completed. | This term may only be used where:<br>• audit elements have a finite period of application (e.g. construction activities, development of a document)<br>• the action has been satisfactorily completed<br>• the Department of Environment (DoE) has provided written acceptance of 'Completed' status for the audit element. |
| Not required at this stage | NR | The requirements of the audit element were not triggered during the reporting period. | This should be consistent with the 'Timeframe' column of the audit table. |
| Potentially Non-compliant | PNC | Possible or likely failure to meet the requirements of the audit element. | This term may apply where during the reporting period the proponent has identified a potential non-compliance and has not yet finalised its investigations to determine whether non-compliance has occurred. |
| Non-compliant | NC | Implementation of the proposal has not been carried out in accordance with the requirements of the audit element. | This term applies where the requirements of the audit element have not been met during the reporting period. |

## 2.2 Compliance Details

### 2.2.1 Condition 1

Clearing within the development is managed through the implementation of the Construction Environmental Management Plan (CEMP) (Cardno 2010a) (Condition 10). Reporting on clearing areas is restricted to discrete areas cleared for the purpose of constructing roads, boundary firebreaks and strategic firebreaks and only include clearing that occurred after construction commenced on the 5th July 2010.

Between the 2nd September 2014 and 4th July 2015, there has been civil construction works within the Avon Ridge Estate in Stage 4 including road construction and clearing of boundary firebreaks.

The area cleared for the construction of roads, lot firebreaks and strategic firebreaks over the 2015 compliance reporting period was determined from engineering construction drawings (provided by Development Engineering Consultants (DEC)) and aerial imagery (comparing 3rd August 2014 and 27th June 2015). **Table 3** shows the cumulative area cleared since the commencement of construction (5th July 2010), the balance of the area remaining that can be cleared and the percentage of total allowable clearing completed.

*Table 3: Areas cleared under EPBC Condition 1*

| CONDITION 1 CLEARING RESTRICTIONS | CURRENT LEVEL OF CLEARING (HA) | REMAINING CLEARING (HA) | PERCENTAGE CLEARING (%) |
|---|---|---|---|
| Up to 30 hectares for the purpose of constructing roads | 13.6 | 16.4 | 45.4 |
| Up to 27 hectares of the purpose of constructing boundary firebreaks on individual lots | 15.5 | 11.5 | 57.5 |
| Up to 6 hectares for the purposes of constructing strategic firebreaks | 2.1 | 3.9 | 35.0 |

### 2.2.2 Condition 2

Clearing within lots (by landowners) is managed through the Contract of Sale and Protective Covenants. Revised versions of the Protective Covenants were approved by the Department in August 2014 and the Protective Covenant for Stage 2 has been applied to Stage 4.

For the period until June 2015 a total of 88 lots have been sold of which clearing by individual landholders has been undertaken on 52 lots.

The area cleared for house sites and driveways over the 2015 compliance reporting period was determined from aerial imagery (comparing 3rd August 2014 and 27th June 2015). **Table 4** shows the cumulative area cleared for house sites and driveways since the commencement of construction (5th July 2010), the balance of area remaining that can be cleared and the percentage of total allowable clearing completed. Since construction of the development to 27th June 2015, there have been 11.8 ha cleared by individual landowners within the Avon Ridge Estate.

*Table 4: Areas cleared under EPBC Condition 2*

| CONDITION 2 CLEARING RESTRICTIONS | CURRENT LEVEL OF CLEARING (HA) | REMAINING CLEARING (HA) | PERCENTAGE CLEARING (%) |
|---|---|---|---|
| Up to 31.4 hectares for the purposes of constructing house sites and buffers around the house sites | 9.7 | 21.7 | 30.8 |
| Up to 6 hectare for the purpose of constructing driveways. | 2.1 | 3.9 | 34.5 |

### 2.2.3 Condition 3

The original Revegetation and Fire Management Plan (RFMP) (Cardno 2010b), entitled *Brigadoon Estate Revegetation and Fire Management Plan Parts 1, 2 and 3* and referred to as the "2010 RFMP" was approved by the Fire and Emergency Services Authority (FESA) (now Department of Fire and Emergency Services (DFES)) in May 2010 and the Department in June 2010.

In response to modifications to the EPBC Act approval conditions and significant changes relating to the revegetation and prescribed fuel reduction program, an update to the RFMP referred to as the "2012 RFMP" (Cardno 2012a) was provided to DFES in August 2013 for approval. Since the completion of the 2012 RFMP, several further required changes relating to fire management and bushfire planning imposed by the City of Swan have arisen. An addendum (referred to as the "2014 Addendum") (Emerge 2014b) was prepared to provide supplementary information, clarification and to update changes made to the 2012 RFMP. The 2012 RFMP and 2014 Addendum was approved by DFES in August 2014 and subsequently provided to the Department for approval in October 2014.

In December, 2014, the Department informed Emerge that they were unable to consider the 2014 Addendum for approval given the 2012 RFMP had not been considered for approval by the Department. The Department advised that they would need a consolidated document in order to approve any updated version of the RFMP, hence the preparation of the 2015 RFMP.

The Revegetation and Fire Management Plan (revised 2015), herein referred to as the "2015 RFMP" was prepared and consolidates the 2010 RFMP, 2012 RFMP and 2014 Addendum. The 2015 RFMP was approved on 9 July 2015 by DFES and subsequently approved by the Department on 29 July 2015.

An overview of compliance of Condition 3 is shown in **Table 5** based upon the existing approved RFMP (Emerge 2015).

*Table 5: Compliance overview of Condition 3*

| CONDITION 3 | STATUS OF COMPLIANCE | STATUS |
|---|---|---|
| Preparation, approval and implementation of a RFMP | Compliant | The 2015 RFMP is in effect. |
| *The person taking the action must ensure that the Revegetation and Fire Management Plan includes (but is not restricted to):* | | |
| Fuel reduction measures (including cool burn measures) specifying the timing and frequency of fuel reduction measures to minimise impacts on Black Cockatoo habitat. | Compliant | A prescribed burn on the eastern portion of the site was conducted on 3rd to 6th October 2014 resulting in a patchy burn with 80% area burned and fuel was successfully reduced.<br>The prescribed burn followed the proposed schedule as described in the 2015 RFMP. |
| Revegetation measures to create additional Black Cockatoo habitat, specifically:<br>i. revegetation for all condition classes (excluding Pristine and Excellent), and vegetation complexes<br>ii. mix, numbers and density of species to be planted<br>iii. timing of proposed planting<br>iv. weed management measures<br>v. the survivorship rate of all revegetation measures must be at least 90% after three years<br>vi. annual monitoring measures within the project area<br>vii. annual monitoring measures undertaken by an appropriately qualified and experienced specialist must commence in the PR Reserve | Compliant | Revegetation has been focused in the PR Reserve. Revegetation and weed control within the PR Reserve has been undertaken and included a wide range of suitable Black Cockatoo habitat species as outlined in the RFMP.<br><br>The three year anniversary for the 90% survival rate has been reached for one site, Site 1A. The results of the spring monitoring survey (**Appendix B**) were assessed against completion criteria. The site meets all completion criteria which include:<br>• survival of 93% (target: 90%).<br>• plants are healthy in appearance and diverse in species.<br>• species richness is 81% of the total number planted (target:65%).<br>• average seedling height has increased between assessments<br>• weed presence is minimal and not inhibiting native plant survival and growth.<br><br>Survival of seedlings across the remaining five sites (planted between 2012 and 2013) are currently above the 90% target, achieving an average species richness over 65%, and plants showing increased plant heights at all sites and most sites have minimal weed coverage.<br><br>Biannual monitoring reports **(Appendix B**) and regular inspections have been undertaken by Tranen (a qualified and experienced revegetation specialist) for all revegetation sites which are still undergoing the monitoring and maintenance period.<br><br>During the 2015 compliance reporting period, no infill planting was undertaken in existing revegetation sites. |

| | | |
|---|---|---|
| viii. mapping of all potential Black Cockatoo habitat trees of 500 mm DBH or greater on individual lots and information on how these will be retained for permanent conservation | Compliant | All trees of 500mm DBH or greater have been mapped and marked with white flagging tape.<br>These trees have been included in the Protective Covenants and must be retained unless located within the house site, Building Protection Zone (BPZ) or required to be removed for fire management purposes.<br><br>Prior to civil construction in Stage 4 during the reporting period, updated recording of coordinates and marking of habitat trees was undertaken to ensure habitat trees were clearly identified on the development and mapped. |

### 2.2.4 Condition 4

Peet has engaged a Fire Management Consultant (FMC) to prepare Building Protection Zone (BPZ) and Hazard Separation Zones (HSZ) for lots in stages 1 to 4. The FMC meets with lot purchasers to locate building envelopes and conduct BAL (Bushfire Attack Level) assessments. During these visits the FMC provides guidance to the new landowners regarding acceptable vegetation modification practices prior to any lot clearing in accordance with the Protective Covenants. The FMC is also required to conduct post clearing inspections to confirm that any vegetation modification has not been beyond what is necessary for fire management as specified within the FMP.

A total of 88 lots have been sold and thinning of plants suitable for foraging for Black Cockatoos within the BPZ has been undertaken in approximately 52 lots. Thinning within the BPZ has not exceeded 112,350 plants suitable for foraging by Black Cockatoos.

### 2.2.5 Condition 5

Protective Covenants were finalised and approved by the Department on 31st August 2010. Revised versions of the Protective Covenants were approved by the Department in August 2014 for Stage 1 (Release 2) and Stage 2 as outlined in the 2014 Compliance Report. The stages following Stage 1 (Release 2) and Stage 2 have used, and will use, the Stage 2 Protective Covenants (unless subsequent versions are approved) including Stage 4.

The proponent will satisfy Condition 5 of the approval through the application of Notifications on Titles as they are created on a stage by stage basis. An overview of compliance for Condition 5 is shown in **Table 6.**

No disturbance to significant trees have been reported within the 2015 compliance reporting period. Monitoring will continue throughout the future stages of construction.

*Table 6: Compliance overview of Condition 5*

| CONDITION 5 | STATUS OF COMPLIANCE | STATUS |
|---|---|---|
| All potential breeding habitat trees protected in perpetuity via a Notification on Title. | Compliant | Notifications on Title have been applied to each newly created lot within stages 1 to 4 which displays potential habitat trees. |
| All trees with a DBH of 500 mm or greater are retained unless they are:<br>• located within the house site<br>• located within the BPZ | Compliant | Protective (Restrictive) Covenants apply to all lots in the development area. These include notification of trees with a DBH of 500 mm or greater and have been issued with all lots |

| | | |
|---|---|---|
| • required to be removed for fire management purposes . | | purchased to date. |

### 2.2.6 Condition 6

On 5th July 2012, the PR Reserve was ceded to the WA State Government. This action completes Condition 6. The Deposited Plan and Certificate of Crown Land Title were included in the 2013 Compliance report (Emerge 2013).

### 2.2.7 Condition 7

To date, 88,225 plants out of a total 214,000 required under the approval have been planted in the PR Reserve. The three year anniversary for 90% survival rate has been reached for one site in the development and the results are detailed in **Section 2.2.3**.

Over the 2015 compliance reporting period, no additional seedlings were planted as infill plantings in existing revegetation sites as no additional planting was required. Biannual revegetation monitoring reports (**Appendix B**) have been prepared which outline survival rates, health, species richness and weed cover. Regular site visits have also been conducted to check on the progress of revegetation and overall condition of the revegetation site to inform any maintenance that is required.

As discussed in the 2014 Compliance Report, the site conditions of the PR Reserve (slope, soil condition and existing vegetation) impose limitations for additional plantings within the reserve. Currently, the number of plants planted exceeds the requirement of plants based on the number of lots created (based on 1000 plants per lot). Discussions with DPaW and the Department to purchase or partly contribute to an offset site are progressing. An amendment to this condition and a formal request to the Department are currently underway. However, for the purpose of addressing compliance within the 2015 reporting period, compliance has been achieved.

### 2.2.8 Condition 8

Approval of the Protective Covenants was granted by DSEWPaC in August 2010. This version of the Protective Covenants (Version 1) was applied to Stage 1 of the development. Protective Covenants for Stage 2 (Version 2) and for Stage 1 (Release 2) (Version 3) were approved by the Department in August 2014. The protective covenant staging and relevant approval was described in more detail in the 2014 Compliance Report. Subsequent stages including Stage 4 have utilised Stage 2 Protective Covenants.

### 2.2.9 Condition 9

All elements specified in Attachment 6 of the approval have been incorporated in either the Structure Plan, conditions of subdivision approval or approved Protective Covenants. Previous compliance reports (Cardno 2011, Cardno 2012b) have provided details on how the different elements contained within Attachment 6 of the Approval were included in the above processes.

The Structure Plan has been endorsed by the Western Australian Planning Commission (WAPC) on the 27th March 2014 and approved Structure Plan was provided in the 2014 Compliance Report. **Table** 7 shows mechanisms from Attachment 6 used to implement Condition 9.

*Table 7: Summary of mechanisms from Attachment 6 used to implement Condition 9*

| MECHANISM | DOCUMENT | REFERENCE |
|---|---|---|
| All habitat trees identified in Attachment 4 must be conserved in perpetuity via a Memorial on Title. | Protective Covenants via Notification on Title. | Protective Covenants, Section 3.6 and Section 7.1. |
| The restriction on building envelopes is a maximum of 10% of the gross lot area. | Structure Plan. | Structure Plan, Provision 1. |
| Requirement for protective covenants to restrict clearing, including the use of a DFES approved Fire Management Consultant must be included. | Protective Covenants. | Protective Covenants, Section 2.1 and Section 3.5. |
| Building development envelopes must not impinge on any areas identified by the Bush Forever vegetation condition classification as the following unless approved by Council:<br>a. Areas determined to be in "pristine" condition; and<br>b. Areas determined to be in an "excellent" condition.<br><br>This includes driveways or other points of access | Structure Plan and Protective Covenants. | Structure Plan, Provision 5.<br>Protective Covenants, Section 3.1. |
| No additional clearing for access roads or other community infrastructure within the project area unless approved by Council | Structure Plan. | Clearing is limited to the areas stipulated in the WAPC Subdivisions Conditions of Approval and demonstrated in the Structure Plan. |
| A Construction Management Plan must be prepared and applied to all stages of development within the project area. | Condition of Subdivision. | WAPC Subdivision Conditions; Condition 14. |
| A Revegetation and Fire Management Plan must be prepared and applied to all stages of development within the project area. | Condition of Subdivision and Structure Plan. | WAPC Subdivision Conditions; Condition 29.<br>Structure Plan; Structure Plan Condition J. |
| There should be no clearing outside the Building Protection Zone areas on the 214 lots, excluding those required for fire management purposes and approved driveway purposes. | Protective Covenants. | Protective Covenants, Condition 2.1 and Condition 7.1. |
| There should be no clearing within the Building Protection Zone after the construction of the first house on each lot. | Protective Covenants. | Protective Covenants, Condition 2.8. |

### 2.2.10 Condition 10

Construction works have been carried out according to the procedures outlined in the CEMP (Cardno 2010a) which was approved by the Department on 24th June 2010. The CEMP procedures that ensure the requirements of Condition 10 are met are outlined in **Table 8**.

*Table 8: CEMP procedures for compliance with requirements of Condition 10*

| CONDITION 10 REQUIREMENT | | CEMP PROCEDURE | PAGE |
|---|---|---|---|
| a. | All habitat trees at Attachment 4 and 4A are to be retained in perpetuity; and | Identified "habitat trees" are to be clearly marked (with yellow spray paint) as disturbance or removal of these trees is not permitted. Construction activities should be limited within 5m of "habitat trees" where possible. | 24 |
| b. | All trees to remain that are greater than 300mm DBH within the subdivision area (as at Attachment 3) and within 10 meters of an area to be proposed to be cleared (excluding those in the Building Protection Zone) are clearly marked and retained. | In accordance with the approval, all trees over 300 mm Diameter Breast Height (DBH) will be retained unless within a:<br>• building envelope;<br>• Building Protection Zone (BPZ);<br>• roads;<br>• strategic firebreak; or<br>• lot firebreak.<br>Additionally, there may be an opportunity to retain additional trees over 300 mm DBH in these areas. All trees over 300 mm DBH and within 10 metres of any area proposed to be cleared (which are not currently marked as "habitat trees") will be marked with white flagging tape to notify contractors and construction personnel that these trees cannot be cleared unless located in an area listed above. | 16 |
| c. | Areas of vegetation that are Black-Cockatoo habitat and not for clearance (including roadside vegetation, streamline vegetation and Public Open Space area) are clearly marked and retained; | Once all clearing lines have been clearly marked and approved by the Site Superintendent/Civil Engineer, the clearing boundary will be fenced with single strand sighter wire and star irons. This may include any trees or areas significance demarcated for retention. | 24 |
| d. | If clearing outside of stipulated area occurs by other contract parties, then the person taking the action must notify the Department in writing and will ensure that these areas will be revegetated to the same density (following the annual winter rain period and between 1 October – 30 November); and | There is to be no clearing outside pre-defined clearing areas and any unauthorised clearing will require the Contractor to revegetate and replace vegetation with the same vegetation type at their own expense.<br><br>All management requirements included within this CEMP shall be complied with. Any breaches will constitute an environmental incident and will require immediate reporting to the Proponent or Site Supervisor/Civil Engineer. | 25<br><br>28 |
| e. | All contracted parties will undergo an induction programme prior to commencement of construction and/or clearing. This programme will include information on EPBC listed species and measure employed within the project areas to protect Black cockatoo habitat. | Prior to the commencement of any activities associated with the construction phase of the Development, all members of the Peet Management Team and Contractors are to participate in a Site Environmental Induction (provided in Appendix C). The Site Environmental Induction is to be conducted by the Proponent or Site Superintendent/Civil Engineer and is detailed further in Section 7.1 of this document. | 23 |

### 2.2.11 Condition 11

This condition has been completed and reported in the 2011 Compliance Report (Cardno 2011).

### 2.2.12 Condition 12

This condition is addressed through the preparation of this Compliance Report.

### 2.2.13 Condition 13

This condition is completed and reported in the 2011 Compliance Report (Cardno 2011).

### 2.2.14 Condition 14

The 2015 RFMP which consolidates the 2010 RFMP, 2012 RFMP and 2014 Addendum was prepared to be considered for approval by DFES and the Department. DFES and the Department approved the 2015 RFMP in July 2015.

### 2.2.15 Condition 15

No request has been received by the Minister requiring better protection for environmental features and this condition is therefore not applicable.

### 2.2.16 Condition 16

Peet has maintained accurate records of all activities associated with or relevant to the conditions of approval. Copies of records are available upon request.

### 2.2.17 Condition 17

This condition is completed and reported in the 2011 Compliance Report (Cardno 2011).

# 3 Conclusion

This report has been prepared to satisfy Condition 12 of the EPBC Act Approval which was granted by the Department on the 8th October 2009. The report addresses Condition 12 by outlining the level of compliance with conditions of the approval for the development in the reporting period of the 2nd September 2014 to 4th July 2015.

A high level of compliance with the approval conditions has been demonstrated in the reporting period. This is due to the implementation of environmental management measures prescribed by the following documents and mechanisms:

- Construction Environment Management Plan (CEMP)
- Revegetation and Fire Management Plan (RFMP)
- Protective Covenants
- Notification on Titles
- Use of Fire Management Consultant (FMC).

Ongoing monitoring and evaluation of environmental management works has and continues to ensure continued compliance with approval conditions.

As discussed in this report (**Section 2.2.7**), a compliance mechanism expected to be reviewed over the next compliance reporting period includes an alternative to further revegetation within the PR Reserve. This will be addressed separately with the Department and has not impacted upon compliance within this reporting period.

# 4 References

Cardno 2009. Response to Submissions: Brigadoon Estate Special Rural Development, Brigadoon Western Australia (EPBC Reference 2008/4250).

Cardno 2010a. Brigadoon Estate Construction Environment Management Plan. Unpublished Report prepared for Peet Limited.

Cardno 2010b. Brigadoon Estate Revegetation and Fire Management Plan (Parts 1-3). Unpublished Report prepared for Peet Limited.

Cardno 2011. 2011 Compliance Report for EPBC Approval 2009/4250, Avon Ridge, Brigadoon. Unpublished Report prepared for Peet Limited.

Cardno 2012a. 2012 Compliance Report for EPBC Approval 2009/4250, Avon Ridge, Brigadoon. Unpublished Report prepared for Peet Limited.

Cardno 2012b. Revegetation and Fire Management Plan Revised, Avon Ridge, Brigadoon. Unpublished Report prepared for Peet Limited.

Emerge Associates (Emerge) 2013. 2013 Compliance Report for EPBC Approval 2009/4250, Avon Ridge, Brigadoon. Unpublished Report prepared for Peet Limited.

Emerge Associates (Emerge) 2014a. 2014 Compliance Report for EPBC Approval 2009/4250, Avon Ridge, Brigadoon. Unpublished Report prepared for Peet Limited.

Emerge Associates (Emerge) 2014b. Avon Ridge Estate, Brigadoon Addendum to Revegetation and Fire Management Plan (Revised 2012). Unpublished Report prepared for Peet Limited.

Emerge Associates (Emerge) 2015. Avon Ridge Estate, Brigadoon Revegetation and Fire Management Plan (Revised 2015). Unpublished Report prepared for Peet Limited.

# 5 Glossary

| TERM | DEFINITION |
|---|---|
| Notifications on Title | Are created under Section 70A of the Western Australian Transfer of Land Act 1893 to notify landowners of factors that may interfere with the use of their land. The person taking the action must put these titles in place to alert future purchasers if their lot contains habitat trees that must be retained in perpetuity and are not to be cleared in line with fire management procedures |
| Protection in perpetuity | A tenure or a conservation status on a notification attached to individual land titles that guarantees permanent preservation of vegetation into the future and ensures there will no clearing will be undertaken. |

# APPENDIX A

emerge ASSOCIATES
Integrated Science & Design

## 2015 REVEGETATION AND FIRE MANAGEMENT PLAN (RFMP)

# AVON RIDGE ESTATE, BRIGADOON

## REVEGETATION AND FIRE MANAGEMENT PLAN (REVISED 2015)

Project Number EP13-041

**Prepared for Peet Limited**
**July 2015**

# Document Control

| DOC NAME | AVON RIDGE ESTATE, BRIGADOON REVEGETATION AND FIRE MANAGEMENT PLAN (REVISED 2015) | | | | |
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| 1 | April 2015 | Anle Tieu | AT | Chrystal King | CKK |
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| A | April 2015 | Anle Tieu | AT | Chrystal King | CKK |
| | Amendment following comments from client and project team | | | | |
| B | June 2015 | Anle Tieu | AT | Jason Hick | JDH |
| | Amendment following comments from DFES | | | | |
| C | July 2015 | Anle Tieu | AT | Jason Hick | JDH |
| | Amendment following comments from DFES | | | | |
| D | | | | | |
| | | | | | |

# Executive Summary

Avon Ridge Estate, Brigadoon (Lots 1010 and 1022 Campersic Road, Brigadoon) (the site) is a special rural estate being developed by Peet Limited (Peet). The site is comprised of a subdivision area and a "Parks and Recreation Reserve" (PR Reserve). This Revegetation and Fire Management Plan (RFMP) has been prepared to satisfy:

- Condition 3 of the *Environment Protection and Biodiversity Act 1999* (EPBC Act) Approval No. 2008/4250.
- An outline development plan provision.
- Conditions for subdivision approvals for the site.

This RFMP (Revised 2015) (2015 RFMP) provides the principles and methods to undertake revegetation over the site, including details on species selection and planting densities for proposed revegetation areas followed by management and monitoring of revegetation works. The RFMP also outlines fire management requirements including fuel reduction, fire break installation and maintenance requirements, the role of a fire management consultant (FMC) and raising awareness of bushfire preparedness with lot purchasers. This RFMP also provides an update on revegetation and fire management undertaken over the site up until February 2014.

Fire management considerations in this RFMP are based on the Fire Management Plan (FirePlan WA 2009) and updated Fire Management Plan (FirePlan WA 2013) prepared for the site. This RFMP supersedes the previously approved RFMP (Cardno 2010a), a revised RFMP (Cardno 2012a) and an addendum to the RFMP for the site (Emerge 2014).

The aim of the RFMP is to reduce the potential impacts on endangered Black Cockatoos which utilise the remnant vegetation within the site whilst reducing the risk of bushfire impacts on future Avon Ridge Estate residents.

This RFMP addresses following key management issues:

- Revegetation measures will be undertaken in degraded areas within the PR Reserve to protect the area's landscape and ecological values and to enhance foraging habitat value for Black Cockatoo species.
- Plant species for revegetation will be selected for species diversity, plant form and include species that are known habitat for Black Cockatoo species.
- Species mix, number and density of plants for revegetation will be developed from advice from revegetation specialists with inputs from previous results and site conditions and the Department of Fire and Emergency Services (DFES).
- Completion criteria of 90% survivorship at the end of three years will be met which has been based on EPBC Act approval conditions.
- A monitoring program will be undertaken by an appropriately qualified and experienced ecologist.
- Fuel reduction measures within the development will be implemented prior to the release of lots which includes prescribed burning in accordance with a prescribed burn plan.
- Fuel reduction measures within lots will include the role of the FMC who will supervise the implementation of the Building Protection Zone (BPZ)
- Potential Black Cockatoo breeding trees measuring 500 mm Diameter Breast Height (DBH) or greater will be retained by mapping locations of the trees, application of Protective Covenants and lot inspections undertaken by the FMC.

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# 1 Introduction

## 1.1 Background

Avon Ridge Estate, Brigadoon, Western Australia is a special rural development currently being developed by Peet Limited (Peet). Avon Ridge Estate is comprised of Lots 1010 and 1022 Campersic Road, Brigadoon, herein referred to as "the site". The location of the site is shown in **Figure 1**. The site is approximately 861 hectares (ha) and is comprised of a subdivision area and a "Parks and Recreation Reserve" (PR Reserve). The subdivision area, as shown in **Figure 2** includes:

- A special rural subdivision of 214 lots across 454 ha with lot sizes ranging from 1.5 ha to 5.05 ha.
- An area of "Public Open Space" (POS) (1ha) within the subdivision area.
- A "Creekline and Wetland Conservation Area" (10 ha) within the subdivision area.

The PR Reserve is approximately 406 ha and was ceded to the Crown in 2011 to protect the area's landscape and ecological values.

This Revegetation and Fire Management Plan (RFMP) as revised in 2015 and referred to herein as the "2015 RFMP" has been prepared to satisfy Condition 3 of the *Environment Protection and Biodiversity Act 1999* (EPBC Act) approval no. 2008/4250 granted by the Department of Environment, Water, Heritage and the Arts (DEWHA) now the Department of Environment (DoE), also referred to as the "Department". In addition to meeting the requirements of the EPBC Act approval, this RFMP also provides the mechanism to satisfy Provision J of the outline development plan (ODP) endorsed by the City of Swan and subdivision approval conditions of the Western Australia Planning Commission (WAPC) which is discussed in further detail in **Section 1.3**. Implementation of the Avon Ridge Estate proposal commenced in 2009 and this RFMP provides information on the progressive compliance with EPBC Act conditions including revegetation and prescribed burn plans.

This 2015 RFMP provides the principles and methods for the proponent to undertake revegetation over the site, including details on species selection and planting densities for proposed revegetation followed by monitoring and management of revegetation areas. The RFMP also outlines fire management requirements involving fuel reduction, fire break installation and maintenance, the use of a fire management consultant (FMC) and raising awareness of bushfire preparedness with lot owners.

## 1.2 Previous revegetation and fire management plans

This 2015 RFMP is preceded by the document entitled *Brigadoon Estate Revegetation and Fire Management Plan Parts 1, 2 and 3* (Cardno 2010a). This previous version of the RFMP, referred to as the "2010 RFMP" (Cardno 2010a) was approved by the Department of Fire and Emergency Services (FESA) (now Department of Fire and Emergency Services (DFES)) in May 2010 and the Department in June 2010.

In response to modifications to the EPBC Act approval conditions, significant changes relating to the revegetation and prescribed fuel reduction program at the site were sought through an update to the RFMP referred to as the "2012 RFMP" (Cardno 2012a). Since the completion of the 2012 RFMP, several further changes relating to fire management and bushfire planning imposed by the City of Swan have occurred. An addendum (referred to as the "2014 Addendum") (Emerge 2014) was prepared to provide supplementary information, clarification and to update changes made to the 2012

RFMP. This current document (2015 RFMP) consolidates the 2010 RFMP, the 2012 RFMP and the 2014 Addendum to be considered for approval by DFES and the Department.

## 1.3 Commonwealth and state approval conditions

Peet submitted a Referral of Proposed Action pursuant to the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) on the 5th of June 2008. The referral outlined how development of the special rural development within Lots 1010 and 1022 Campersic Road Brigadoon, Western Australia was proposed to be implemented to reduce threats to and protect Black Cockatoo habitat. On the 2nd of July 2008, the proposal was deemed a "Controlled Action" due to potentially significant impacts on "listed threatened species and ecological communities", being:

- Carnaby's Black Cockatoo
- Forest Red Tailed Black Cockatoo
- Baudin's Black Cockatoo.

As part of this process, Peet formulated a comprehensive mitigation and offsets package to minimise impacts on the listed threatened species. A significant component of this mitigation and offsets package is the replacement of habitat for threatened Black Cockatoo species. This included revegetation over the site, using plant species that are suitable for use by Black Cockatoo species, for foraging, roosting and potentially breeding.

Peet received conditional consent for the proposal on the 8th of October 2009 (EPBC 2008/4250). One of the conditions of the approval (Condition 3) was to prepare a "Revegetation and Fire Management Plan" to be approved by the Fire and Emergency Services Authority (FESA), prior to any clearing or construction on the site.

Specifically, Condition 3 requires the following:

*The person taking the action must prepare a Revegetation and Fire Management Plan that applies to the 100 ha within the Parks and Recreation Reserve and 450 ha for the subdivision (as identified at Attachment 5) including all 214 individual lots. The proponent must obtain written approval from FESA prior to submission to the Department for approval. The person taking the action must not commence clearing or construction within the project until the Department has approved the Revegetation and Fire Management Plan in writing. Once approved this plan must be implemented.*

*The person taking the action must ensure that the Revegetation and Fire Management Plan includes (but is not restricted to):*

*a. Fuel reduction measures (including cool burn measures) specifying the timing and frequency of fuel reduction measures to minimise impacts on Black Cockatoo habitat.*

*b. Revegetation measures to create additional Black Cockatoo habitat across the project sites, including in the Parks and Recreation Reserve, specifically:*

*i. revegetation for all condition classes (excluding pristine and excellent classes) and vegetation complexes (including maps);*

*ii. mix, numbers and density of species to be planted;*

*iii. timing of proposed planting (must be during or following the annual winter rain period and generally between 1 June and 30 November);*

iv. *weed management measures;*

v. *the survivorship rate of all revegetation measures must be at least 90% after three years. If after three years of the date of the planting, a survival rate of 90% of the planted trees is not achieved, all dead trees must be replaced with other Black Cockatoo habitat species within 12 months and maintained for at least an additional two years;*

vi. *annual monitoring measures within the project area undertaken by an appropriately qualified and experienced ecologist and must commence within 12 months of the completion of revegetation and continue for at least three years after the initial revegetation planting in any particular area (given that revegetation will be staged across the development);*

vii. *annual monitoring measures undertaken by an appropriately qualified and experienced specialist must commence in the Park and Recreation Reserve within 12 months of completion of revegetation and continue for at least three years after the initial revegetation planted in the Parks and Recreation Reserve for the purposes of establishing the survivorship rates and replanting efforts within the project area;*

viii. *mapping of all potential Black Cockatoo habitat trees of 500 mm dbh or greater on individual lots and information on how these will be retained for permanent conservation.*

Avon Ridge Estate is currently being developed in accordance with an approved outline development plan ()DP) and subdivision approvals. The ODP outlines the intended land use within the site whilst the subdivision plans demarcate proposed lots and an internal road network consistent with the ODP. The preparation of a RFMP for the site was required via a provision of the ODP and as conditions of subdivision approval.

Thus, in addition to meeting the requirements of the EPBC Act approval, this RFMP also provides a mechanism to satisfy ODP provision (J) which requires:

*"An updated fire and revegetation management plan is to be prepared at the time of subdivision. This is to ensure that revegetation and fire management outcomes are consistent with the requirements of FESA, City of Swan, DEC, EPA and DEWHA".*

Conditions 19, 21 and 21 of subdivision approvals issued by the Western Australian Planning Commission (WAPC) (references 144087, 141396 and 147722 respectively) also require:

*"A Fire and Revegetation Management Plan being prepared, approved and relevant provisions implemented during subdivisional works (including, but not limited to, the construction of alternative egress to O'Brien road and the identified strategic firebreaks), in accordance with the WAPC's Guideline Planning to Bushfire Protection Edition 2, May 2010 (in particular Appendix 3) to the specifications of the local government and/or the Department of Fire and Emergency Services (Local Government)".*

## 1.4 Purpose of this document

The purpose of this RFMP is to consolidate the 2012 RFMP and the 2014 Addendum and provide the overarching objectives and principles for the revegetation over the site whilst mitigating bushfire risk to the site. These include:

- Replace foraging habitat for Black Cockatoo species through revegetation of areas within the PR Reserve considered suitable for revegetation so that the species do not significantly alter their use of the site and a net benefit for Black Cockatoo species is achieved.
- Ensure that the revegetation within the PR Reserve does not increase the bush fire risk and is consistent with the approved *Brigadoon Estate Fire Management Plan* (FirePlan WA 2013) (**Appendix A**) by maintaining a separation between revegetation areas and private lots supported by strategic and lot firebreaks.
- Reduce the risk and severity of bushfire within the subdivision area through vegetation modification within lots to be undertaken by the lot owner with the assistance of a FMC in a manner that does not unnecessarily impact or reduce Black Cockatoo foraging habitat values.
- Undertake revegetation and fire management in accordance with *Planning for Bush Fire Protection* Guidelines (WAPC *et al*. 2010).
- Establish a network of strategic firebreaks to provide fire appliance access.
- Undertake hazard reduction so that significant vegetation within the site is not adversely impacted and to minimise risk to life and property.

# 2 Site Description

## 2.1 Site details

The site is situated approximately 36 kilometers (km) north-east of the Perth Central Business District (CBD) in the City of Swan (**Figure 1**). The Swan River and a railway reserve are located west of the site at the bottom of the valley and a creekline and wetland conservation area is located within the centre of the site (**Figure 2**). The site is characterised by steep slopes on the western, northern and southern boundaries and is relatively flat along its eastern boundary.

## 2.2 Environmental values

### 2.2.1 Flora and vegetation

The site occurs in the Jarrah Forest of the Darling Botanical District of the South West Botanical Province (Beard 1979). A vegetation assessment of the subdivision area (Siemon and Associates 2006) identified eight plant community types (as shown in **Figure 3**). Due to historical logging and clearing for gravel extraction and agricultural use, the condition of the vegetation varies as shown in **Figure 4**. The majority (79%) of the subdivision area was in “Very Good” to “Good” condition based on the Bush Forever vegetation condition rating system (Government of Western Australia 2000) as outlined in **Table 1**. A smaller area of the site (2%) was in “Excellent” condition. The remainder of the subdivision area (19%) was in “Poor” (“Degraded”) to “Very Poor” (“Completely Degraded”) condition. Although the PR Reserve has not been subject to a specific flora and vegetation survey, ecologists from Cardno (Cardno 2012a) have confirmed through site visits and aerial photograph interpretation that over two thirds of the PR Reserve is in “Completely Degraded” and “Degraded” condition as shown in **Figure 5**.

*Table 1: Summary of Bush Forever Vegetation Condition Scale (Government of Western Australia, 2000)*

| CONDITION SCALE | DESCRIPTION |
|---|---|
| Pristine | Pristine or nearly so, no obvious signs of disturbance. |
| Excellent | Vegetation structure intact, disturbance affecting individual species and weeds are non-aggressive species. |
| Very Good | Vegetation structure altered, obvious signs of disturbance. For example, disturbance to vegetation structure caused by repeated fires, the presence of some more aggressive weeds, dieback , logging and grazing. |
| 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 grazing. |
| Degraded | Basic vegetation structure severely impacted by disturbance. Scope for regeneration but not to a state approaching good condition without intensive management. For example, disturbance to vegetation structure caused by frequent fires, the presence of very aggressive weeds, partial clearing, dieback and grazing. |
| 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. |

### 2.2.2 Weeds

The vegetation assessment of the subdivision area of the site (Siemon and Associates 2006) identified a number of weed species present within the subdivision area. The dominant weed species and their environmental weed potential are outlined in the **Table 1** below.

*Table 2: Dominant weed species and environmental weed potential (Siemon and Associates 2006)*

| COMMON NAME | SCIENTIFIC NAME | ENVIRONMENTAL WEED PRIORITY |
|---|---|---|
| Cape weed | *Arctotheca calendula* | Moderate |
| Pennyroyal | *Mentha pulegium* | Moderate |
| One-leaf cape tulip | *Moraea flaccida* | High |
| Guildford grass | *Romulea rosea* | High |
| Victorian coastal teatree | *Leptospermum laevigatum* | High |
| Wild Gladioli | *Gladiolus caryophyllaceus* and *G. undulatus* | Moderate |
| Paterson’s curse | *Echium plantagineum* | High |
| Rose pelargonium | *Pelargonium capitatum* | High |
| Fennel | *Foeniculum vulgare* | Low |
| Flatweed | *Hypochaeris glabra* | Low |
| Annual ryegrass | *Lolium rigidum* | Moderate |
| Geraldton wax | *Chamaelaucium uncinatum* | Moderate |
| Rose flowering gum | *Eucalphtus leucoxylon rosea* | Low |

### 2.2.3 Dieback

Dieback is the common name used to describe the disease symptoms of, and the presence of the causal agent *Phytophthora cinnamomi* in Western Australia. Many plant species which provide foraging habitat for Black Cockatoo species are susceptible to *Phytophthora* dieback. The loss of foraging, breeding and roosting habitat by *Phytophthora* dieback has been identified as a primary threat to Black Cockatoos (*EPBC Act Referral Guidelines for Three Threatened Black Cockatoo Species: Carnaby’s Cockatoo* (endangered) *(Calyptorhynchus latirostris), Baudin’s Cockatoo (vulnerable) (Calyptorhynchus baudinii) and Forest Red Tailed Black Cockatoo (vulnerable) (Calyptorhynchus banksii naso)* (DSEWPAC 2012). In June 2012, Cardno ecologists undertook a dieback assessment of lots within the southern area adjoining the PR Reserve to determine the presence and extent of *Phytophthora* dieback infestation to determine the risks to potential future areas of revegetation. Dieback was not found within the area surveyed. However, it was suspected that the naturally occurring honey fungus (*Armillaria luteobubalina*) which affects the roots of eucalypt

trees to be present. Appropriate construction hygiene practices for the prevention of dieback will assist in reducing the spread of this disease at Avon Ridge.

Whilst the dieback Phytophora was not detected within some areas of the site, infestation of Phytophthora dieback into revegetation areas has the potential to significantly reduce the success of revegetation works. As part of the adaptive management principles guiding this RFMP, if any area proposed for revegetation are determined to be infested with dieback or susceptible to Phytophthora infestation, the suite of species selected for revegetation will be chosen from lists of species known to show resistance to dieback infection.

Cockatoo foraging or habitat species local to the area which are listed as being resistant to infection by *Phytophthora cinnamomi* dieback include:

- Golden Wattle (*Acacia saligna*)
- Marri (*Corymbia calophylla*)
- Flooded gum (*Eucalyptus rudis*)
- Wandoo (*Eucalyptus wandoo*)
- Honey Bush (*Hakea lissocarpha*)
- Urchin Hakea (*Hakea petiolaris*).

# 3 Revegetation

## 3.1 Objectives

A total of 214,000 seedlings will be planted as required by Condition 3 of EPBC Act Approval No. 2008/4250 which was based on the number of lots created and an allocation of 1000 plants per lot. It was proposed in the 2010 RFMP that revegetation occur across the site (subdivision area and PR Reserve). However, revegetation is now proposed to occur within the PR Reserve to optimise the success of plant establishment and survival through management actions that are only practicable within the PR Reserve such as fencing revegetation sites to reduce herbivory.

Adaptive management is being used to plan for future revegetation areas, with survivorship, species mix, types of planting locations, vulnerability to grazing, potential for vandalism and site safety and accessibility guiding future activities. Tranen Revegetation Systems, revegetation specialists with considerable revegetation experience in the southwest of Western Australia have assisted in planning the revegetation program and have been engaged by the proponent to implement the revegetation works. Prior to implementing any new additional revegetation works, DFES will be consulted regarding any modifications to the proposed revegetation works as outlined in this document.

Revegetation works commenced in 2011, and the revegetation works undertaken between August 2011 and July 2013 are summarised in this section.

## 3.2 Work specifications

### 3.2.1 Revegetation areas

#### *3.2.1.1 Revegetation undertaken between 2011-2013*

Revegetation commenced in 2011 and the majority of plantings have been undertaken within the flatter, degraded areas within the PR Reserve shown in **Figure 5**. These flatter areas do not contain extensive gravel which would inhibit revegetation success. These areas have previously been cleared for grazing and the general condition of the areas proposed for revegetation is shown in **Plate 1**.

*Plate 1: "Completely Degraded" or parkland cleared area within Parks and Recreation Reserve identified for revegetation works (Cardno 2010a)*

The sparse vegetation within revegetation areas is generally characterised by a relatively low fuel level. Revegetation will be undertaken over areas in "Completely Degraded" or "Degraded" condition where fuel loads are unlikely to significantly increase over time. The revegetation will therefore be the primary driver of increased fuel load within the revegetation areas.

Between 2011 to 2013, 88,255 plants were planted across six sites over 24.3 ha, leaving a balance of 125,745 plants to be planted to reach the additional target of 214,000 plants. The details of the revegetation undertaken over six sites across the PR Reserve which include the date of revegetation, number, density species list is shown in a planting summary contained within **Appendix B**. The location of historic revegetation sites are shown in **Figure 6**.

To demonstrate that the revegetation areas will not pose an unacceptable level of risk to the development, the future vegetation classification in accordance with *Australian Standard Construction of buildings in bushfire-prone areas AS3959-2009* (Standards Australia 2009) (AS3959) was determined based upon the proposed revegetation. Based upon the species planted and planting density, the resulting vegetation classification of existing revegetation areas is likely to be:

- Revegetation Area 1A – Woodland (20–30% cover) over Tall Shrubland (30% cover).
- Revegetation Area 2 – Woodland (20% cover) over Tall Shrubland (30% cover).

The revegetation falls within acceptable levels of risk and will not significantly increase the bushfire threat within the PR Reserve. The vegetation classification of existing revegetation areas is shown in **Figure 7**.

Revegetation within Areas 3 and 4 has been less successful to date and therefore the future cover and vegetation classification has not been determined. Monitoring and maintenance of revegetation has been ongoing and will continue for three years post planting in each revegetation area. Maintenance includes biannual weed control in spring and autumn which helps to reduce weed competition and also reduces fuel loads within revegetation areas. Dead plants will be replaced to achieve 90% tubestock survival after three years in accordance with the EPBC Act condition requirements.

#### *3.2.1.2 Management plan actions and outstanding revegetation requirements*

The additional areas proposed for revegetation within the PR Reserve have been degraded through historic land uses. Large areas have been mapped as “Completely Degraded” or “Degraded” based on the Bush Forever vegetation condition rating system (Government of Western Australia 2000) as shown in **Figure 5** and **Plate 1**.

At a planting density of 1 plant per $m^2$, approximately 10.7 ha is required to accommodate the remaining planting requirements. An assessment to determine possible areas for future revegetation was undertaken by Cardno in 2012 (Cardno 2012b) which identified flatter and mostly cleared areas within the PR Reserve as possible revegetation areas. Following revegetation from 2011 to 2013, an area of 12.3 ha for future revegetation remains and is shown in **Figure 8**. This slightly exceeds the area required to plant the outstanding number of plants (based on 1 plant per $m^2$).

### 3.2.2 Seed collection and species selection

#### *3.2.2.1 Revegetation undertaken between 2011-2013*

Between 2011-2013, tubestock for the project was grown from local provenance seed (where possible) that has been collected from within 30 km of the site. Most seedlings were grown in 100 mm root training pots which provide a good growing medium and enable them to establish to a size required to be able to sustain the pressures of transplanting into bushland areas. Tubestock were ordered from nurseries in the October to November in the year prior to planting to ensure seedlings have a sufficient size for planting. All nurseries that have supplied tubestock for this project are required to hold a current accreditation under the Nursery Industry Accreditation Scheme Australia (NIASA).

The species used in revegetation across the site were species that were:

- Already present over the site and have been identified within the plant communities identified in the Brigadoon Vegetation Survey (Siemon and Associates 2006) (**Figure 3**).
- Included within the regional vegetation complexes (Heddle *et al*. 1978) present over the site and would be expected to occur within the site prior to degrading land uses.
- Known to provide foraging, roosting or breeding habitat for Black Cockatoos or known to occur in conjunction with these species in a natural/ecological setting.
- Included within the *Plant Guide within the Building Protection Zone for the Swan Coastal Plain of Western Australia* (FESA 2011a).

The emphasis of revegetation works is on the augmentation of local Black Cockatoo foraging habitat. Many of the species planted as part of revegetation works are species that are known to provide foraging, roosting or nesting habitat for Black Cockatoo species. Consideration was also been given to the resistance of particular species to dieback, with a dieback resistant plant species utilised for revegetation in infested or suspected areas. The revegetation species are listed in **Table 3**, which also indicates the habitat value of each of these species for Black Cockatoo species.

*Table 3: Proposed revegetation species*

| SCIENTIFIC NAME | COMMON NAME | FORM | HABITAT FOR BLACK COCKATOO SPECIES | | |
|---|---|---|---|---|---|
| | | | NESTING | ROOSTING | FEEDING |
| *Acacia lasiocarpa* | Panjang | shrub 0.5 – 1.5m | | | |
| *Acacia pulchella* | Prickly Moses | shrub to 6m | | | |
| *Allocasuarina humulis* | Dwarf sheoak | shrub 1 to 4m | | | |
| *Banksia lindleyana* | Porcupine Banksia | shrub 1 to 3m | | | |
| *Banksia sessilis* | Parrotbush | shrub to 3m | | | X |
| *Callistemon phoeniceus* | Lesser Bottlebrush /Toobada | small tree to 6m | | | X |
| *Calothamnus quadrifidus* | One sided bottlebrush | shrub 1 to 4m | | | |
| *Corymbia callophylla* | Marri | tree to 40m | X | X | X |
| *Eucalyptus wandoo* | Wandoo | tree 3 to 25m | X | X | X |
| *Gompholobium tomentosum* | Hairy Yellow Pea | shrub to 1 m | | | |
| *Grevillea bipinnatifida* | Fuchsia Grevillea | shrub 0.2 to 1m | | | X |
| *Hakea lissocarpha* | Honeybush | shrub to 1.5m | | | X |
| *Hakea prostrata* | Harsh Hakea | shrub to 3m | | | X |
| *Hakea undulata* | Wavy-leaved Hakea | shrub 1 to 2m | | | X |
| *Hibbertia subvaginata* | | shrub to 1.2m | | | |
| *Hypocalymma robustum* | Swan River Myrtle | shrub 0.4 to 1m | | | |
| *Kennedia coccinea* | Coral vine | shrub to 0.5m | | | |
| *Kennedia prostrata* | Scarlet Runner | shrub to 0.5m | | | |

The species list provided in **Table 3** is not exhaustive and other native species found within the site may be used for revegetation. It is important to note that there are a variety of plant forms proposed to be included within the revegetation species mix (i.e. the species are not all trees) and these species are of varying sizes (and canopy densities) at maturity.

In view of the largely parkland cleared nature of the proposed revegetation areas, the majority of the species proposed for use as part of revegetation works are proteaceous shrub or understorey species which have been lost over the site through degrading processes (clearing, grazing by livestock).

#### *3.2.2.2 Management actions and outstanding revegetation requirements*

Seed collection and species selection for future revegetation will be undertaken as outlined in **Section 3.2.2.1.**

DFES will be consulted if modifications to seed collection and species selection are made.

### 3.2.3 Site preparation for revegetation

#### *3.2.3.1 Fencing*

*Revegetation undertaken between 2011-2013*

Four of the six revegetation sites were fenced (**Plate 2**). Two sites were not able to be fenced due to amenity issues from adjacent lot owners and/or the steep nature of the revegetation sites, which made it impractical to install fencing. Plants within these unfenced sites experienced higher herbivory and additional infill planting was undertaken to ensure the completion criteria could be met (see **Section 4**).

*Plate 2: Fencing around a revegetation site*

*Management Plan Actions and outstanding revegetation requirements*

Fencing will be erected around revegetation areas where possible to protect seedlings from grazing and trampling by kangaroos and feral animals as well as damage by unauthorised off-road vehicle use. The fenced revegetation sites do not pose additional fire management issues within the PR Reserve. The revegetation areas are comparatively small to the entire PR Reserve and separated from each other. Gates to revegetation areas are not locked and all revegetation areas are accessible for bushfire suppression. Furthermore, after the completion criteria of revegetation is met, fencing will be removed and will therefore not pose a long term bushfire management issue.

Future revegetation sites will be small in area (compared to the entire area of the PR Reserve) and sites will be fenced. Gates will be unlocked to be accessed for bushfire management purposes.

#### *3.2.3.2 Pre-planting weed management*

*Revegetation undertaken between 2011-2013*

A combination of Glyphosate and Simazine (or Oust® pre-emergent) was used in the pre-planting weed control program which was undertaken during soil preparation (see **Section 3.2.3.3** below). One site required the manual removal of olive trees. During the maintenance period, the typical mixture of Glyphosate and Metsulfuron Methyl was used for weed control which successfully suppressed both summer and winter growing weeds.

*Management plan actions and outstanding revegetation requirements*

Herbicides such as Glyphosate and Fusillade ® will be used to control the majority of broadleaf and grassy weeds prior to any revegetation. More resilient weeds such as Cape Tulip (*Moraea flaccida)* and Paterson's Curse (*Echium plantagineum)* which are also listed as Priority 1 (P1) species, Declared species under the *Agriculture and Related Resources Protection Act 1976* would need to be controlled through the addition of stronger herbicides such as such as Metsulphuron or Chlorosulphuron to this mix.

Glyphosate is generally applied at a rate of 1 to 2% with mixes of chlorosulphuron and metsulphuron added at a rate of 0.01 – 0.05ml/L. Fusillade ® would generally be applied at a rate of between 0.1 – 0.5ml/L (100 – 500ml/ha) but for hardier weed species such as Perennial Veldt grass (*Ehrharta calycina)* this rate would increase to approximately 8ml/L (4L/ha). All herbicide application mixes will include a wetting agent which will enhance the uptake of the chemical by breaking down any repellent waxy substances on the leaves of the target plants.

In larger completely cleared areas, weed control can be undertaken using machine operated spraying vehicles in conjunction with soil preparation activities (see **Section 3.2.3.3** below). However the majority of the spray application will be applied using backpacks or vehicle mounted retractable hoses. In areas with proposed planting densities lower than 3000 seedlings/ha, the application of herbicides will be undertaken in a spot spraying method rather than a blanket application to control weeds in the specific area for seedling planting.

The revegetation contractor will provide Material Safety Data Sheets for all chemicals brought onto the site to comply with occupational health and safety regulations.

#### *3.2.3.3 Soil preparation*

*Revegetation undertaken between 2011-2013*

Deep ripping (as shown in **Plate 3**) can lead to increased regeneration of the existing soil seedbank of both weed seeds and native species. The existing revegetation sites were deep ripped to 1 m depth with a tyne, 1.8 m apart. Due to the potential stimulation of the weed soil seedbank following ripping, a pre-emergent herbicide was applied along the rip lines to reduce competition with seedlings. This has proven effective at reducing weed competition but may also have prevented native seeds germinating. Monitoring of revegetation installed in 2011 following deep ripping did not record significant germination or establishment of native species along the rip line from the soil seed bank (ie. in addition to the planted seedlings). It is also likely that given the degraded nature of the PR Reserve that the native soil seed bank has been heavily depleted over time.

*Plate 3: Areas showing deep ripped soil (Cardno 2010a)*

*Management Plan Actions and outstanding revegetation requirements*

Soil preparation is required to improve the establishment of seedlings and the ease and speed of planting. Soil preparation will be undertaken prior to any future revegetation. Scarification and deep ripping are cultivation techniques to prepare hard, poorly structured soils which may have poor water infiltration and therefore could lead to poor plant vigour. Scarification involves the use of non-inversion cultivation (using narrow points) to a depth of 15 to 20 cm whereas deep ripping involves the cultivation (over 20 cm depth) using a tyne, normally on the back of a bulldozer (Department of

Primary Industries NSW 2013). For example, deep ripping by Alcoa involves ripping returned soil to a depth of 1.5 m using a tyne with wings, which creates mounds and furrows approximately 1.5 m wide (Gardner 2001).

A combination of grazing and other forms of land disturbance in revegetation sites within the PR Reserve have resulted in soil compaction and varying levels of weed infestation. Deep ripping is considered essential to prepare the soil for revegetation due to soil compaction and is proposed where machinery can access the revegetation sites.

### 3.2.4 Planting

#### *3.2.4.1 Timing of planting and seedling planting*

*Revegetation undertaken between 2011-2013*

Seedlings were planted between May to July dependent on availability of rainfall. Following substantial rainfall, soil moisture conditions are optimal to promote seedling establishment and growth.

The seedlings were planted using a hand-held planting device and a fertiliser tablet placed with each seedling. These fertiliser tablets provided essential nutrients and trace elements to assist with establishment of the seedlings.

*Management Plan Actions and Outstanding revegetation*

Seedlings will be planted between the winter months of May through to July to take advantage of seasonal rainfall which aids establishment.

#### *3.2.4.2 Revegetation densities*

*Revegetation undertaken between 2011-2013*

Between 2011 and 2013, six sites were revegetated as shown in **Figure 6**. Revegetation was targeted in bare areas classified as “Completely Degraded” or “Degraded” condition.

The species and number of seedlings planted, spacing and density within each revegetation site over 2011-2013 is detailed in **Appendix B**. Plant species were categorised into the following plant lifeforms: trees, shrubs and groundcover in accordance with the *Plant Guide within the Building Protection Zone* (FESA 2011a). Whilst it is acknowledged that the guide was designed for the Swan Coastal Plain and not specifically for the Jarrah forest, the guide was used to categorise plant lifeforms and therefore an applicable tool for this purpose. The average planting density across the six revegetation sites was 0.6 plants per $m^2$. The species planted were a mix of trees, shrubs and ground cover and were randomly planted along the rip line. The plant density for tree species (based on calculations of sites which have been monitored over the longest period) is 1 tree per 6.9 $m^2$ to 16.3 $m^2$. Tree species included *Allocasuarina fraseriana, Banksia grandis, B. ilicifolia, B. menziesii, B. prionotes, Corymbia calophylla, Eucalyptus marginata, E. rudis* and *E. wandoo*. Based upon the completed revegetation, the future vegetation classification (for bushfire risk purposes) has been determined for revegetation areas1A and 2 and is shown in **Figure 6**.

In existing revegetated sites, seedlings were planted along 1.8 m rip lines.

#### *3.2.4.3 Management plan actions and outstanding revegetation requirements*

Planting densities will be determined by revegetation contractors based on existing canopy cover, site characteristics and tubestock species physiology. The species and lifeform (groundcover, shrub or

tree) selected for each site is also dependent on the availability of seedlings of each species. The revegetation contractors will be responsible for documenting the number, species and location of seedlings planted within the site. Prior to works being committed, DFES will be consulted regarding the proposed planting densities.

In future revegetation sites, width of rip lines will be reduced to 1 m by reducing the width of tynes used to achieve a planting density of 1 plant per $m^2$. There is also potential to undertake infill planting in existing and fenced revegetation sites which provides additional areas for future possible revegetation. Pockets of bare areas where machinery is unable to access may also be planted using petrol powered hand augers.

The vegetation structure planning for new revegetation areas will aim for a stem density of 500 to 800 stems/ha of trees and 8,200 to 8,500 stems/ha for shrubs and ground cover. It is anticipated that tree cover will be in the vicinity of 30 to 75%; shrub and ground cover in the range 30 to 80% with a grassy understorey. Future revegetation sites will also use plant species which have been successful at the revegetation sites and will not use sandy soil Banksia species (*Banksia ilicifolia, B. menziesii* and *B. prionotes*) which have not been successful within the PR Reserve.

Planting densities and records regarding planting details for future revegetation will be undertaken by revegetation contractors. Prior to works undertaken, DFES will be consulted regarding the proposed planting density.

### 3.2.5 Pest control

#### *3.2.5.1 Revegetation undertaken between 2011-2013*

Herbivory and damage caused by kangaroos and rabbits reduce the survival of seedlings. A 1.8 m ring-lock fence was erected along the perimeter of revegetation areas where possible. Peet also engaged a pest controller to undertake the control of rabbits, goats and pigs within the estate as part of the implementation of a Pest Management Strategy for Avon Ridge.

#### *3.2.5.2 Management plan actions and outstanding revegetation requirements*

Grazing and trampling by kangaroos and rabbits are the most likely pests to significantly impact the success of revegetation. A fence will prevent herbivory and will also prevent access by grazers and unauthorised access by four wheel drive vehicles and dirt bikes. Pest control will continue intermittently throughout the development period as and when required. This will help reduce the continued degradation or remnant vegetation through feral animal grazing.

New revegetation areas will be fenced to prevent herbivory and disturbance by kangaroos and rabbits.

### 3.2.6 Dieback management

#### *3.2.6.1 Revegetation undertaken between 2011-2013*

A precautionary approach during revegetation works was undertaken where general dieback hygiene measures were adopted over the site to ensure that any potential spread of dieback is minimised. This included:

- A requirement that vehicles, tools equipment and machinery be free of mud and soil on entry into and exit from areas of bushland.

- Ensuring that additional offsite soil, gravel or sand required for construction is free of Dieback (where possible) by selecting appropriate providers and discussing Dieback concerns with each provider.

This approach is in accordance with the *Guide for Landholders and Community Conservation Groups for Managing Phytophthora Dieback in Bushland* (Kilgour 2009) an initiative of the Dieback Working Group, and the advice available from the Dieback Response Group.

#### *3.2.6.2 Management plan actions and outstanding revegetation requirements*

A Phytophthora dieback survey was undertaken by Cardno ecologists in June 2012 to guide revegetation activities within the PR Reserve (see **Section 2.2.3**). Whist the survey did not detect dieback in the areas assessed, dieback has been mapped in numerous locations within the South West region and similar vegetation community types as the site. Therefore the potential for this pathogen to be spread during the revegetation is being given consideration during planning for future revegetation. A precautionary approach during revegetation works will therefore be implemented.

Future revegetation works will apply an ongoing precautionary approach to dieback hygiene.

### 3.2.7 Unauthorised access

#### *3.2.7.1 Revegetation undertaken between 2011-2013*

Fencing and signage informing the public of revegetation works was installed around revegetation areas.

#### *3.2.7.2 Management plan actions and outstanding revegetation requirements*

The PR Reserve is currently accessed by four wheel drives and dirt bikes which can impact revegetation works within the area. The construction of a fence around revegetation areas will deter entrance to revegetation areas and signage will informing the public of revegetation works being undertaken.

Future revegetation areas will be fenced to deter unauthorised access to and signs erected to inform the public of revegetation works.

# 4 Monitoring and Maintenance

## 4.1 Objectives

The objectives of the monitoring and maintenance actions are to ensure the intended revegetation outcomes are achieved and revegetation is successful in the short term and self-sustaining in the longer term.

## 4.2 Work specifications

### 4.2.1 Completion criteria

Completion criteria are considered a practical management tool to measure the success of revegetation. Specific targets (defined by measured outcomes or milestones) are required for monitoring and reporting of revegetation projects. Completion criteria must be sufficiently stringent to ensure that the overall objectives of revegetation have been met. These criteria must also be designed to allow effective reporting and auditing to define an endpoint for revegetation activities.

To satisfy EPBC Act approval conditions, the completion criteria of a 90% survival rate after a period of three years after initial planting needs to be met. The three year monitoring timeframe applies to the date that plants are initially planted and dead plants are replaced with infill planting across the three year period to achieve a 90% survival rate.

At the end of the three year maintenance period, the following completion criteria are required to be met:

- Survivorship rate to be at least 90% (a condition of the EPBC Act approval).
- Plants are healthy in appearance and diverse in species with no mass losses.
- Species diversity is 65% (i.e. 65% of the species planted have survived).
- The average seedling height has increased between assessments.
- Weed presence is minimal and not inhibiting native plant survival and growth.

These criteria are considered realistic based on other revegetation works in the area and the seedling planting densities provided. These expectations are for a period of average weather conditions with no extreme events (including bush fire). Based on the adaptive management approach of this RFMP, if dieback appears to impact on the survival of the revegetation species, changes may need to be made to the species list to accommodate a larger number of dieback resistant species. Revegetation monitoring will assist in the establishment of survivorship rates and replanting efforts required within the site. Where survival rates are not meeting the required targets, infill planting will be undertaken to ensure the 90% survival rate is achieved.

A report will be compiled for the PR Reserve revegetation works at the end of the monitoring and maintenance period which will state whether the project has met the completion criteria, and if not, what actions will be undertaken to rectify this.

### 4.2.2 Monitoring

#### *4.2.2.1 Revegetation undertaken between 2011-2013*

For revegetation that has been implemented, survival and species richness results have been monitored on a biannual basis. The evaluation of transects at each revegetation site monitored percentage survival of total number of plants but did not record the specific species survival. Due to the monitoring approach adopted, some assumptions and general observations were made regarding the survival of species but this was not quantified.

Based upon the first revegetation area (Area 1A) planted in 2011, the survival rate after the first year was 89% (Tranen 2012). In the second revegetation site (Area 2), the survival rate was 66% after the first year (Tranen 2013). Species richness remained high for both areas after one year of planting. Of the 21 species planted in Area 1A, all species were recorded (Tranen 2012) and in Area 2, 17 out of 18 species were recorded (Tranen 2013) after one year of planting. The distribution of plants was even and fairly consistent throughout the site. Low plant survival rates were recorded in close proximity to remnant vegetation compared to areas where there was less or no remnant vegetation.

Natural recruitment of native plants (in addition to planting seedlings) occurred within the revegetation site but at this stage (2.5 years after installation) does not constitute a large proportion of the biomass. Recruitment is patchy within Site 1A and minor native recruitment has also been observed within Site 2. The species that were observed germinating from the soil seed bank ranged from tree species (predominantly *Eucalyptus rudis*) to shrubs (predominantly *B. sessilis* and *Hibbertia* spp.) and grasses (*Austrostipa flavescens*) (Tranen 2013 and Roy Wittkuhn (Tranen) 2013, *pers comm*. December 17 2013).

#### *4.2.2.2 Management plan actions and outstanding revegetation requirements*

Ongoing monitoring will inform maintenance actions to ensure compliance criteria are met. All monitoring will be undertaken by an appropriately qualified and experienced ecologist familiar with the site context and the species diversity of the revegetation. Formal monitoring will be undertaken on a biannual basis and a report prepared to document the outcomes of the monitoring. Revegetation will also be inspected on a monthly basis to inform any maintenance that may be required. Formal monitoring will be conducted by traversing the rip lines (see **Plate 4**) and 10 m x 10 m quadrats in areas where tubestock is planted and counting the number of alive and dead tubestock to enable an accurate assessment of survival rates.

*Plate 4: Planting within rip lines (Cardno 2010a)*

All monitored transects will be photographed to provide a visual record of revegetation development, and other general information will be recorded, including:

- Date
- Quadrat number
- GPS location
- Surveyor initials
- General comments on weeds and pest attack.

Survival assessment within revegetation areas will be conducted to enable comparison of revegetation success in differing landscape elements. This assessment involves a stem count of alive and dead tubestock until the number of living plants reaches 2000. The results of this data will then be used to determine the survival percentage for each area.

### 4.2.3 Maintenance

#### *4.2.3.1 Revegetation undertaken between 2011-2013*

Based on the survival rate determined from monitoring (see **Section 4.2.2**), infill planting was undertaken in autumn/winter to ensure completion criteria will be met after the three year period of revegetation maintenance.

Dependent on the level of weed infestation within each revegetation area, weed control using a mix of Glyphosate and Metsulfuron Methyl was undertaken over summer, autumn, winter and/or spring.

In areas where fencing and gates were damaged (**Plate 5**), these were repaired.

*Plate 5: Missing gate at a revegetation site*

#### *4.2.3.2 Management plan actions and outstanding revegetation requirements*

Maintenance will be guided by the results of the monitoring program. Where areas of revegetation do not meet the completion criteria specified above (**Section 4.2.1**), infill planting will be undertaken in order to achieve 90% tubestock survival after three years.

It is expected that ongoing weed control will be required during revegetation and will be undertaken during autumn and/or spring (as required) over the three year revegetation program to reduce competition for light, water and nutrients. The weed control as outlined in **Section 3.2.3.2** will also be informed by the outcomes of the monitoring program.

Other maintenance considerations may include repairing fences, erosion control and pest control.

# 5 Fire Management

## 5.1 Introduction to fire management requirements

Fire risk management aims to reduce the threat to residents, property and native flora and fauna from the effects of uncontrolled bush fire. Within the Avon Ridge Estate, fire management actions will be balanced with the need to retain and protect native vegetation and undertake revegetation and revegetation works within the PR Reserve (**Figure 6** and **Figure 8**). The preparation of a Fire Management Plan (FMP) was a requirement of the ODP and subdivision approvals for the development of Avon Ridge Estate. This RFMP serves to integrate the FMP prepared by FirePlan WA (2013) for the site in accordance with the *Planning for Bush Fire Protection Guidelines* (WAPC *et al.* 2010) with the revegetation requirements required by the Department to offset the impacts of the development on Black Cockatoos, under EPBC Act approval No. 2008/4250.

The FMP (**Appendix A**) is being implemented across the site and all revegetation activities will be undertaken in accordance with this plan so as not to create an unacceptable fire risk. The aim of the FMP is to reduce the threat to residents and fire fighters in the event of bush fire within or near the site (FirePlan WA 2013). The following fire management elements are covered in the FMP:

- Road systems (including the construction of a public road connection between the northern portion of the subdivision and O'Brien Road)
- Strategic and internal firebreak systems
- Dwelling construction in accordance with AS3959
- Building Protection Zones
- Hazard Separation Zones
- Hazard reduction
- Driveways.

The fire management elements outlined above are discussed in more detail in the FMP (**Appendix A**).

This section of the RFMP discusses the elements of the FMP which are relevant to vegetation which will be retained and revegetation activities within the site. These include bush fire fuel loading, hazard reduction burning and vegetation modification.

## 5.2 Bush fire fuel loading

Bush Fire Fuel loading is defined as the amount of fuel present in any given area and is the material that is consumed in a fire. DFES's *Visual Fuel Load Guide for the shrub vegetation of the Swan Coastal Plain and Darling Scarp* (FESA 2012) defines fuel load as the "oven dry weight of fine fuel (< 6 mm in diameter for live fuel and < 3 mm for dead fuel) per unit area, commonly expressed as tonnes per hectare". The relationship between fuel loads and fire behaviour as described in the above guide is as follows:

> *"Many factors influence fire behaviour but none is more significant than fuel. Fuel is the availability, size, arrangement, moisture content and type of flammable material available. Understanding the different aspects of fuels can help predict the likelihood of fire and how a fire will behave under certain conditions, which can in turn help manage the risks and assess the best fire suppression options. As fuel load increases the potential run (fire*

*spread) and heat output (fire intensity) increases thus increasing the risk to life, property, the environment and fire fighter safety." (FESA Visual Fuel Load Guide 2012).*

A fuel load for a given site can be measured using the *Forest Fire Behaviour Table of Western Australia* (Sneeuwjagt and Peet 1985) and the *National Fire Curriculum Learning Manual 3.17* (FESA and DEC 2000) and by measuring litter depth and using the *Visual Fuel Load Guide* (FESA 2012) based on the vegetation structure/community present.

The fuel load (tonnes/hectare) in the site has been assessed across a range of vegetation communities present in 2009. Fuel loadings ranged from 11 tonnes per hectare to 30 tonnes per hectare. Additional fuel load assessments were carried out in specific areas of Public Open Space (POS) over the site including the Wetland and Creekline Conservation Area and the Southern Public Open Space, herein referred to as the "Southern POS". The Wetland and Creekline Conservation Area is located in the north of the subdivision (as shown in **Figure 2** and **Figure 10**) with a creekline running north to south with vegetation comprised of woodland and forest. The Southern POS is located outside and south of the site (as shown in **Figure 11**) and is characterised by remnant vegetation and grasslands. These are discussed in further detail below in **Sections 5.3.2** and **5.3.3**.

Managing fuel loads within lots is also important in reducing the impact of bushfires on the safety of owners, property, surrounding neighbours and the ability of fire fighting crews to control fires and defend property. High fuel loads result in hotter, faster moving fires and crown fires (combustion of tree canopies) which have a more significant impact on native flora and fauna. Generally, a wildfire burning with an intensity of no more than 2000 kilowatts per metre (kw/m) can be extinguished by fire fighters using direct machine and water tanker attack. The fuel loading of the site will be maintained in accordance with the approved FMP (**Appendix A**) with the intention that fire intensities (over 2000 kw/m) will not occur.

## 5.3 Bushfire risk areas

### 5.3.1 Parks and Recreation Reserve

The PR Reserve has been determined to be an "Extreme" fire risk in the Fire Management Plan (Fireplan WA 2013) and therefore the responses have been developed to account for this. The proposed revegetation within the PR Reserve is not considered to significantly increase the bushfire risk based on rate of spread calculations described below.

As the revegetation spacings and density achieves an Open Woodland vegetation classification (20% to 30% with an understorey of shrubland (30%) as outlined in **Section 3.2.1**), the fuel loads of the site will be similar to the existing vegetation (**Figure 7**). The slopes of the land from the Swan River eastward to the Avon Ridge Estate varies between 10° to 20°. It is known that the rate of forward spread of bushfires in this landscape double for every 10° increase in slope. As some areas are 15° to 20° slope, the rate of spread is up to 4 times that of flat land. Therefore the greatest factor influencing the rate of spread in this landscape is the slope and not the increase in vegetation in the areas that are being revegetated. Furthermore, revegetation is targeted for a relatively small area (24.3 ha) of the entire PR Reserve (393 ha) and therefore, the proposed revegetation within the PR Reserve is not considered to significantly increase the bushfire risk.

### 5.3.2 Wetland and Creekline Conservation Area

The vegetation in the Wetland and Creekline Conservation Area was classified in accordance with AS3959 *Construction of buildings in bushfire-prone areas*. The vegetation classification mapping for this area is shown in **Figure 10** and is described as Open Woodland over Closed Heath in the creekline to Open Forest moving upslope to the west and east.

Using the *Prescribed Burning Methodologies for Safe and Effective Burning* (FESA and Conservation and Land Management (CALM) 2004), fuel loads in the Open Forest were calculated at 15 tonne/ha as at July 2014.

### 5.3.3 Southern Public Open Space

The Southern POS area is outside and south of the site (see **Figure 11**).The vegetation in the Southern POS area was classified in accordance with AS3959 and the vegetation classification mapping for this area is shown in **Figure 11**. The vegetation in the western portion of the Southern POS varies from Open Grassland with small areas of Woodland over Grassland. Generally this vegetation is considered to be “Degraded” in accordance with the Bush Forever vegetation condition rating system (Government of Western Australia 2000) and using the *Prescribed Burning Methodologies for Safe and Effective Burning* (FESA and CALM 2004), fuel loads can be calculated. Fuel loads in the Grassland would be approximately 4.5 tonnes/ ha at the peak but are heavily grazed by kangaroos and would be approximately 2 to 3 tonnes/ha during the summer months. Given the vegetation condition of this area (being “Degraded”), the fuel load is not expected to change significantly over time.

The vegetation in the eastern portion of the Southern POS (east of the western arm of Connemara Drive) varies from Low Shrubland, Woodland over Sparse Shrubland to Open Forest. In the Open Forest fuel loads are a total of 14 tonnes/ha (as at July 2014).

## 5.4 Hazard reduction burning

Hazard reduction burning is a tool that can be used to help achieve fire management objectives (FESA and DEC 2000). Hazard reduction burning (or prescribed burning) is defined as the planned application of fire, under pre-determined environmental conditions and within defined geographical boundaries to reduce fuel in an area that can significantly reduce fire behaviour and fire suppression activities. Land managers from government and non-government agencies in Western Australia utilise hazard reduction burning to achieve management objectives. These management objectives include:

- Protection of human life, private property and assets from the effects of wildfire.
- Environmental management (flora and fauna habitat).
- Regeneration of degraded sites.
- Management of land (silviculture/forest revegetation).

Hazard reduction burns for the site are planned over a number of years, to create a mosaic of differing fuel ages and loads. This is appropriate for biodiversity retention, as it allows fauna to disperse and maintains the diversity within the plant communities over the site. The creation of this mosaic of differing fuel ages and loads will also allow Black Cockatoo species to continue to use the site as the cool nature of the burns will not affect the majority of the foraging species. Advice from the Western Australian Museum has noted that properly conducted hazard reduction burns have not reduced

foraging habitat at Department of Defence training areas at Bindoon situated north of the site (Office of the Appeals Convenor 2008).

The hazard reduction burning program primarily considered the staging plan, followed by assessing the fuel load levels across the site. To reduce fuel loads prior to the sale of lots, areas most likely to be impacted by high fuel hazard were prioritised. Hazard reduction was proposed in areas interfacing the eastern boundary first followed by areas along the northern boundary. The proposed areas and timing for this hazard reduction burning (based on the current staging plan) are shown in **Figure 12**. The hazard reduction burning program commenced in 2013 and an update to the program is provided in **Section 5.5**. The hazard reduction burn boundaries as shown in **Figure 12** are based on the constructed firebreaks (both in-lot and strategic) firebreaks, existing tracks and the boundary between the subdivision stages.

The hazard reduction burning has been scheduled to provide new lot owners with a subdivided lot that has a reduced fuel loading and complies with the FMP at the time of sale.

Planning for prescribed burning involves determining and arranging the following:

- Fuel loadings
- Forecast weather conditions (taking into consideration smoke management)
- Fire management resources
- Traffic control and access
- Notification of nearby lot owners and residents
- Post burn review.

The burn prescription for Avon Ridge Estate have been developed in consultation with the City of Swan. Experienced fire fighters and fire appliances will be used to carry out all hazard reduction burns. The preference is that Bush Fire Brigades from the City of Swan are used; however this will depend on personnel and equipment availability. The Brigades will be coordinated by an experienced fire manager acting on behalf of Peet.

Hazard reduction burning is prohibited during “Prohibited Burning Times”, pursuant to the *Bush Fires Act 1954* (for the 2014/15 period this is December 1st to March 31st inclusive) and also on days when the Fire Danger Index reaches “Very High” to “Catastrophic”. During “Restricted Burning Time”, permits are required from the local Fire Control Officer for any burning pursuant to the *Bush Fires Act 1954*. The timing for hazard reduction burning within the development site will need to comply with these requirements. In addition, smoke management guidelines as contained in the City of Swan firebreak and hazard reduction notice, *Your Guide to the 2014/15 Fire Season* (**Appendix C**) are required be complied with.

The aim of any hazard reduction burn will is to reduce fuel loads by 60% across 80% of the proposed burn area. The burn is primarily confined to the understorey layer, with the intention to cause no more than 20% overstorey crown scorch. Any hazard reduction burn will be carried out in the September to October period so as to achieve a low intensity burn and low scorch height. A hazard reduction burn will also encourage natural recruitment of native plants and avoid any potential impacts caused by lot owners undertaking cool burns in an ad-hoc manner in the first few years of being on their property which could potentially degrade remnant vegetation. Completing a hazard reduction burn prior to development will provide a high level of community protection as fuel loads will be significantly reduced prior to people living in the area.

In addition to prescribed burns as proposed, fuel loads within the Avon Ridge Estate are also maintained in compliance with the City of Swan *Your Guide to the 2014/15 Fire Season* (**Appendix C**). These include:

- Maintenance of fire service access routes on an annual basis.
- Maintenance of firebreaks by land owners of purchased individual lots or by Peet for unsold created lots on an annual basis.
- Maintenance of existing access tracks within undeveloped areas to current standards (4 to 6 m) to enable fire appliance access and separation of areas of remnant vegetation.
- Hazard reduction in compliance with Building Protection Zone (BPZ) and Hazard Separation Zone (HSZ) requirements in lots with established dwellings undertaken by lot owners on an annual basis. Indicative BPZ and HSZ for lots interfacing the Southern POS are shown in **Figure 13**.

Should the undertaking of the prescribed burn be delayed due to unforeseen circumstances such as unsuitable weather conditions and the unavailability of personnel to conduct, DFES will be informed and the proposed prescribed burn be planned for the following year.

The City of Swan *Your Guide to the 2014/15 Fire Season* (**Appendix C**) specifically outlines the requirements for lot owners with regards to:

- Installation of firebreaks.
- Maintenance of grass heights
- Installation and maintenance of the BPZ including acceptable bushfire fuel loads
- Installation and maintenance of the HSZ including acceptable bushfire fuel loads
- Adherence to measures outlined within an approved Fire Management Plan.

The firebreak notice also outlines the City of Swan options for enforcing compliance with the notice including entering onto the land to carry out the requirements of the notice at the expense of the lot owner, plus financial penalties. A similar notice is expected to be issued over coming years to provide lot owners and the general community information regarding the City of Swan's expectations with regards to fire management.

## 5.5 Proposed burning times

### 5.5.1 Update on prescribed burns (2013-14)

**Table 4** below outlines the initial proposed burn plan and details the actual burn pan outcomes.

*Table 4: Proposed prescribed burn plan*

| PROPOSED PRESCRIBED BURN PLAN TIMING | RECORD OF BURN | NOTES |
|---|---|---|
| 2013 | Burn was undertaken on 19th to 23rd June, 2013 | Patchy burn with 80% fuel reduction over approximately half of the burn area. |
| 2014 | Burn was undertaken on 3rd to 6th October 2014 | Patchy burn with 80% fuel reduction over the area. |
| 2015 | Not yet conducted | N/A |
| 2016 | Not yet conducted | N/A |

The prescribed burn which was initially proposed for 2010 in the 2010 RFMP was partially undertaken between the 19th and 23rd June 2013 as shown above in **Table 4** and spatially in **Figure 12**. This was undertaken by the East Swan Volunteer Bushfire Brigade who were contracted by Peet. Additional areas outside of the proposed "2010" area were also burnt. The weather conditions during the burn period ranged from 18°C to 20°C and 32 to 49% relative humidity at 3pm. Edge burns were conducted on the northern, western and eastern sides at night on the 19th and 20th of June 2013 (**Figure 12**). Some pockets were burnt out during the day over the period as required. The prescribed burn resulted in a patchy burn with 80% fuel reduction achieved over approximately half of the proposed burn area.

The remainder of the area proposed for 2010 and additional areas were burnt between the 3rd and 6th October, 2014 resulting in a good quality low intensity burn. This was undertaken by twenty volunteers utilising six appliances from the East Swan Volunteer Bushfire Brigade who were contracted by Peet. The burn commenced on the evening of the 3rd of October 2014 and concluded on the 6th of October 2014. As part of the burn preparation, Brigade personnel raked fuel away from habitat trees so that they did not catch on fire during the hazard reduction burn. The burn commenced about 1600hrs and was completed by 2100hrs. The burn resulted in a patchy burn with 80% of the burn area where fuel was successfully reduced. The 20% of unburnt area were rocky areas or low fuel areas. The hazard reduction burn achieved the burn objective of 60 to 80% of the area burnt.

Although there has been a delay in undertaking the prescribed burning, the delay has not impacted on the achievement of fire management objectives as lots have not be released until such time as fuel loads have been appropriately reduced.

### 5.5.2 Management plan actions and future management

A prescribed burn plan has been developed by the fire management consultancy, FirePlan WA in liaison with DFES and the City of Swan over the Avon Ridge Estate. It is proposed that hazard reduction burns be undertaken in four stages, to reduce the direct impact on local fauna and minimise landscape impacts. The location and timing of each burn is shown in **Figure 12**.

Prescribed burns will continue and this may involve East Swan Volunteer Bushfire Brigade (or other volunteer brigade). DFES and the City of Swan will be informed by Peet's appointed FMC of the completion of prescribed burns. Should prescribed burns be delayed or not undertaken as proposed within this 2015 RFMP a revised prescribed burn plan will be forwarded to DFES.

Should hazard reduction burning be unable to be performed prior to the creation of lots, alternative fire management measures to reduce fuel loading will be prescribed by the FMC prior to lot sale. These

alternative fire management measures may include the clearing of accumulated woody debris, removal of leaf litter and dead plant material, the use of grass-selective herbicides or the slashing of parkland cleared areas. These fire management measures are described within the FMP provided as **Appendix A**.

## 5.6 Vegetation Modification

### 5.6.1 Management plan actions

Following development and sale of lots, fuel reduction management will need to be undertaken by the individual lot owners in accordance with the FMP (**Appendix A**). The FMP will be supplied to all lot owners and there will be a notification on the title that the FMP must be adhered to and complied with.

Lot owners are permitted to clear vegetation (excluding identified habitat and significant trees identified for retention) within the prescribed "Building Envelope Area" (as shown in **Figure 9**). Building Envelopes Areas have been designated over all lots in the subdivision area to protect environmental values of the site such as creeklines and creekline buffers, areas of "Pristine" and "Excellent" condition vegetation, known Priority Flora locations and Potential Priority Flora habitat.

The Building Envelope Area includes the "building envelope" which is an area where the dwelling and any outbuildings need to be contained. The Building Envelope Area also identifies the area where vegetation with the BPZ and HSZ can be modified in accordance with the FMP. The provisions of the Outline Development Plan (ODP) (as endorsed by the City of Swan) state "Building Envelopes are to be no more than 10% of the Gross Lot Area". Peet will provide a service to purchasers to have the building envelope, BPZ and HSZ within their lot inspected by a qualified FMC (at Peet's cost) to ensure compliance prior to the commencement of any in lot clearing.

Several measures and processes are in place to ensure the vegetation modification is undertaken and maintained in the long term by the lot owner. Peet's appointed FMC will undertake the following assessments:

- BAL (Bushfire Attack Level) rating assessment in accordance with AS3959.
- Pre-clearing checklist to identify trees and shrubs requiring vegetation modification.
- Post-clearing checklist to confirm vegetation modification has been undertaken.

The FMC will also provide the following information to the lot owner:

- The DFES "Bushfire Ready" publications and contact details of the local bushfire brigade who can undertake hazard reduction burns on the lot owner's behalf.
- Bushfire hazard regulations imposed and enforceable by the City of Swan on an annual basis.
- Establishment of the Avon Ridge Estate Bushfire Ready Group (BRG) and encourage lot owners to participate.

The provision of site specific inspections and advice by the FMC will enable lot owners to install and maintain the BPZ and HSZ, and will result in a high level of preparedness of lot owners to reduce fuel hazards within lots. Peet will also provide lot owners purchaser information as part of the contract of sale which explains the requirement of BPZs and HSZs, the role of the FMC and other fire management information.

### 5.6.2 Role of Fire Management Consultant in vegetation modification

The FMC's role is to ensure fuel reduction is undertaken within purchased lots whilst retaining identified habitat and significant trees in accordance with the FMP. The site specific fuel hazard assessment undertaken by the FMC is summarised in a flowchart (**Appendix D**) and is described in more detail below.

The lot owner is firstly required to inform Peet of the proposed house design and building envelope. Peet then arranges the initial inspection by the FMC to inspect the lot to determine if the building envelope is in the correct location. The lot owner is encouraged to be present during the inspection to familiarise themselves with and attain knowledge of the BAL assessment process and fuel hazard reduction requirements. If the building envelope is determined to be in the correct location by the FMC, a BAL assessment will be undertaken in accordance with AS3959 and the lot owner can proceed with an application for a building license from the City of Swan.

At the initial inspection by the FMC, should the FMC determine that the building envelope is not in a correct position, a suitable building envelope will be chosen by the lot owner in consultation with the FMC and a pre-clearing site check and BAL assessment will follow. The lot owner can then proceed with the building licence application at the City of Swan as described below.

The BAL assessment determines the building construction requirements to withstand bushfire attack. The BAL assessment takes into account a number of factors including the Fire Danger Index, the slope of the land, types of surrounding vegetation and its proximity to any building. Specific advice on modification of vegetation within the BPZ and the HSZ will be prepared and the information recorded in a pre-clearing checklist. During the site assessment and in accordance with the Protective Covenant, the FMC identifies and labels individual trees and identifies areas of leaf litter and fuel load to remove to attain the fuel load requirements in the BPZ and HSZ as well as advising lot owners on ongoing maintenance requirements to maintain low fuel load levels. The FMC will consider the requirements to meet the BPZ and HSZ in accordance with the FMP while avoiding extensive clearing. The lot owner submits to the City of Swan the position of building envelope, location of vegetation and completed BAL assessment.

Following the issue of a building licence by the City of Swan, the land owner undertakes vegetation modification in accordance with the completed pre-clearing checklist and Protective Covenant. Following vegetation modification, the FMC conducts another site inspection prior to occupancy and completes a post-clearing checklist to confirm that the vegetation modification has been completed in accordance with the advice provided in the pre-clearing checklist and onsite inspection.

### 5.6.3 Role of Fire Management Consultant in ongoing fuel load maintenance and fire management

In addition to providing site specific advice to the lot owner as part of the building process, the FMC will also provide the lot owner with information regarding ongoing maintenance of fuel loads and fire management requirements.

Information provided to the lot owner include:

- DFES produced and supplied publications and DVDs such as *Homeowners Bushfire Survival Manual* and *Winter Burning Guide – Controlled burns in winter may help to protect your home this summer*.

- Referral to the East Swan Volunteer Bushfire Brigade for further information and to engage them to undertake hazard reduction burns on their lot if they are not comfortable in conducting the burning.
- Awareness of the establishment of the Avon Ridge Estate Bushfire Ready Group (BRG).

Establishing a BRG which is DFES program will increase the resilience of a community to bushfire risk and will be initially be supported by Peet. The inaugural Avon Ridge Estate BRG meeting has been planned for Spring 2015. Peet will organise and fund annual information sessions for Avon Ridge Estate residents attended by the FMC and representatives from DFES, the East Swan Volunteer Bushfire Brigade and City of Swan over three years. Information on how to form the Avon Ridge Estate BRG as well as fuel hazard reduction and bushfire readiness training and support by the agencies will be provided.

It is envisaged that following the initial support of Peet in organising the information session, the Avon Ridge Estate BRG will be established, coordinated by residents of Avon Ridge Estate and supported by DFES, the East Swan Volunteer Bushfire Brigade and the City of Swan.

In addition to providing bushfire hazard reduction information, the FMC will also inform the lot owner the City of Swan's bushfire hazard regulations. These include:

- The requirement to implement and maintain the BPZ and HSZ in accordance to the Firebreak Notice for the City of Swan under Section 33 of the *Bushfires Act 1954* (**Appendix C**). The FMC provides practical advice to lot owners on how to adhere to the bushfire hazard requirements.
- Notification of proposed Amendment No. 99 (Bushfire Amendment) to the City of Swan council Local Planning Scheme No. 17 (City of Swan 2013) which will, amongst other amendments identify bushfire prone areas (BPA) within the City of Swan and designate all bushfire prone areas into the Special Control Area under the City's Local Planning Scheme No 17. Currently, the entire Avon Ridge Estate falls within a proposed BPA and under Clause 6.5.6 of the proposed amendment (Development and subdivision of land within a BPA) (City of Swan 2013) the local government may apply conditions of planning approval including "*implementation of specific fire protection measures*" which may include the BPZ and HSZ within lot owners' lots.

### 5.6.4 Future management

Maintenance of the BPZ and HSZ can be undertaken through prescribed burning or hazard reduction through mechanical means. From information provided by the FMC as outlined in the previous section (**Section 5.6.3**), lot owners will undertake fuel reduction within their own lots. The need for and timing of any future fuel reduction burns will be based upon the rate of fuel accumulation which will differ across the site based on the type and density of vegetation. In accordance with the FMP, lot owners will need to maintain their fuel loadings within lots as follows (see **Figure 13**):

- Within the BPZ at less than or equal to (≤) 2 tonnes per hectare (t/ha).
- Within the HSZ at ≤ 4 to 6 t/ha.
- Beyond the HSZ at ≤ 6 to 8 t/ha.

Therefore, the nature of future fuel reduction measures will be based on the need to meet the fuel loading targets as outlined in the FMP, and given the variation in vegetation condition and density across the site, and the fact that different fuel reduction methods may be adopted, it is extremely unlikely that extensive areas of the Avon Ridge Estate will be subjected to fuel reduction measures (including cool burns) in the same year. It is more likely that this will be undertaken across different

years and with different temporal frequencies which will create an overall mosaic of fuel loads across the development.

Additionally, lot owners can reduce fuel loads through mechanical and chemical methods including:

- controlling environmental weeds
- mowing or slashing of grass weeds
- herbicide treatment of weeds
- pruning of vegetation
- raking and disposal of dead leaves and branches
- utilising green waste collection services.

Lot owners will be required to reduce their fire hazards prior to the summer fire season and will need to undertake their fuel reduction in conjunction with the maintenance of firebreaks, which are required to be cleared under Section 33 of the *Bush Fires Act 1954* (for 2014/15 this is from November 2nd until 30th April).

## 5.7 Conservation and Public Open Space areas within the subdivision area

Native vegetation within the Wetland and Creekline Conservation Area and a Southern POS to the south of the subdivision pose a bushfire threat to adjacent lots. To ensure that lots are not exposed to BAL-29 or higher and therefore considered an acceptable risk, a combination of setbacks and higher building construction will be applied to homes. This is discussed in more detail below.

### 5.7.1 Wetland and Creekline Conservation Area

All habitable buildings in lots that are located adjacent to the Wetland and Creek Line Conservation Area of the site are to be setback a minimum of 60 m from the edge of the Wetland and Creek Line Conservation area boundary. This will be implemented through a Detailed Area Plan (DAP) for the relevant stages of land release.

A 60 m zone of modified vegetation will be created around each habitable dwelling (in accordance with the FMP (Fireplan WA 2013)), which will include a 20 to 30 metre wide BPZ (determined by onsite assessment by a FMC, as discussed further in **Section 5.6**) and a 20 to 40 metre HSZ. In accordance with the FMP, fuel loads are to be maintained below 2 tonnes/ha in the BPZ and below 4 to 6 tonnes/ha in the HSZ and are to be maintained by the lot owner in perpetuity. Management of the BPZ and HSZ to the standards detailed in a FMP are enforceable by the City of Swan through the City of Swan Firebreak Notice (**Appendix C**).

In accordance with the FMP (Fireplan WA 2013) habitable buildings within this location are to be constructed to BAL 29 (BAL 29 has a heat Flux of less than 19 Kw/$m^2$ to 29 Kw/$m^2$).

In order to understand the potential fire behaviour associated with the Wetland and Creekline Conservation Area, Fireplan WA undertook fire behaviour calculations to demonstrate the acceptability of the proposed fire management measures.

Rates of spread and fire intensity were calculated for the Wetland and Creekline Conservation Area based upon inputs shown in **Table 5** with the results provided in **Table 6**.

*Table 5: Fire behaviour calculation inputs for the Wetland and Creekline Conservation Area*

| PARAMETERS | VALUE | SOURCE |
|---|---|---|
| Air Temperature (°C) | 33 | Bureau of Metrology (2014) |
| Relative Humidity (%) | 30 | Bureau of Metrology (2014) |
| Wind Speed (km /h) | 20 | Bureau of Metrology (2014) |
| Fuel Load (tonnes /ha) | 15* | Fireplan WA See **Section 5.3.2** |
| Drought Factor | 6 | McArthur Forest Fire Danger Meter Mk5 |
| Modifier | x1 | McArthur Forest Fire Danger Meter Mk5 |

*Open forest vegetation

*Table 6: Fire behaviour results for the Wetland and Creekline Conservation Area*

| SLOPE | RATE OF SPREAD OF BUSHFIRE | FIRE INTENSITY (FROM FIRE BEHAVIOUR FORMULAS – FESA 2013) |
|---|---|---|
| Flat ground | 238 m/hr | Not applicable to the site |
| 10° | 476 m/hr | 3,570 Kw/m |
| 15° | 666 m/hr | 4,996 Kw/m |

The fire intensity values provided in **Table 6** can be used in conjunction with the relevant fuel type from the *Guide and Tables for Bushfire Management in Western Australia* (FESA 2011b)) to determine acceptable firefighting methods. For a bushfire with an intensity of <2000 Kw/m and/or a rate of spread <400 m/h in forest or woodland a direct machine and tanker attack would be possible if the fire started in the morning or late afternoon of a day with the weather conditions detailed above. If the fire intensity was greater than 4000 Kw/m then an indirect attack (such as a back burn) would possibly succeed.

Research conducted by Gould *et al.* (2003) noted that "*The relationship describing the effect of head fire width and wind speed on rate of spread in forest fires were similar to that for grass fires. The head fire width required to realise the potential rate of spread increases with increasing wind speed. At wind speeds in excess of 20 km/ hr the head fire width to achieve the potential rate of spread of forest fires is likely to be greater than required for fire in open grasslands or grassy woodlands and is probably in excess of 300 metres. Forest Fires during their build up period can maintain quasi-steady rates of spread that are well below their potential rates of spread for several hours …..*"

The Wetland and Creekline Conservation Area is 77 m at its widest point (**Figure 10**), with the creekline running north-south. This means that a bush fire starting to the north of the edge of the Avon Ridge Estate would first burn up the narrow creek line then upslope towards habitable buildings. The proposed 60 m setback to habitable dwellings and the implementation of a BPZ and HSZ in this area (minimum 60 m) means that the head fire width of 300 m is unlikely to be reached and therefore the rate of spread (and the fire intensity) is less than predicted in the calculations.

From AS3959 (Method 2 Section 2.1) the heat flux onto building at 10° upslope and 10 tonnes /ha will be:

- 20 metres from the building – 20.33kw/m²

- 40 metres from the building – 8.83 kw/m²
- 60 metres from the building – 4.86 kw/m²

As previously discussed construction requirements for habitable buildings in lots adjoining the Wetland and Creekline Conservation Area is BAL 29 (heat flux of less than 19 Kw/$m^2$ to 29 Kw/$m^2$ (AS3959 Table 3.1)) and the 60 metres down slope from the habitable building is managed to 2 tonnes/ha in the BPZ and 4 to 6 tonnes/ha in the HSZ. Based upon the above, it is unlikely that the heat flux of a bush fire will exceed that of which the dwellings have been constructed to withstand (as the fuel loads surrounding the house will be reduced through the implementation of a BPZ and HSZ) and that the bushfire strategies and fire mitigation requirements detailed in the FMP (Fireplan WA 2013) are sound and effective.

### 5.7.2 Southern Public Open Space

All habitable buildings in lots that are located adjacent to the PR Reserve to the west and north and the Southern POS area to the south are to be setback a minimum of 60 metres from the strategic Firebreaks or fire service access ways and habitable building are to be constructed to meet BAL 29 (BAL 29 has a heat Flux of less than 19 Kw/$m^2$ to 29 Kw/$m^2$). This is detailed in the FMP (Fireplan WA 2013).

A 60 m zone of modified vegetation will be created around each habitable dwelling (in accordance with the FMP (Fireplan WA 2013), which will include a 20 to 30 metre wide BPZ (determined by onsite assessment by a FMC, as discussed further in **Section 5.6**) and a 20 to 40 metre HSZ. In accordance with the FMP, fuel loads are to be maintained below 2 tonnes/ha in the BPZ and 4 to 6 tonnes/ha in the HSZ and are to be maintained by the Lot owner in perpetuity. Management of the BPZ and HSZ to the standards detailed in a FMP are enforceable by the City of Swan through the City of Swan Firebreak Notice (**Appendix C**).

In order to understand the potential fire behaviour associated with the Southern POS, Fireplan WA undertook some fire behaviour calculations to demonstrate the acceptability of the proposed fire management measures.

Rates of spread and fire intensity were calculated for the Southern POS based upon inputs shown in **Table 7** with the results provided in **Table 8.**

*Table 7: Fire behaviour calculation inputs for the Southern POS*

| PARAMETER | VALUE | SOURCE |
|---|---|---|
| Air Temperature (°C) | 33 | Bureau of Metrology (2014) |
| Relative Humidity (%) | 30 | Bureau of Metrology (2014) |
| Wind Speed (km /h) | 20 | Bureau of Metrology (2014) |
| Fuel Load (tonnes /ha) | 14* | Fireplan WA See **Section 5.3.3** |
| Drought Factor | 6 | McArthur Forest Fire Danger Meter Mk5 |
| Modifier | x1 | McArthur Forest Fire Danger Meter Mk5 |

* Open forest vegetation

The outputs from **Table 8** can be used in conjunction with the fuel type (from *Guide and Tables for Bushfire Management in Western Australia* (FESA 2011b)) to work out the acceptable firefighting methods. For a bushfire with an intensity of less than 2000 Kw/m and or a rate of spread less than 400

m/h in forest or woodland a direct machine and tanker attack would be possible if the fire started in the morning or afternoon of a day with the weather conditions detailed above. If the fire intensity was greater than 2000Kw/m then an indirect attack (such as a back burn) would possibly succeed. It is also worthwhile noting that aerial water bombers are generally successful when fire intensity is less than 2000Kw/m when backed up by ground forces.

*Table 8: Fire behaviour results for the Southern POS*

| SLOPE | RATE OF SPREAD OF BUSHFIRE | FIRE INTENSITY (FROM FIRE BEHAVIOUR FORMULAS – FESA 2013) |
|---|---|---|
| Flat ground | 222 m/hr | Not applicable to the site |
| 5° | 310 m/hr | 2,170Kw/m |
| 10° | 444 m/hr | 3,108 Kw/m |

As outlined above, research conducted by Gould *et al.* (2003) noted that to achieve a maximum rate of spread a head fire width in excess of 300 m is potentially required. The Southern POS is 227 metres wide at the western edge measured from Campersic Road (**Figure 11**) and the creekline runs east-west through the centre of this area. The means that a bush fire starting on the edge of Campersic Road would first burn downslope before burning upslope toward the Avon Ridge Estate. On this basis, it is unlikely that a 300 m fire head width would be reached (before the fire enters a low fuel environment such as a BPZ or HSZ).

**Figure 13** shows that the BPZ and HSZs proposed for lots adjacent to this Southern POS area are overlapping creating an almost continuous low fuel area 60 metres wide protecting habitable buildings.

From AS3959 (Method 2 Section 2.1) the heat flux onto building at 10° upslope and 10 tonnes /ha will be:

- 20 metres from the building – 20.33kw/m²
- 40 metres from the building – 8.83 kw/m²
- 60 metres from the building – 4.86 kw/m²

As previously discussed building construction of habitable building in lots adjoining the Southern POS is BAL 29 (heat flux of greater than19 Kw/$m^2$ to 29 Kw/$m^2$ (AS3959 Table 3.1)) and the 60 metres down slope from the habitable building is managed to less than 2 tonnes/ha in the BPZ and less than 4 to 6 tonnes/ha in the HSZ. Given the implementation of a BPZ and HSZ on lots, it is unlikely that the heat flux of a bush fire will exceed that of which the dwellings has be designed to withstand and that the bushfire strategies and fire mitigation requirements detailed in the FMP (Fireplan WA 2013) are sound and effective.

## 5.8 Fire management in the Parks and Recreation Reserve

On 5th July 2012, the PR Reserve (Reserve 51076) was ceded to the WA State Government as part of the Stage 1 subdivision approval. The PR Reserve is currently managed by the Department of Lands and fire management is undertaken by DFES in accordance with a Memorandum of Understanding (MoU) that exists between the two departments. Notwithstanding this, the implementation of BPZs and HSZs in addition to increased construction levels will allow for protection of houses within the subdivision and is not dependent on the management of adjacent reserves

including the PR Reserve. Modelling undertaken by Fireplan WA for the adjacent reserves (Wetland and Creekline Conservation Area and the Southern POS) which pose a bushfire threat to the subdivision has been undertaken (**Section 5.3**) and demonstrated that through a combination of setbacks and building construction, lots are not exposed to BAL -29 or higher and therefore considered an acceptable risk.

## 5.9 Management of existing vegetation

In addition to the management of revegetation, the management of remnant vegetation within Avon Ridge Estate will be strictly controlled through a Construction Environmental Management Plan (Cardno 2010b) for the construction stage of development. Restrictive Covenants and notifications on Titles will be used to control clearing by future lot owners. All identified “habitat trees” which provide habitat for black cockatoo species will be clearly marked during the construction period and will be retained. The locations of habitat trees to be retained are listed in **Appendix E**. Trees over 500 mm Diameter Breast Height (DBH) (which are not "habitat trees") will also be marked during construction and retained unless these occur within a building envelope, BPZ, roads, strategic firebreaks and lot firebreaks.

Under the Protective Covenants, lot owners will not be able to clear vegetation other than what is required for dwellings, driveways, outbuildings and for fire management. In addition, prior to any thinning or clearing of vegetation for fire management by purchasers, the FMC is required to undertake a pre-clearing and post-clearing inspection as detailed in **Section 5.6.2**.

# 6 Conclusion

This 2015 RFMP provides the principles and methods to undertake revegetation over the site, including details on species selection and planting densities for proposed revegetation areas followed by monitoring and management of revegetation works. This RFMP also outlines fire management requirements such as fuel reduction, fire break installation and maintenance, role of a Peet appointed FMC and raising awareness of bushfire preparedness.

The RFMP has been prepared to satisfy:

- Condition 3 of the *Environment Protection and Biodiversity Act 1999* (EPBC Act) approval No. 2008/4250.
- An Outline Development Plan provision.
- Conditions for subdivision approvals for the site.

The objective of the RFMP is to mitigate the loss of Black Cockatoo habitat species whilst reducing the risk of bushfire for future Avon Ridge Estate residents. The key management issues are as follows:

- Revegetation measures will be undertaken in degraded areas within the PR Reserve to protect the area's landscape and ecological values and to enhance foraging habitat value for Black Cockatoo species.
- Plant species for revegetation will be selected for species diversity, plant form and include species that are known habitat for Black Cockatoo species.
- Species mix, number and density of plants for revegetation will be developed from advice from revegetation specialists with inputs from previous results and site conditions and DFES.
- Completion criteria of 90% survivorship at the end of three years will be met which has been based on EPBC Act approval conditions.
- A monitoring program will be undertaken by an appropriately qualified and experienced ecologist.
- Fuel reduction measures within the development will be implemented prior to the release of lots which includes prescribed burning in accordance with a prescribed burn plan.
- Fuel reduction measures within lots will include the role of the FMC who will supervise the implementation of the Building Protection Zone (BPZ).
- Potential Black Cockatoo breeding trees measuring 500 mm Diameter Breast Height (DBH) or greater will be retained by mapping locations of the trees, application of Protective Covenants and lot inspections undertaken by the FMC.

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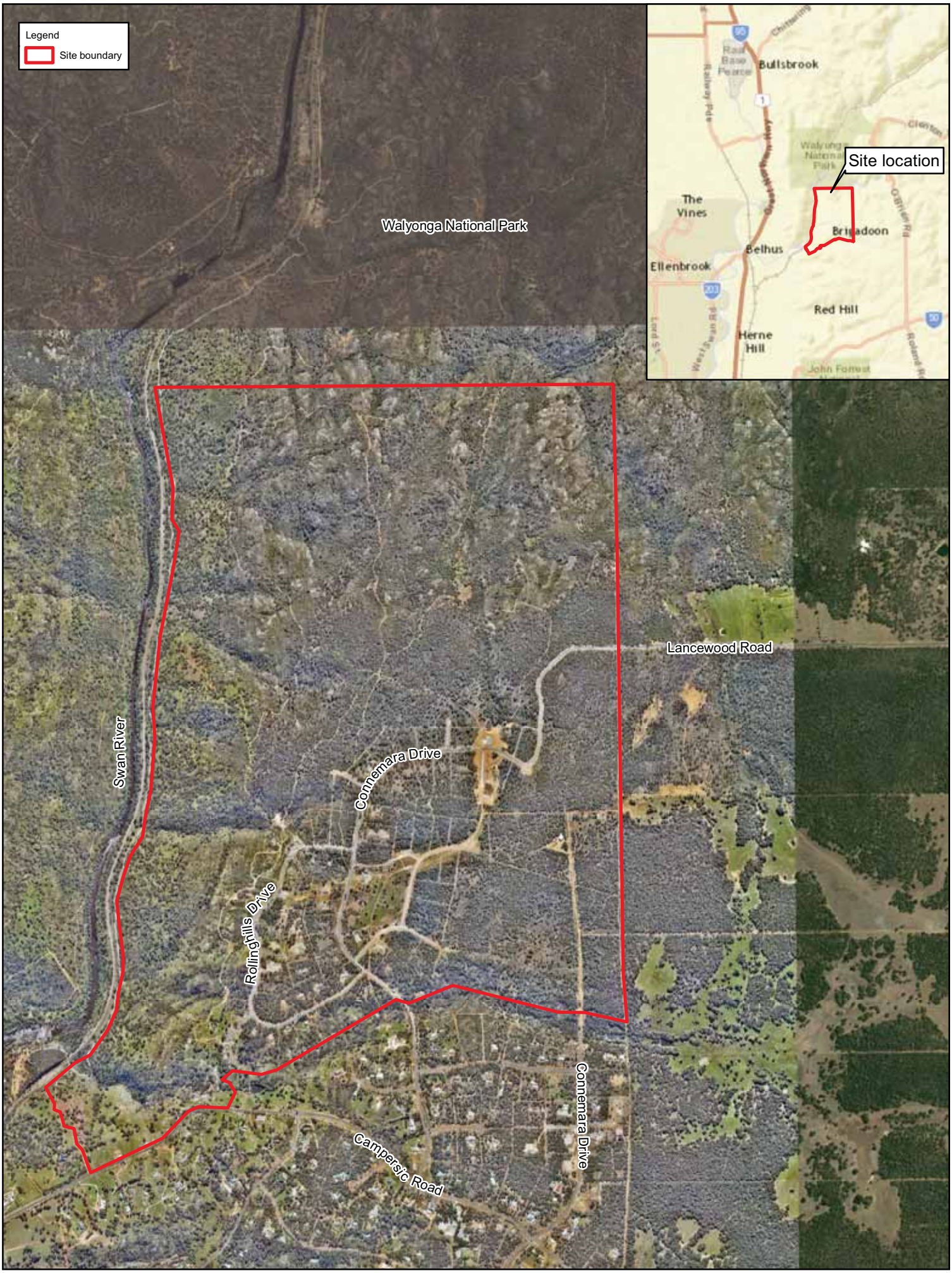
# FIGURES




| | | | |
|---|---|---|---|
| **Figure 1:** | **Site Locality** | **Plan Number: EP13-041(09)--F23** | |
| Project: | Revegetation and Fire Management Plan<br>Avon Ridge Estate Brigadoon | Drawn: GRO | Date: 23/02/15 |
| | | Approved: CKK | Date: 08/04/15 |
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emerge ASSOCIATES
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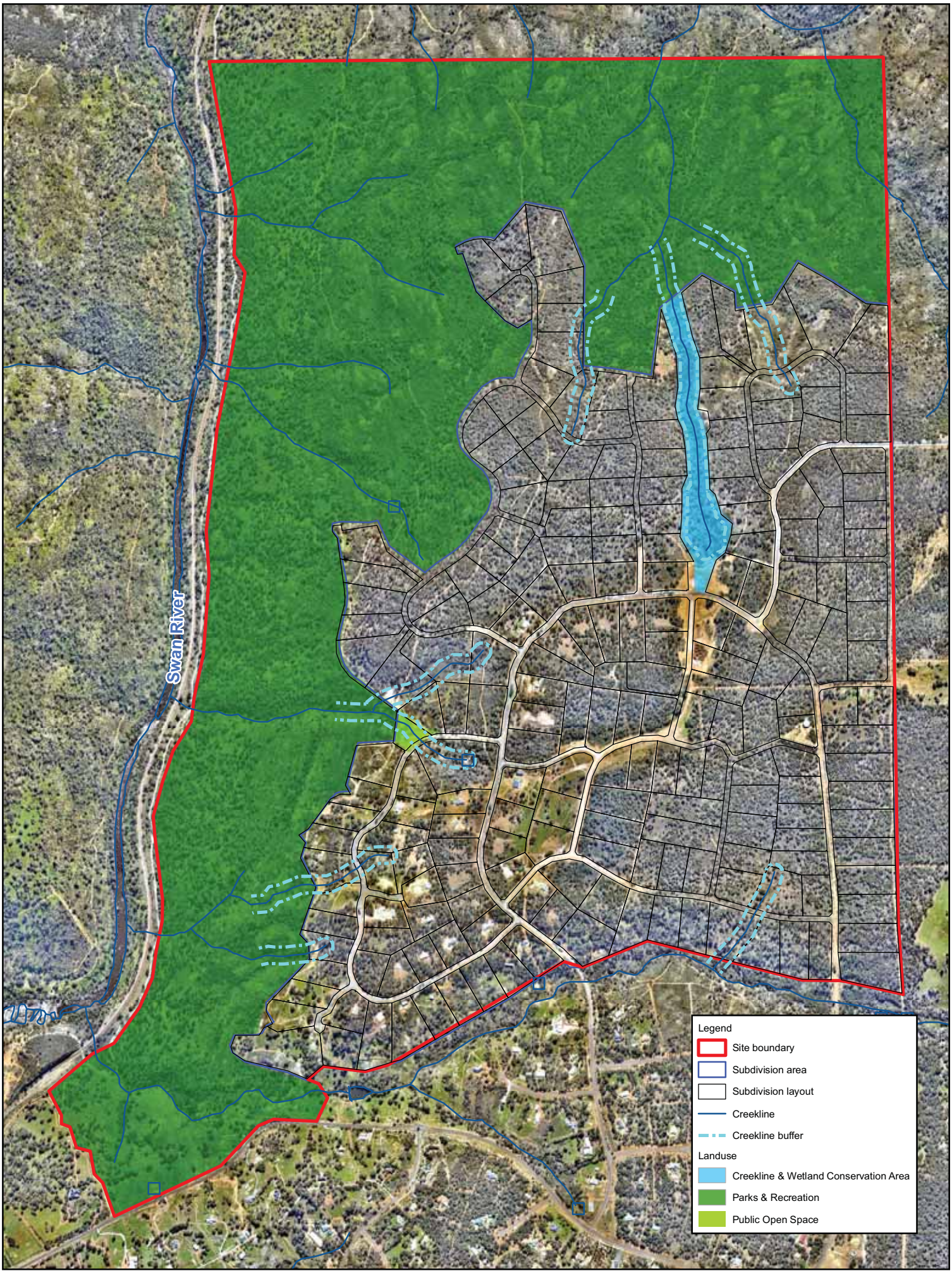


| | |
|---|---|
| **Figure 2:** | **Site Plan** |
| Project: | Revegetation and Fire Management Plan<br>Avon Ridge Estate Brigadoon |
| Client: | Peet Limited |

**Plan Number: EP13-041(09)--F24**

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emerge ASSOCIATES
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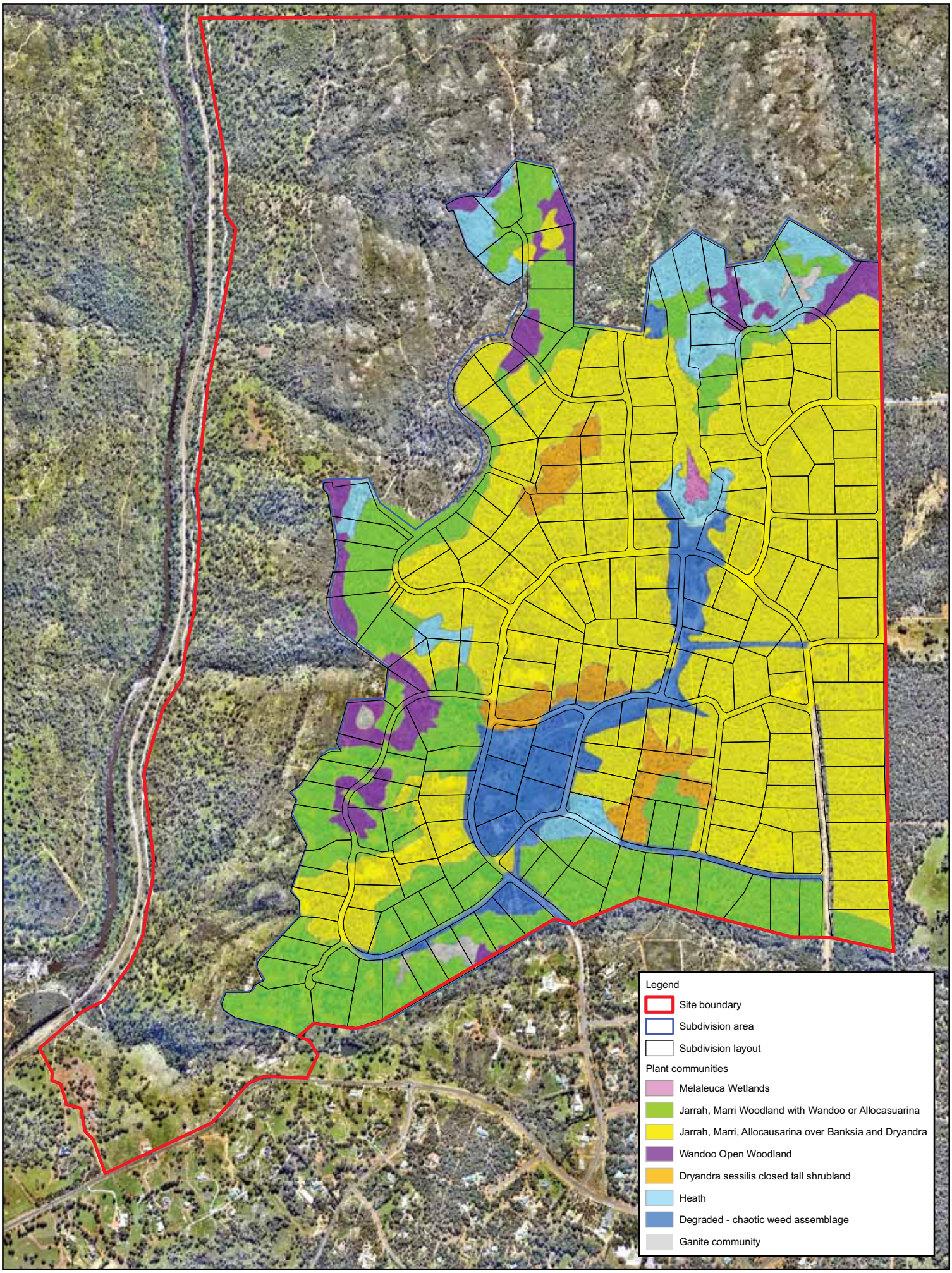


**Figure 3: Plant Communities within Avon Ridge Estate**

Project: Revegetation and Fire Management Plan
Avon Ridge Estate Brigadoon

Client: Peet Limited

**Plan Number: EP13-041(09)--F25**

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|---|---|---|---|
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| Approved: | CKK | Date: | 08/04/15 |
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Sources: The following datasets were used in the production of this map: Plant communities - Nicole Siemon and Associates (2006)

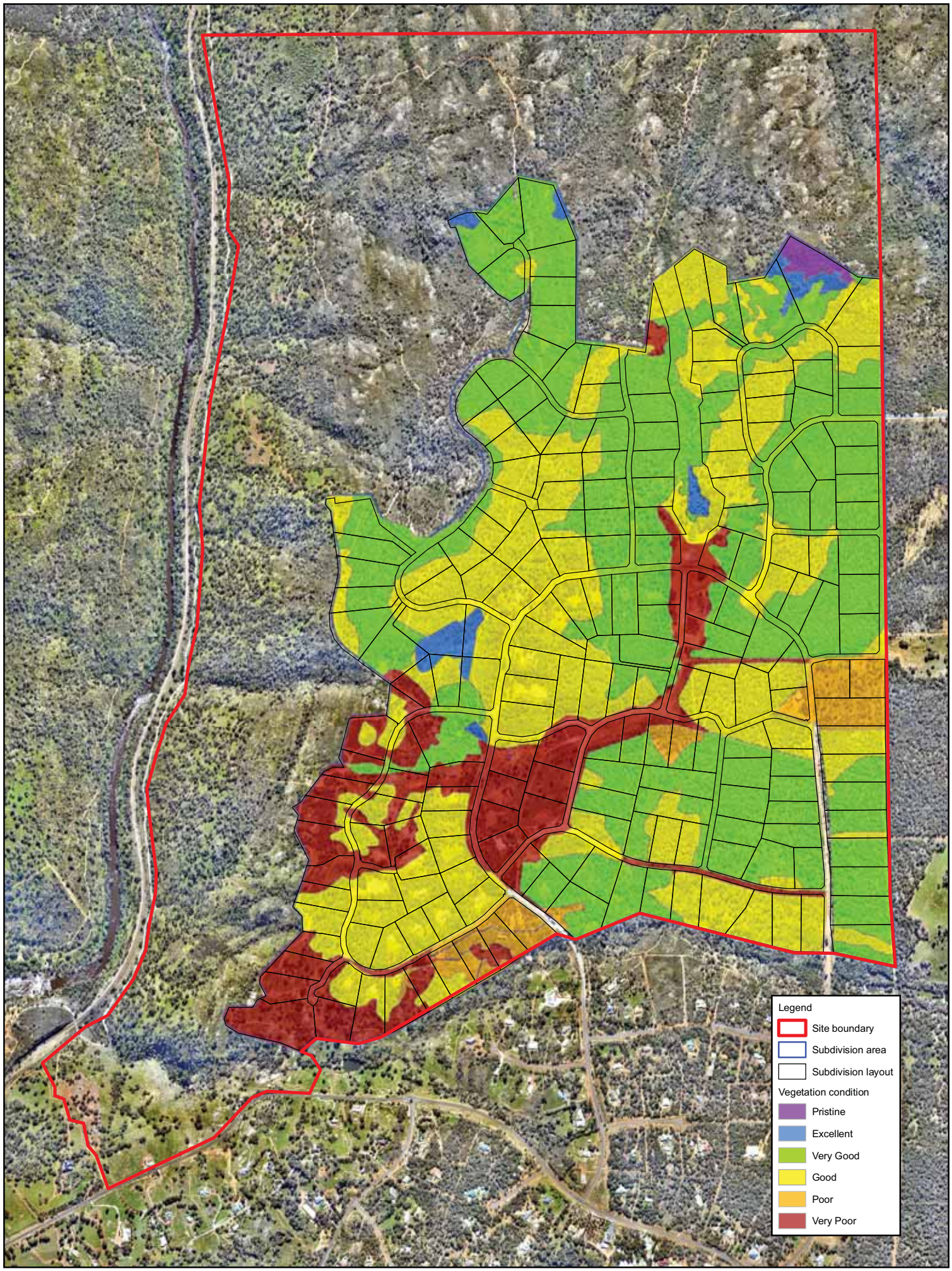


**Figure 4: Vegetation Condition within Avon Ridge Estate**

Project: Revegetation and Fire Management Plan
Avon Ridge Estate Brigadoon

Client: Peet Limited

**Plan Number: EP13-041(09)--F26**

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|---|---|---|---|
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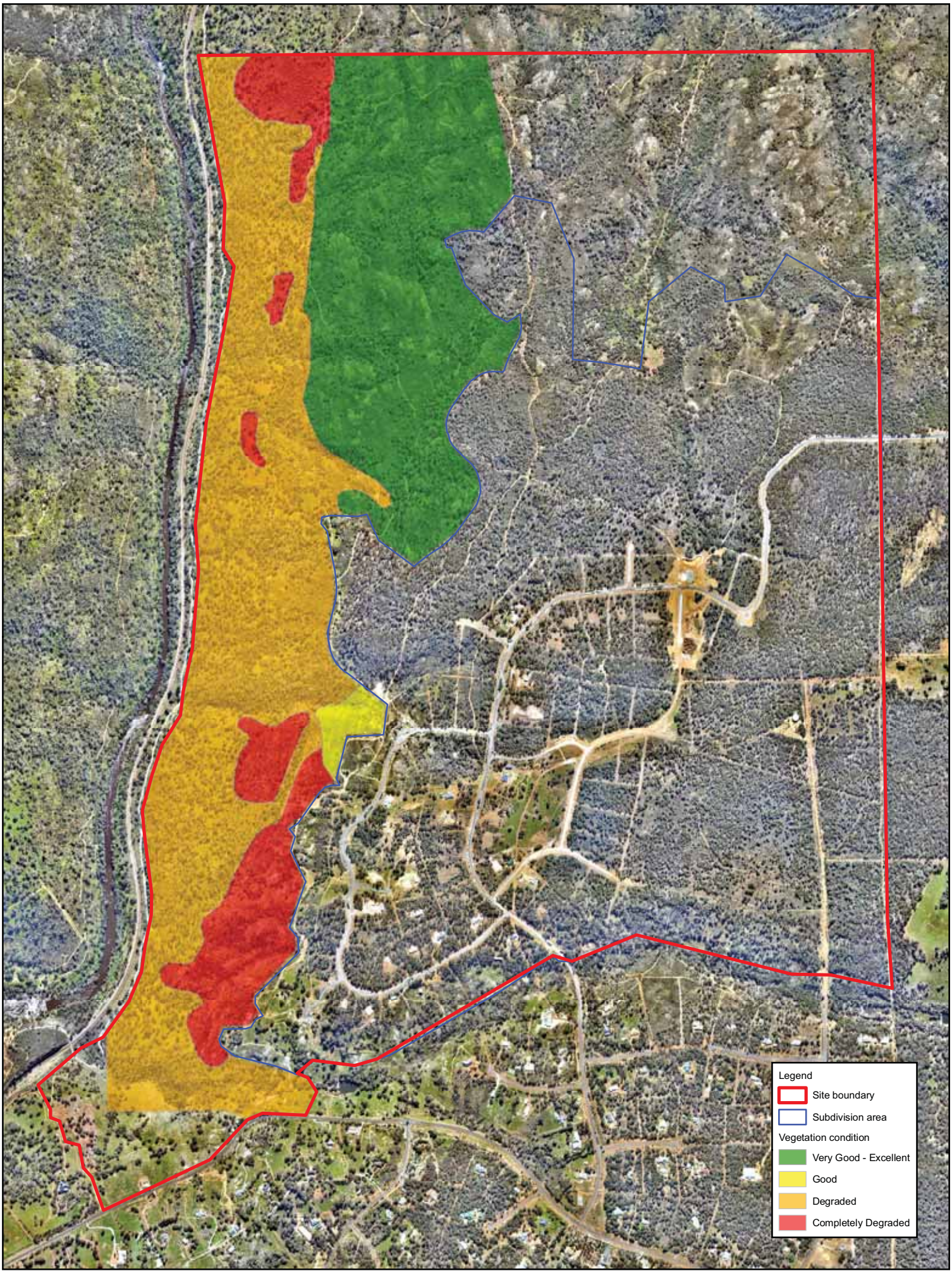
Sources: The following datasets were used in the production of this map: Plant communities - Nicole Siemon and Associates (2006)

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|---|---|
| **Figure 5:** | **Vegetation Condition within the Parks and Recreation Reserve** |
| Project: | Revegetation and Fire Management Plan<br>Avon Ridge Estate Brigadoon |
| Client: | Peet Limited |

| | | | |
|---|---|---|---|
| **Plan Number: EP13-041(09)--F27** | | | |
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emerge ASSOCIATES
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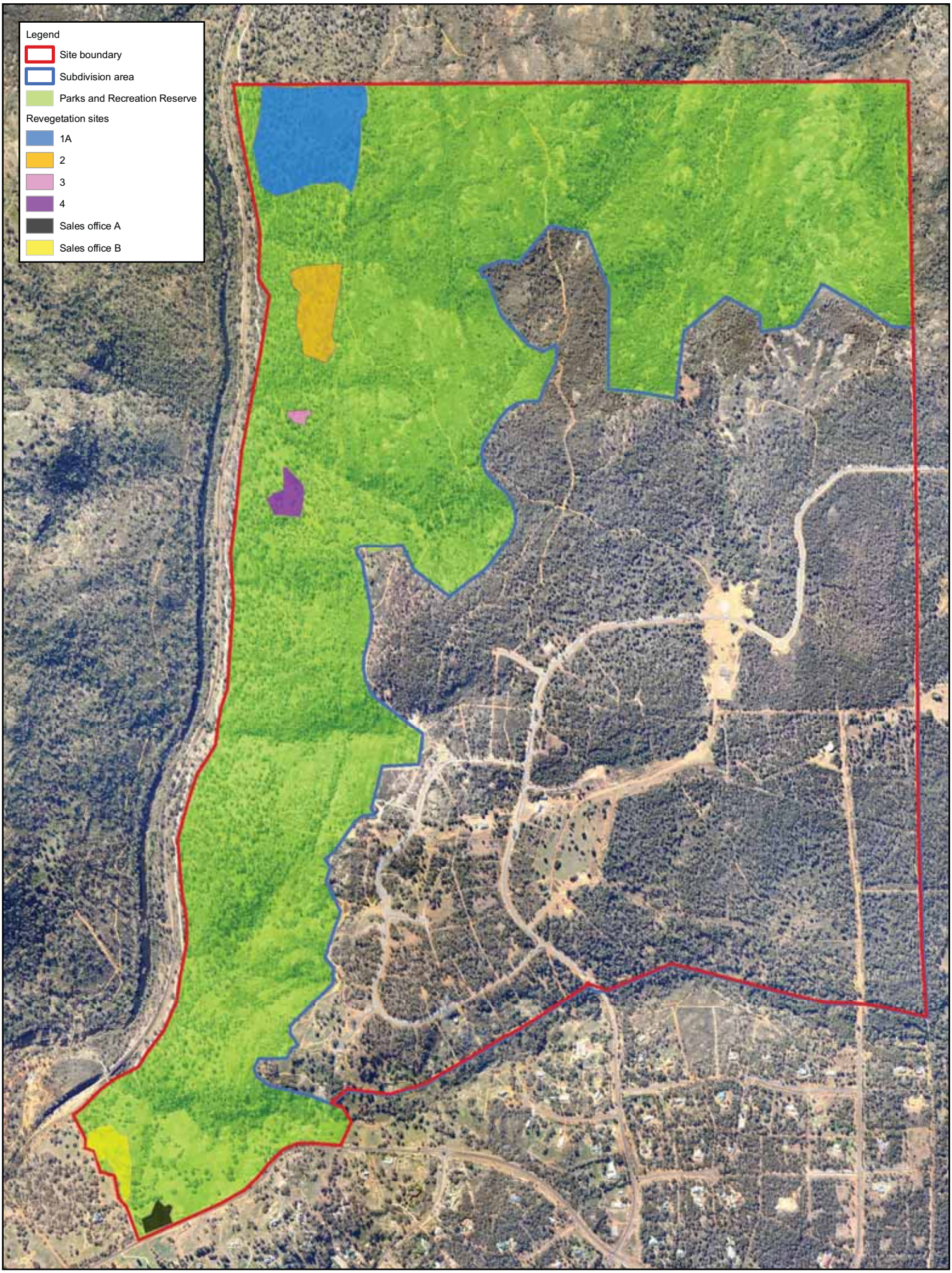
Sources: The following datasets were used in the production of this map: Plant communities - Cardno (2010)

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|---|---|
| **Figure 6:** | **Revegetation Sites Within the Parks and Recreation Reserve** |
| Project: | Revegetation and Fire Management Plan<br>Avon Ridge Estate Brigadoon |
| Client: | Peet Limited |

**Plan Number: EP13-041(09)--F28**

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emerge ASSOCIATES
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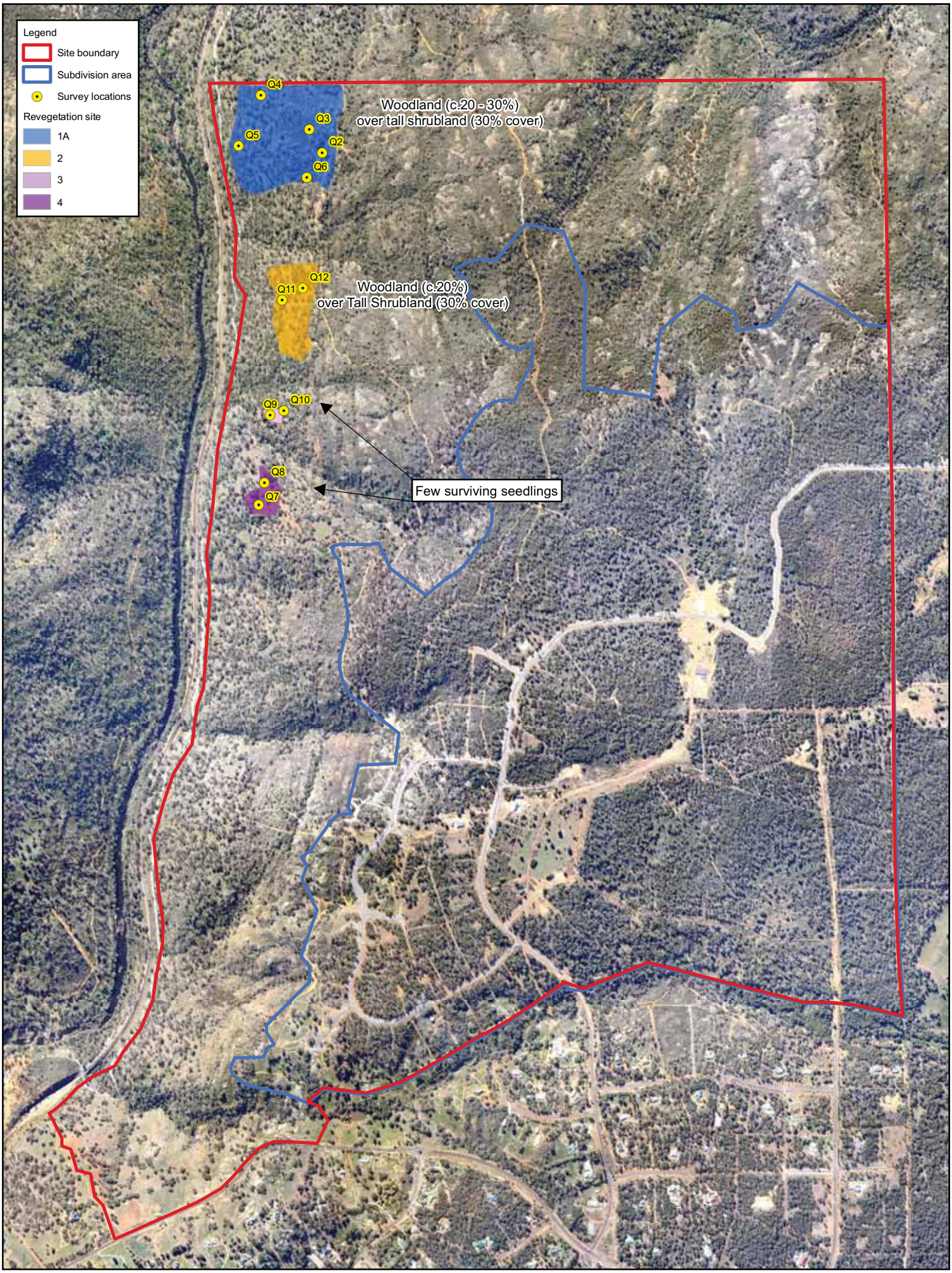
Sources: The following datasets were used in the production of this map: Parks and Recreation Reserve - DoP (2013)

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| **Figure 7:** | **Future Vegetation Classification of Revegetation Areas** | **Plan Number: EP13-041(09)--F34** | |
| Project: | Revegetation and Fire Management Plan<br>Avon Ridge Estate Brigadoon | Drawn: GRO | Date: 23/02/15 |
| | | Approved: CKK | Date: 08/04/15 |
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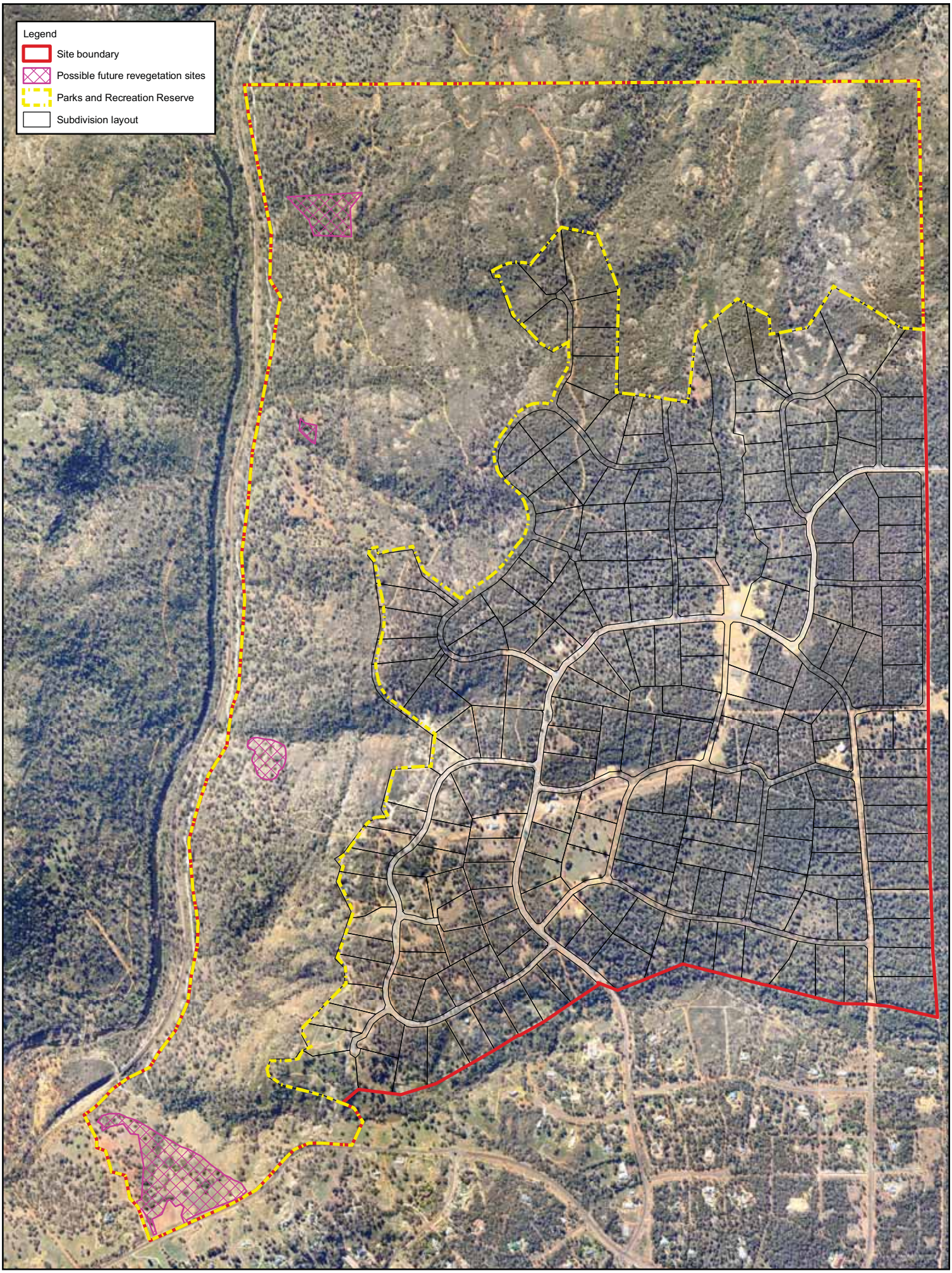


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|---|---|
| **Figure 8:** | **Future Revegetation Sites within the Parks and Recreation Reserve** |
| Project: | Revegetation and Fire Management Plan<br>Avon Ridge Estate Brigadoon |
| Client: | Peet Limited |

**Plan Number: EP13-041(09)--F29**

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0 150 300 600 Metres

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Sources: The following datasets were used in the production of this map: Parks and Recreation Reserve - DoP (2013)


**Figure 9:** **Strategic Firebreak and Building Envelope Area Plan**

Project: Revegetation and Fire Management Plan
Avon Ridge Estate Brigadoon

Client: Peet Limited

**Plan Number: EP13-041(09)--F32**

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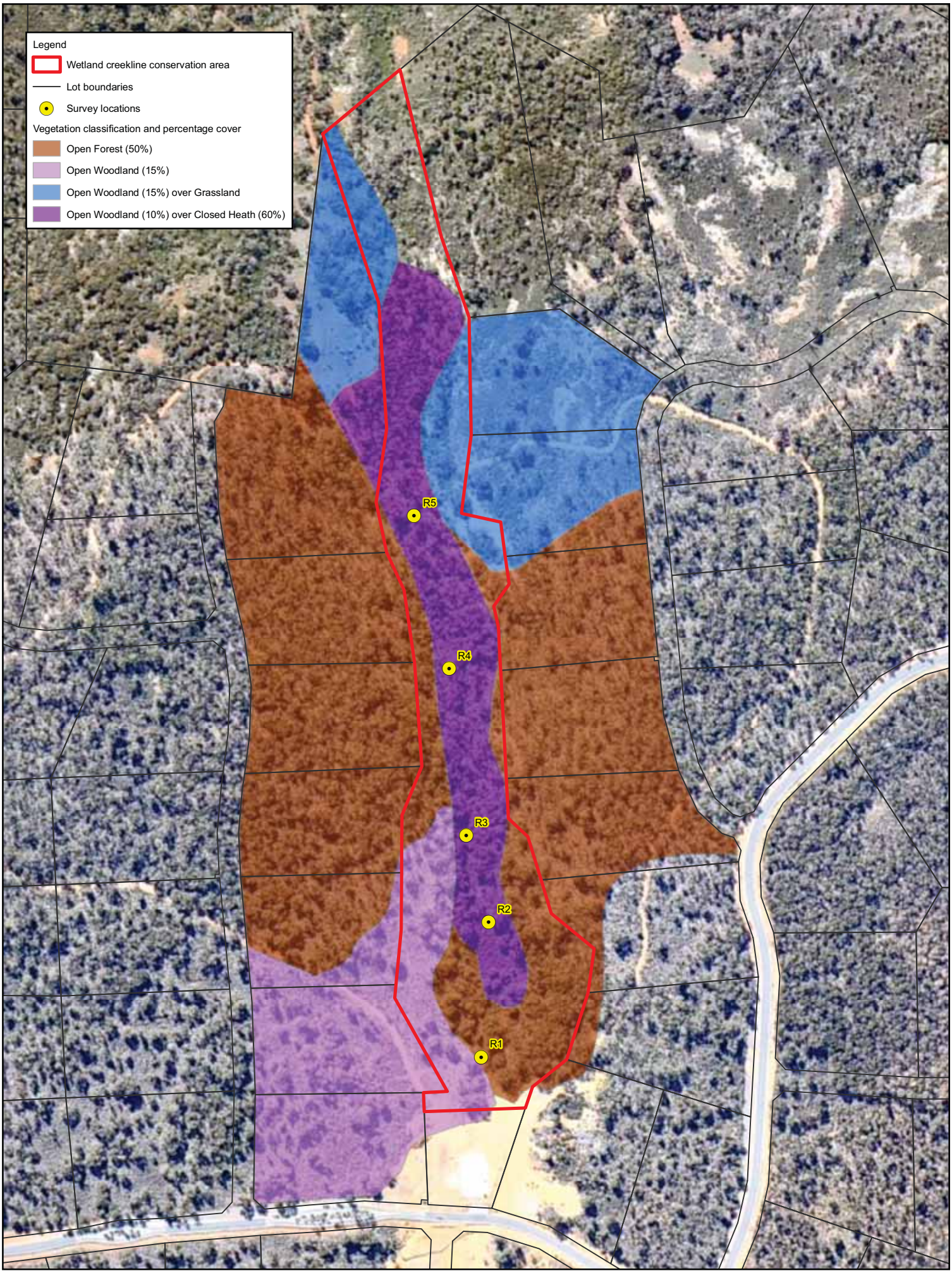


**Figure 10: Wetland and Creekline Conservation Area Vegetation Classification**

Project: Revegetation and Fire Management Plan
Avon Ridge Estate Brigadoon

Client: Peet Limited

**Plan Number: EP13-041(09)--F35a**

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|---|---|---|---|
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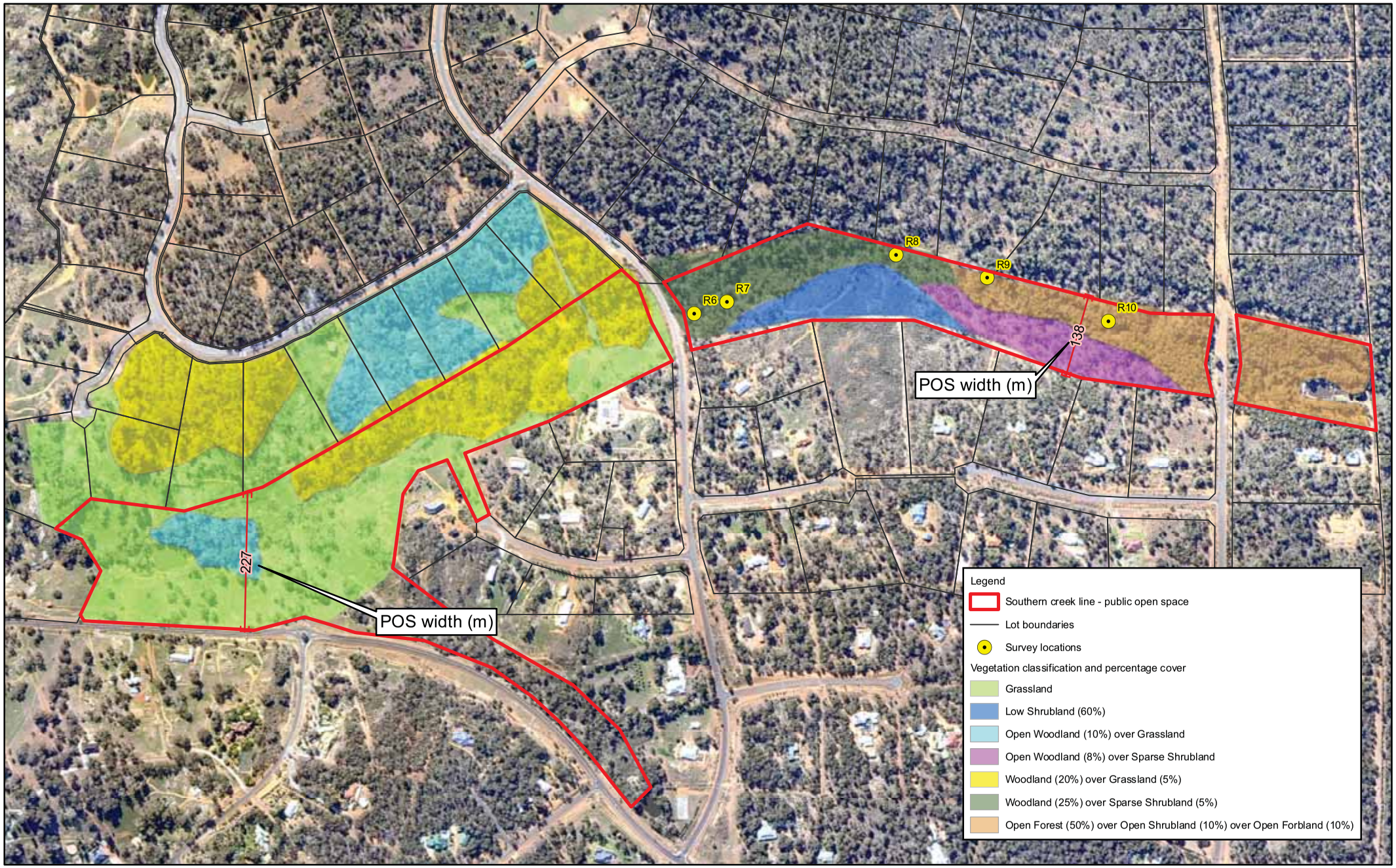


**Figure 11: Southern Public Open Space Vegetation Classification**

| | |
|---|---|
| Project: | Revegetation and Fire Management Plan<br>Avon Ridge Estate Brigadoon |
| Client: | Peet Limited |

**Plan Number: EP13-041(09)--F36a**

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0 75 150 300 Metres

emerge ASSOCIATES Integrated Science & Design

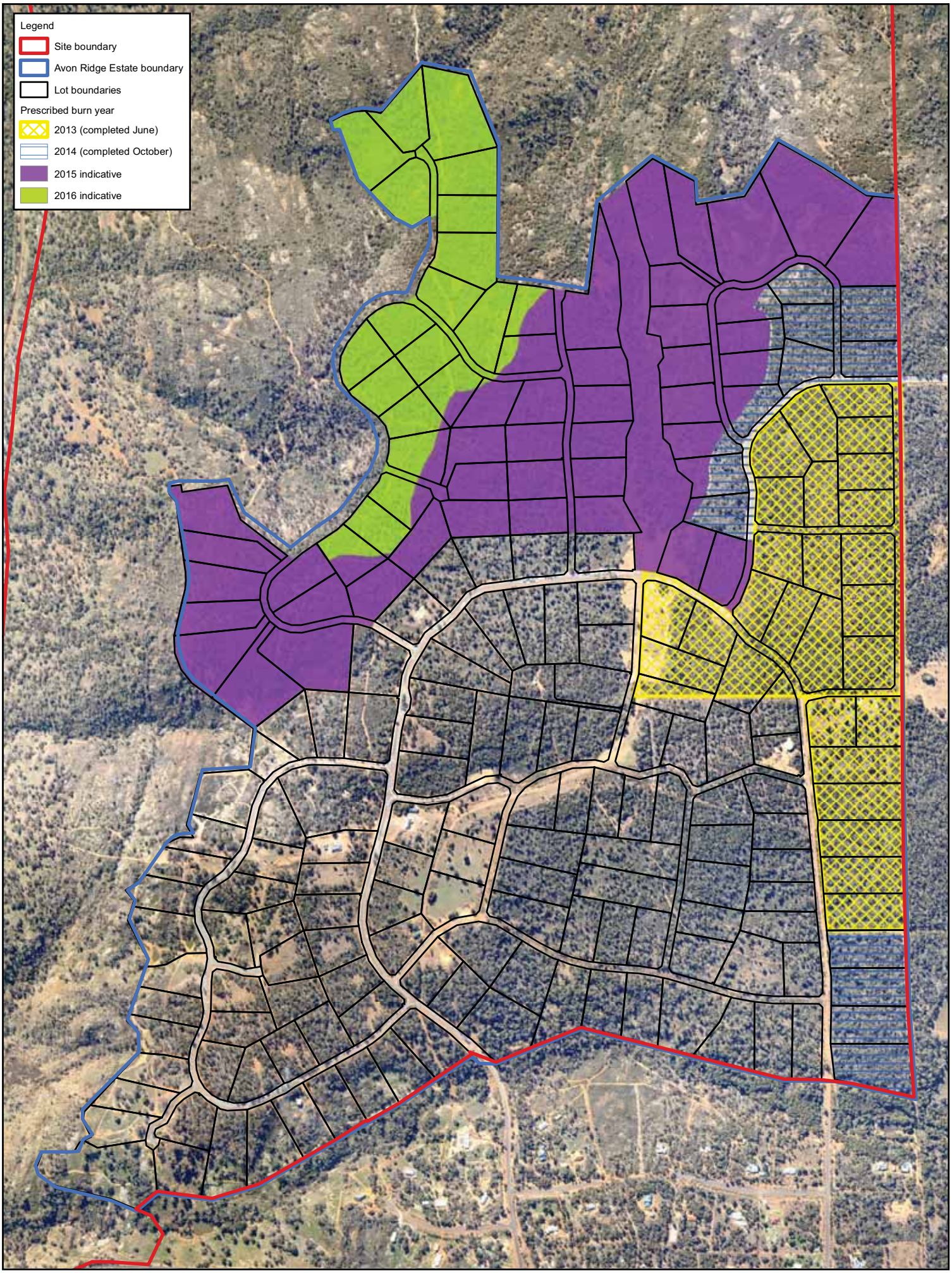


**Figure 12: Prescribed Burn Plan**

Project: Revegetation and Fire Management Plan
Avon Ridge Estate Brigadoon

Client: Peet Limited

**Plan Number: EP13-041(09)--F31a**

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|---|---|---|---|
| Drawn: | GRO | Date: | 17/04/15 |
| Approved: | CKK | Date: | 17/04/15 |
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| | |
|---|---|
| **Figure 13:** | **Indicative Building Protection and Hazard Separation Zones** |
| Project: | Revegetation and Fire Management Plan<br>Avon Ridge Estate Brigadoon |
| Client: | Peet Limited |

| | | | |
|---|---|---|---|
| **Plan Number: EP13-041(09)--F37a** | | | |
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# APPENDIX A

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## FIRE MANAGEMENT PLAN, FIREPLAN 2013

# FIRE MANAGEMENT PLAN

# Lot 1010 Brigadoon Estate

## CITY OF SWAN

**Prepared by: FirePlan WA**

**July 2009**

**Amended June 2011.**

**Amended August 2013**

# TABLE OF CONTENTS

# 1.0 PURPOSE OF THE MANAGEMENT PLAN

The purpose of this Bushfire Management Plan is to detail the Fire Management methods and requirements that will be implemented within the proposed subdivision. The aim of the Bushfire Management Plan is to reduce the threat to residents and fire fighters in the event of a fire within or near the subdivision.

# 2.0 SUBDIVISION LOCATION AND DETAILS

The subject land comprises Lot 1010 Brigadoon Estate and is located approximately 12 kms northeast of Midland (refer Diagram 1). It is proposed to subdivide the remaining portion of the Brigadoon estate into 214 Lots varying in size from 1.5ha to 5 ha.

# 3.0 SITE DETAILS

The proposed site is located in the plateau area of the remaining portion of the original Brigadoon estate. The land sloping to the north and west into Avon River is proposed to be handed over to the Western Australian Planning Commission as a Reserve.

The proposed development site is undulating with the eastern and northern edge roughly following the 225 metre AHD contour rising to 290 metre AHD along the eastern boundary.

In the south the site adjoins the previously developed portion of the Brigadoon Estate. Along the eastern boundary is cleared and partly cleared land used for stock grazing.

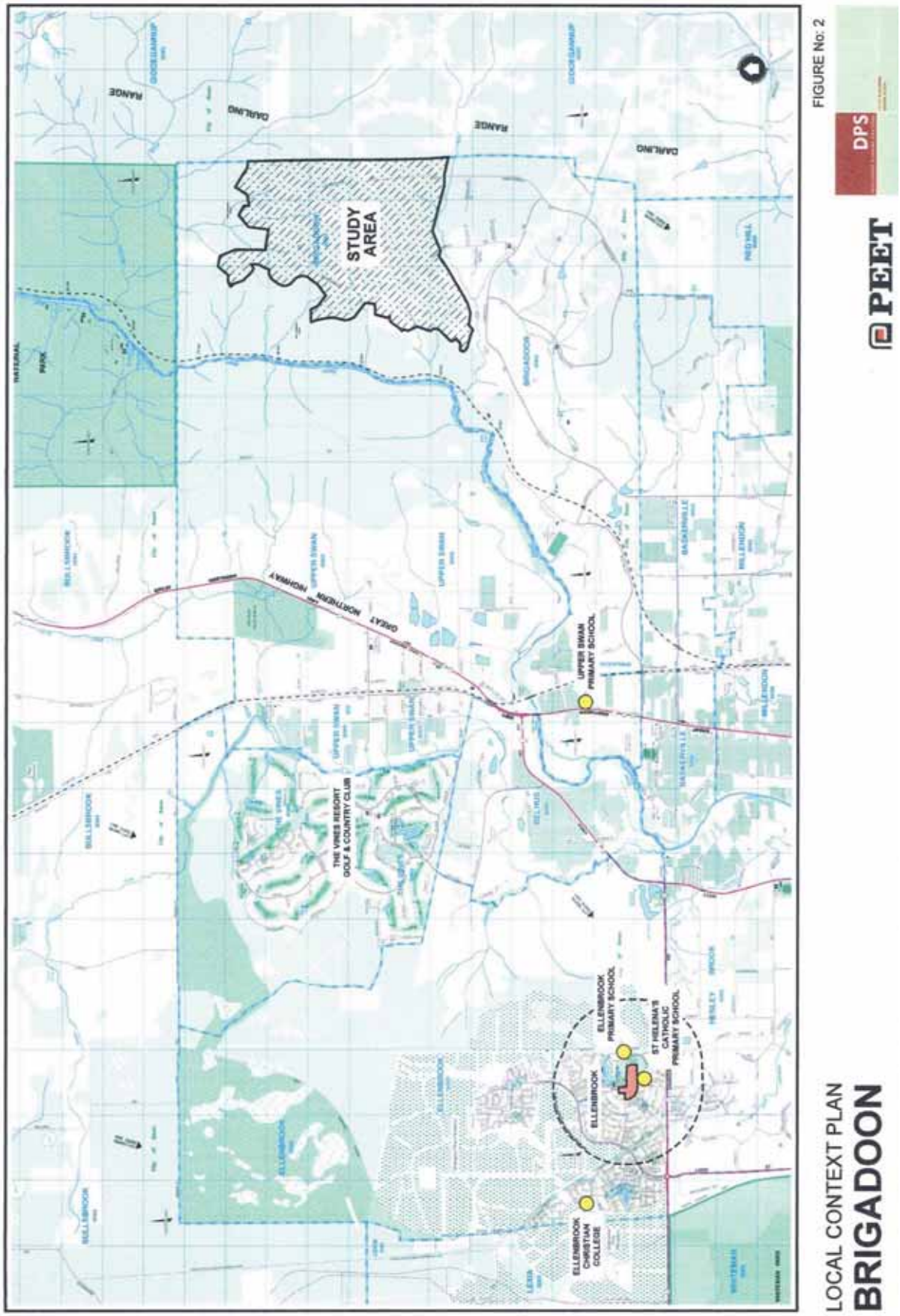
There are no creek or river systems running through this portion of the Brigadoon Estate.

# 4.0 STATUTORY CONDITIONS

The Western Australian Planning Commission requires the preparation of a ‘Bushfire Management Plan’ for the proposed development as part of the Development Application. This document has been prepared to satisfy that requirement.

As fire management strategies may require altering to meet changing environment and land use needs, it is advised that provisions of the Bush Fires Act 1954 may still be enforced in addition to this Fire Management Plan.

## Diagram 1 Locality of Proposed Subdivision Not to Scale



# 5.0 BUSH FIRE HAZARD ASSESSMENT

The assessment of fire risk takes into account existing site conditions which include:

- Topography with particular reference to ground slopes and accessibility;
- Vegetation cover – both remnant and likely revegetation; and
- Relationship to surrounding development.

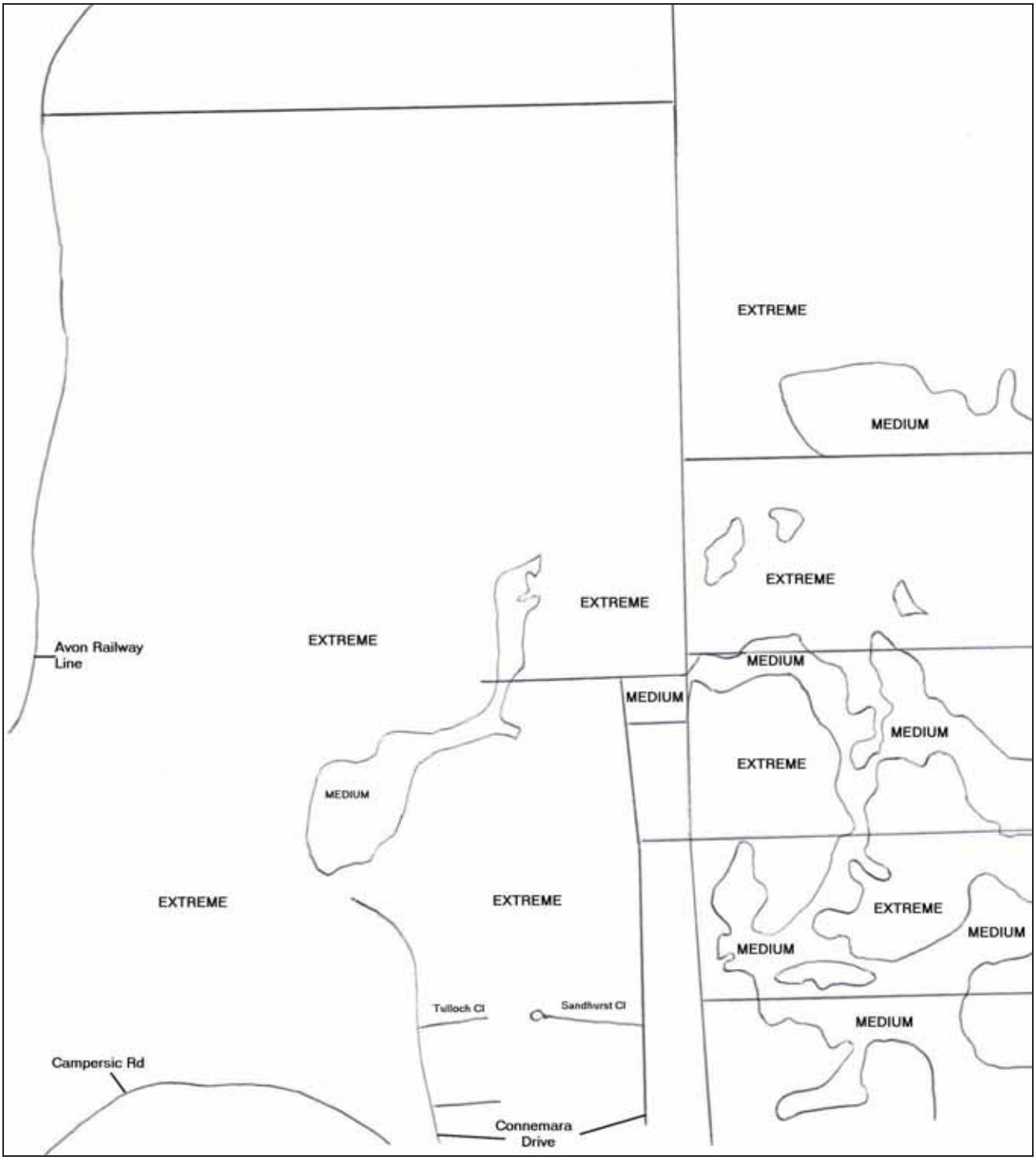
The Bush Fire Hazard Assessment for the proposed Lots is Extreme in remnant vegetation and Medium in cleared areas. See Diagram 2.

The Bush Fire Hazard assessment for the adjoining properties is Extreme in remnant vegetation and is Medium in cleared areas.

The Mediterranean climate experienced by this area is such that the majority of rain falls in late autumn through to early spring. This rainfall supports substantial vegetation growth which dries off in Summer/Autumn.

The combination of prevailing winds and dry vegetation poses a fire risk and bush fire control is considered essential for the protection of life and property, and to ensure that frequently and uncontrolled burning does not degrade existing and replanted vegetation.

**Diagram 2 Bush Fire Hazard Assessment** – Not to scale



# 6.0 FIRE MANAGEMENT PLAN

The aim of the Fire Management Plan is to reduce the threat to residents and fire fighters in the event of bush fire within or near the site.

The Fire Management Plan has been developed to incorporate fire management methods.

- Road Systems
- Strategic and Internal Firebreaks systems;
- Dwelling Construction;
- Building Protection Zones;
- Hazard Separation Zone;
- Hazard Reduction; and
- Driveways.

## 6.1 Road System

The current developed Brigadoon area has very poor access being Campersic Road. This provides one access/egress to the developed area. Recently an additional access has been provided.

In the proposed development a link from Connemarra Drive to O'Brien Road will be provided. This will provide an alternative emergency egress for the proposed residents but also for the existing residents of Brigadoon.

## 6.2 STRATEGIC FIREBREAK SYSTEMS

A strategic firebreak is to provide access for fire appliances and on their own would not stop a fire. The strategic firebreak provides a location where fire fighters can carryout a back burn operation if safe to do. The strategic firebreak is to be cleared to 6 metres wide with a 4 metre trafficable surface. In some areas such as steep slopes, a clearing width of 8 metres may be required in order to achieve a trafficable surface of 4 metres. In steep slopes a 4 metre wide one coat seal will make the surface trafficable.

Where necessary passing bays 6 metres wide will be installed every 200 metres and turn around areas every 500 metres. See Diagram 3 for Standards.

Strategic firebreaks linking the outer break with the outer road system will be installed at regular intervals of between 4 and 6 lots. These linking strategic firebreaks can be a part of the access within each lot or an internal firebreak and do not necessarily have to be located on the lot boundary. Rural gates (minimum width 4.1 metres) will be installed in the rear fence line to provide access from the strategic firebreak within the lot to the outer strategic firebreak. The fence is to be truncated to allow fire appliances to turn into the outer strategic firebreak

The strategic firebreaks would be placed in an easement on the title in favour of Council.

Gates and fencing will not be allowed across the boundary strategic firebreak and rural gates (minimum width 4.1 metres) would be erected where the strategic firebreak accesses a public road. Standard Council key system would prevent vehicle access. Signs "Fire Access Only" will be placed on the gates by the developer.

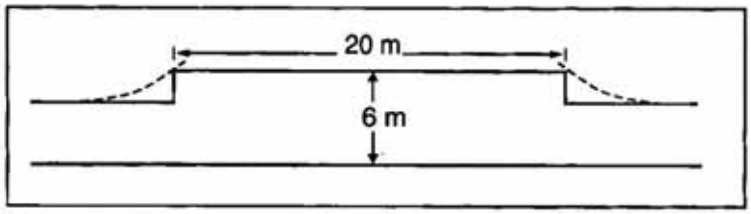
On the strategic firebreak located within the lots linking the outer strategic firebreak and the inner road system, rural gates with standard Council locks will be provided at the time of fencing.

A special area rating system could be implemented to cover the cost of the strategic firebreak maintenance. Peet & Co will establish and maintain the boundary strategic firebreaks until all lots are sold.

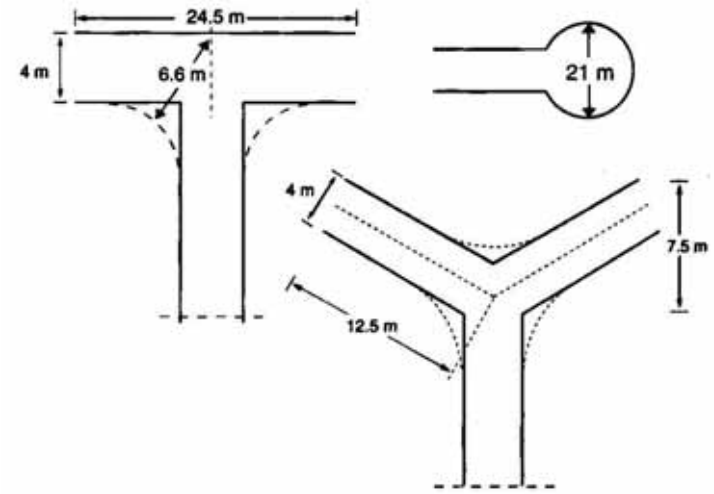
By that time the cost of maintenance would have been established by Peet & Co.

This strategic firebreak system is consistent with the previous development in Brigadoon and meets the standards of the City of Swan.

**Diagram 3 Passing Bay and Turn around areas Specifications**




*Passing bay measurements.*




*Turn around area measurements.*

## 6.3 INTERNAL FIREBREAKS

All lots are to comply with the firebreak requirements of the City of Swan Firebreak Notice in addition to this fire management plan. Firebreaks may be constructed to avoid soil erosion and trees of significance and may be located away from the Lot boundary as agreed with the City of Swan.

Internal Firebreaks are to be installed by the developer in all P.O.S. areas to the standard as detailed in the Firebreak Notice. The developer will maintain these firebreaks until all lots are sold and would be funded by rating system detailed in Section 6.2.

## 6.4 DWELLINGS

### 6.4.1 Dwelling Construction

Individual dwellings on each lot shall be designed and built to conform with:

- Building Code Of Australia (BCA); and
- Australian Standards AS 3959-2009.

All dwellings immediately adjoining the Parks and Recreation reserve are required to comply with the Australian Standard AS 3959-2009 "Construction of Buildings in Bush Fire Prone areas "BAL-29" as a minimum requirement. All other dwellings on the site are to be constructed to AS 3959-2009 BAL 19 as a minimum or as determined by individual Building Site Assessments by a Fire Planning Consultant provided free to the landowner by the Developer. A copy of this site assessment report would be forwarded to the City of Swan Fire Officer ( emailed after inspection completed) and the City of Swan Building Department (as part of the Building License Application)

Copies of *The Homeowners Bush Fire Survival Manual, Prepare Act Survive* and the City of Swan Firebreak Notice or other suitable documentation will be issued to each property owner by the Developer on the sale of an allotment.

### 6.4.2 Dwelling Setbacks

All dwellings are to be setback 60 metres from the boundary strategic firebreak.

### 6.4.3 Evaporative Air conditioning

To improve building safety evaporative air conditioners will not be allowed to be installed in dwellings adjoining Regional or Public Open Space. Further advice on evaporative airconditioners is available on the FESA website www.fesa.wa.gov.au → Publications → Safety Information →Fire (Home)

## 6.5 BUILDING PROTECTION ZONE

The aim of the Building Protection Zones is to reduce bush fire intensity close to dwellings, and to minimise the likelihood of flame contact with buildings.

The Building Protection Zone is a low fuel area immediately surrounding a building.

Non flammable features such as driveways, vegetable patches, lawn, or landscaped gardens (including deciduous trees) should form part of building protection zones. Isolated trees and shrubs may be retained within building protection zones. A Building Protection Zone of minimum of 20 metres is to be constructed around all buildings and must be within the Lot boundaries. It must fulfil the following conditions:

- Bush Fire fuels and dry grass must be maintained below a height of 50mm and a maximum of 2 tonnes/ha.

- The first 5m around all building is to be cleared of all flammable material. Reticulated gardens may be located in this zone.

- For the next 25 metres (i.e. from 5-30metres surrounding any buildings) the spacing of trees should be such that crowns are spaced 10 metres apart (when tree reaches maturity). Prune lower branches so that they are at least two metres off the ground to stop a surface fire spreading into the trees. Isolated shrubs and understorey species can be retained but dense understorey vegetation should be thinned. Remove dead leaves and branches from shrubs and trees.

- Branches, must be removed at least 2 metres back from the eaves of all buildings.

- All leaves, tall grass, and clearing slash of trees must be removed from within the building protection zone area to maintain the low fuel zone prescribed above.

- Building Protection Zone and Hazard Separation Zones are to be installed prior to any dwelling construction commencing and is to be part of the Building Licence approval.

- Building Protection Zones are to be maintained in perpetuity by the Landowner.

Example of Compliant Building Protection Zone

Example of Compliant canopy Tree crowns not touching

## 6.6 HAZARD SEPARATION ZONE

There must be physical separation between bush fire hazards and development. Hazard Separation Zones assist in reducing fire intensity when a bush fire impacts on buildings within a subdivision.

It is essential that owners maintain the building protection and hazard separation zones to have any degree of safety.

- The Hazard Separation Zone should extend at least a further 30 metres beyond the building protection zone. The width of the Hazard Separation Zone will be determined at the stage of the Building Site Assessment and depends on the Slope and distance to unmodified vegetation.

- Bush fire fuel loadings must be maintained within the Hazard Separation Zone to a maximum of 4-6tonnes/ha.

- Remove all leaves, tall dead grass (in cleared areas), twigs and tree branches periodically by burning, heaping, carting away or mulching to achieve reduced fuel loading as prescribed above.

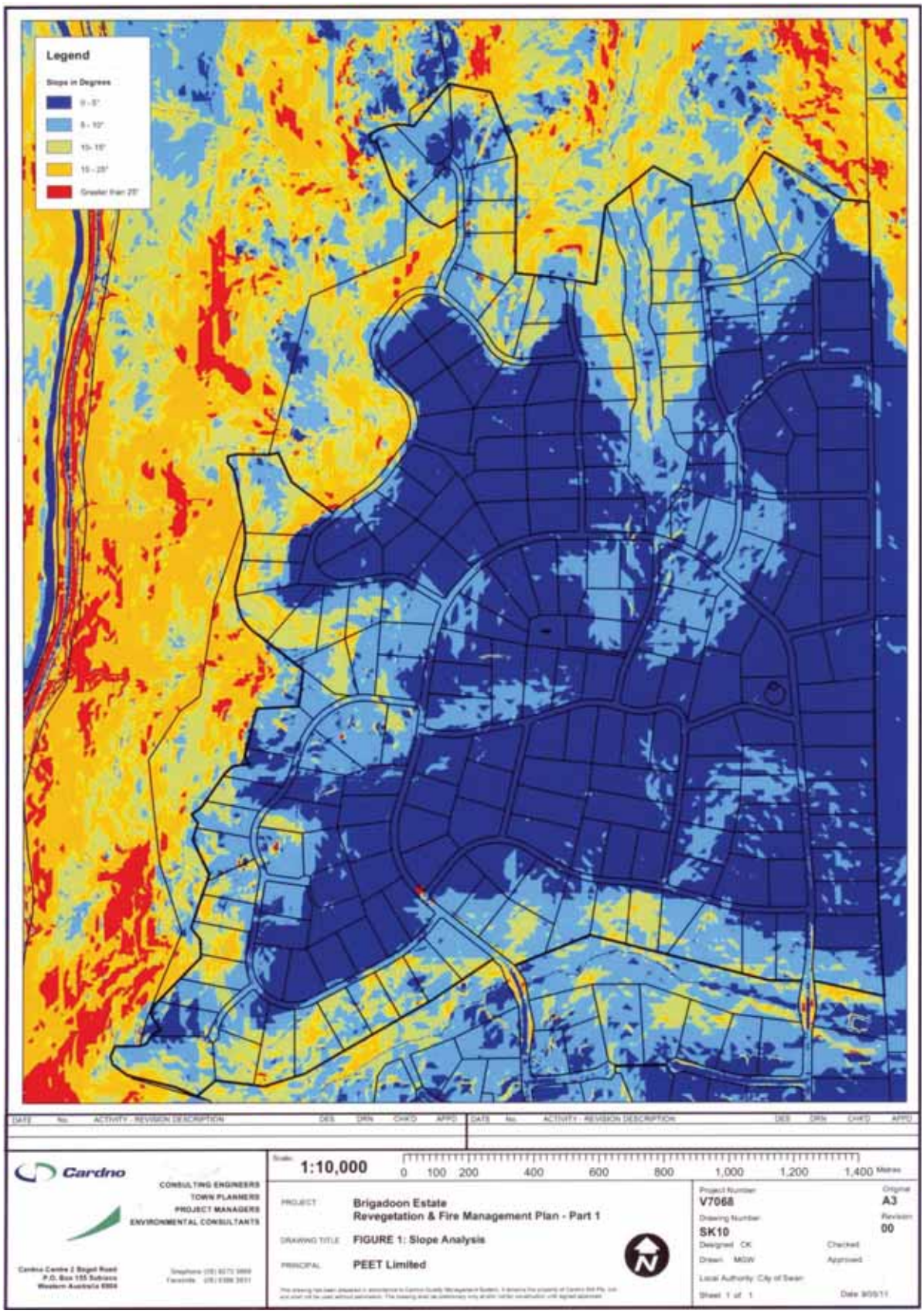
- Tree crowns are to be a minimum of 10 metres apart. Groups of 2-3 trees will be permitted provided no trunks are more than 6 metres apart and that there is a separation of 10 metres between crowns of tree clumps.

- The Hazard Separation Zone is to be installed by the landowner prior to construction of a dwelling on the site and maintained by the landowner to the detailed standard above in perpetuity

  If bush fire fuel is removed from small areas say about a quarter of the hazard separation zone each year then the impact on the vegetation within the lot is minimised.

Compliant Hazard Separation Zone Bush Fire Fuels to be maintained below 4-6 tonnes/ha

**Figure 1 Slope Map**
**To assist with determining Construction Standard and Hazard Separation Zone width**



### 6.7 HAZARD REDUCTION

In remnant vegetation bush fuels outside hazard separation zones, must be maintained below 6-8 tonnes/ha. City of Swan can provide advice on appropriate techniques to achieve this.

Dry grass fuels must be maintained below 50mm over the whole of each lot and can be achieved by mowing, grazing and slashing.

### 6.8 DRIVEWAYS

Driveways are to be constructed with a trafficable width of 4 metres. Where the driveways are more than 50 metres from a public road, driveway standards are to be as follows:-

- Minimum Trafficable surface: 4 metres
- Horizontal clearance: 6 metres
- Maximum Grades: 1 in 8
- Maximum grade over <50 m: 1 in 5
- Maximum average grade: 1 in 7
- Minimum weight capacity: 15tonnes
- Maximum crossfall: 1 in 33
- Curves minimum inner radius12 metres
- Passing Bays every 200 metres
- Turn Around areas: every 500 metres and within 50 metres of a house.

### 6.9 PLANTING OF TREES

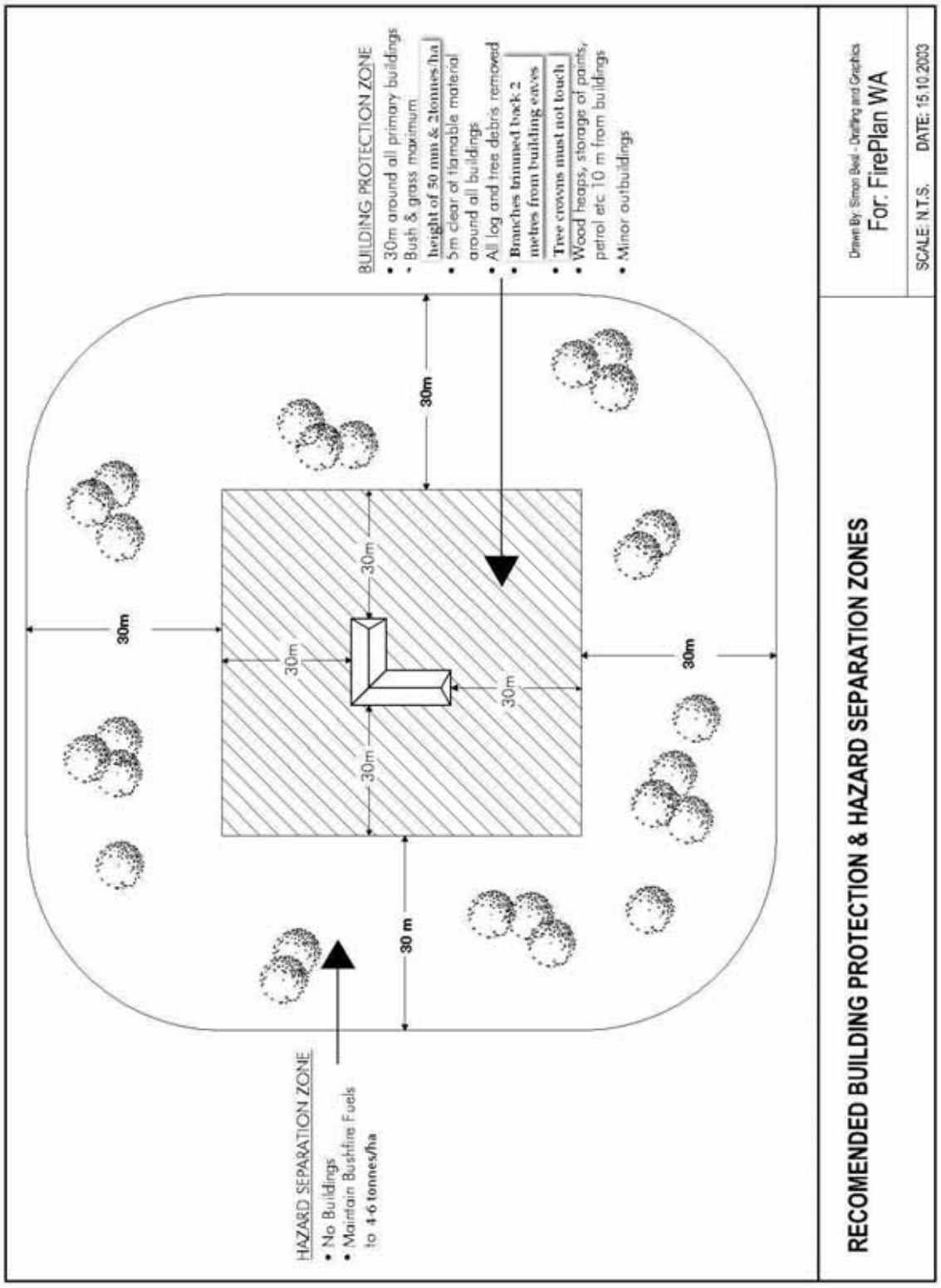
Planting of trees is not permitted within 6 metres of the centre of any firebreak. Trees planted within the Building Protection Zone must comply with the standard outlined in Section 6.5.

## 7.0 FIRE FIGHTING FACILITIES

Reticulated water will be supplied from the Water Corporation mains. Fire hydrants are to be installed every 200 metres along internal roads and marked with standard fire hydrant markings as detailed in Appendix B.

To improve fire suppression capability fire hydrants will be installed at 100 metre intervals on the outer road system interfacing with Regional Open Space (that is to the west and north of the development).

**Diagram 4 Sample Building Protection Zone and Hazard Separation Zone.**
Actual BPZ & HSZ widths will be determined at time of Building Site Assessment see Section 6.4.1



# 8.0 SUMMARY

## 8.1 Overall Fire Threat

The design of this development and the facilities constructed at the time of development are such that with implementation of this Fire Management Plan, fire threat to persons and property within the subdivision is significantly reduced.

## 8.2 Property Owner's Responsibilities

To maintain the reduced level of risk and threat of fire, the owners/occupiers of lots created by this proposal will be responsible for undertaking, complying and implementing measures protecting their own assets from the threat and risk of bush fire.

- Maintain internal firebreaks (clear of flammable material) on their property by the dates shown on the City of Swan Firebreak Notice as detailed in Section 6.2 & 6.3
- Maintain in good order and condition all property fencing and gates ensuring that overgrown vegetation does not encroach over the firebreak;
- Ensure all domestic dwellings are designed and constructed in full compliance with the requirements of the City of Swan. It is a requirement that homes are built to the AS3959 "Construction of Buildings in Bush Fire Prone Areas" as detailed in Section 6.4
- Implement and maintain Building Protection Zone as detailed in Section 6.5;
- Implement and maintain Hazard Separation Zone as detailed in Section 6.6.
- The owners of Lots 188, 189, 190, 245, 246, 262, 263, 286, 288, 372 and 373 are to liaise with the Department of Parks and Wildlife with respect to ensuring minimisation of Clearing associated with implementation and maintenance of Hazard Separation Zones and for hazard reduction outside of these however within each Lot;
- Implement hazard reduction as detailed in Section 6.7;
- Install and maintain driveways as detailed in Section 6.8;
- Planting of trees is to be carried out as detailed in Section 6.9.
- Infill revegetation species that have been introduced according to the Revegetation Plan *may* exceed and contradict this Fire Management Plans requirement for HSZ and possibly BPZ. Initially to ensure a level of survival rate depending on future conditions and climate, it will be the property owner's responsibility to ensure that the HSZ and BPZ continue to comply with the requirements outlined within this FMP by retaining selected successful vegetation while maintaining HSZ and BPZ. Property owners may need to seek advice from the City of Swan and DEC in future years to effectively achieve the requirements of this Fire Management Plan while ensuring the survival of retained vegetation species.

## 8.3 Developer's Responsibilities

Prior to subdivision being given final approval by the W. A. Planning Commission the developer shall be required to carry out works as described below. Subsequent to final approval to subdivide, the developer shall have no further responsibilities to provision of fire fighting facilities on lots which pass from there ownership.

- Lodging a section 70A Notification on each Certificate of Title proposed by this subdivision. The Notification shall alert purchasers of land and successors in Title of the responsibilities of this Fire Management Plan;
- Install alternative egress to O'Brien Road prior to Stage 1 land releases.
- Construction of strategic firebreaks as detailed in Section 6.2;
- Install internal firebreaks in accordance with City of Swan Firebreak Notice.
- Peet Limited is to provide a service to purchasers to have the Building Protection Zone and Hazard Separation Zone on their Lot inspected by a qualified Bushfire Protection Consultant (at Peet Limited's cost) to ensure compliance prior to clearing occurring and to ensure compliance after clearing has been undertaken. At the same time a Building Site Assessment will be carried out to determine the Construction standard of a dwelling.
- Install fire hydrants and mark fire hydrants as detailed Section 7.0
- Supply a copy of this Fire Management Plan, The Homeowners Bush Fire Survival Manual and Prepare Act Survive to each property owner on sale of the allotment;
- Maintain strategic firebreaks as detailed in Section 6.2 until all lots are sold.

## 8.4 City of Swan Responsibilities

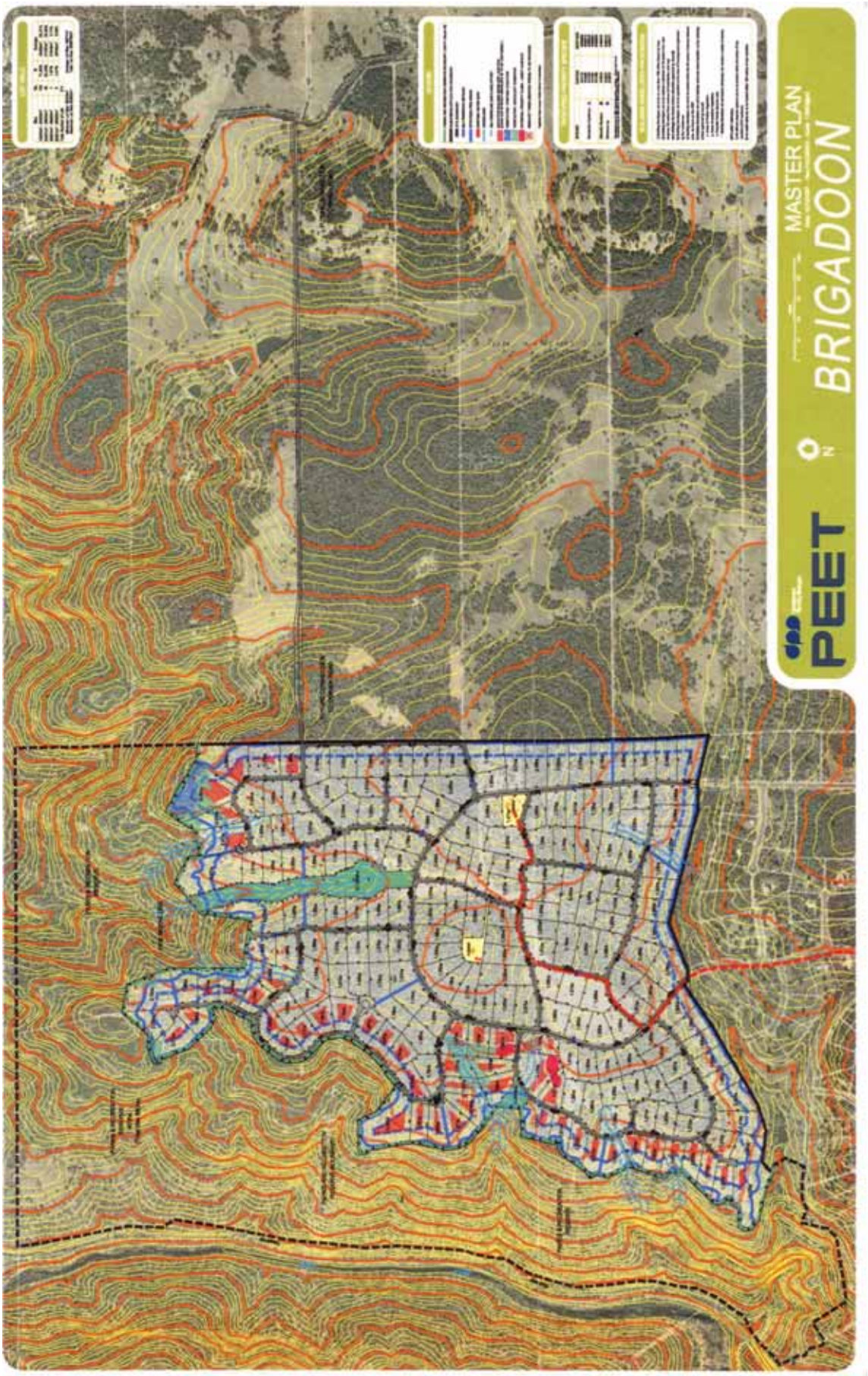
The responsibility for compliance with the law rests with individual property owners and occupiers and the following conditions are not intended to unnecessarily transfer some to the responsibilities to the City of Swan.

The City of Swan shall be responsible for:

- Endorsing a Section 70A Notification on each Certificate of Title affected by this Fire Management Plan.
- Developing and maintaining District Fire Fighting Facilities.
- Maintaining in good order the condition of the district water tanks and the apparatus for fire fighting purposes.

- Maintaining a supply of gate locks to be made available at cost to relevant landowners on request.
- Maintain strategic firebreaks with funding provided by a differential rating system imposed on all new Lot owners by the City of Swan once all lots are sold within the development.

**Appendix A Strategic Firebreak Location – Not to Scale.**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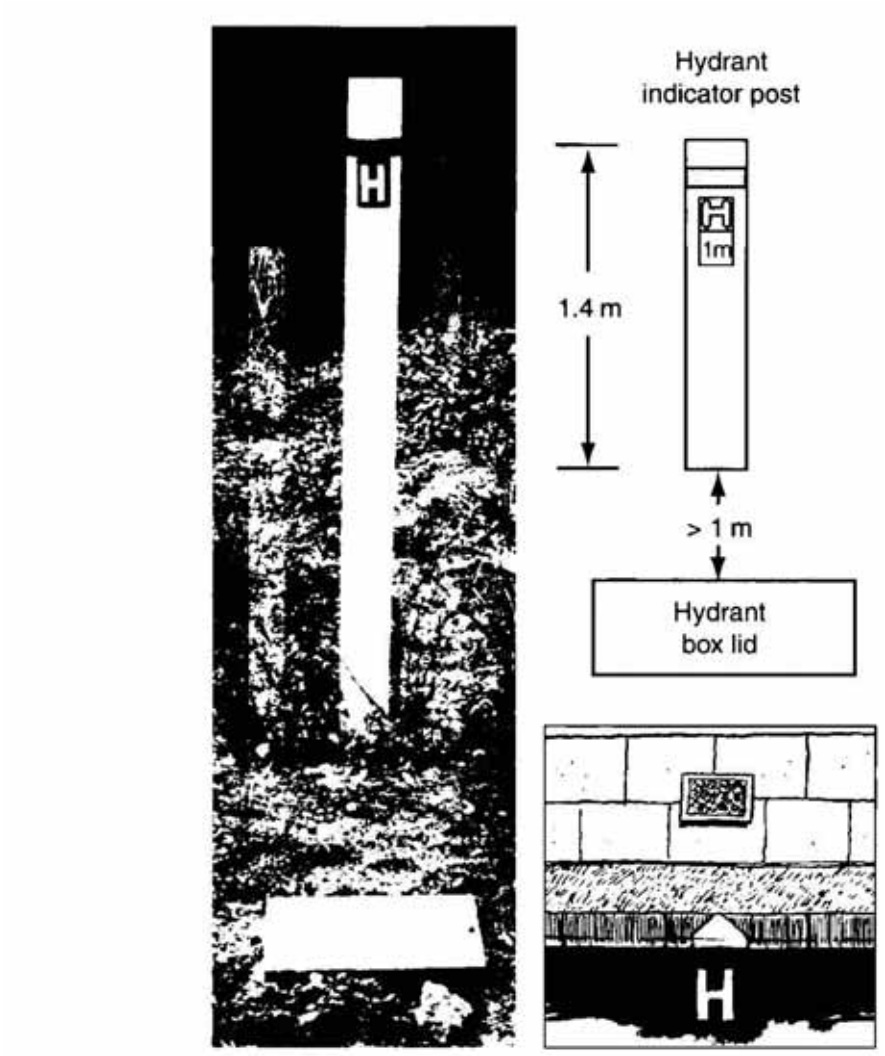
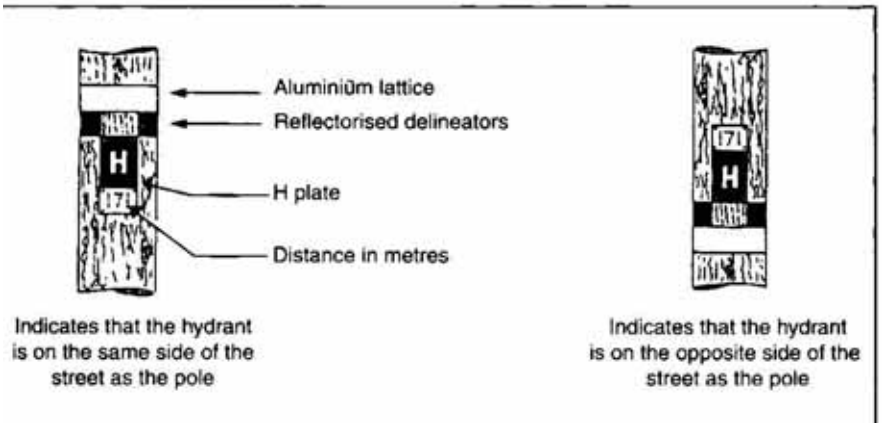
## Appendix B Fire Hydrant Markings.

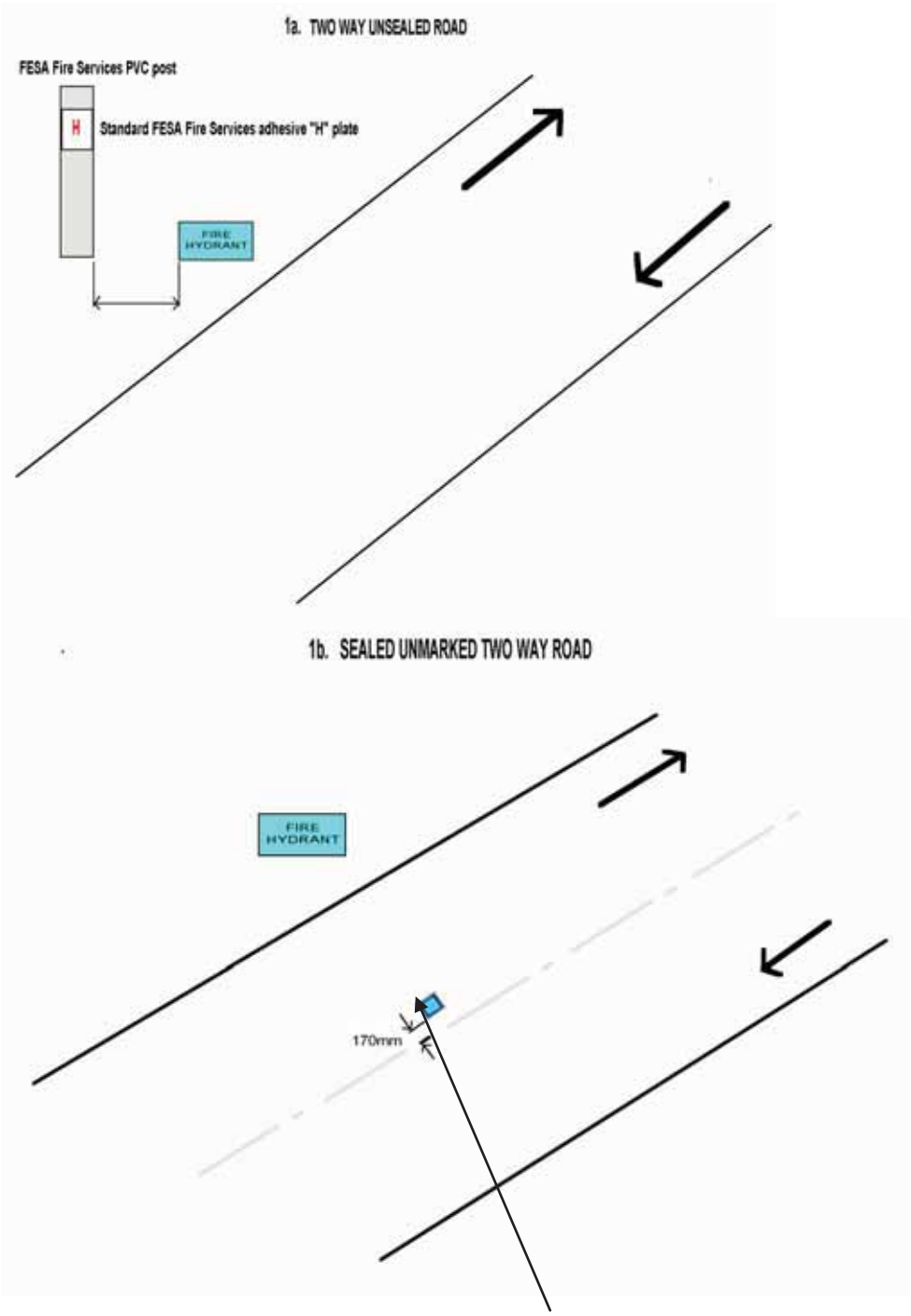



*Hydrant indicators post.*



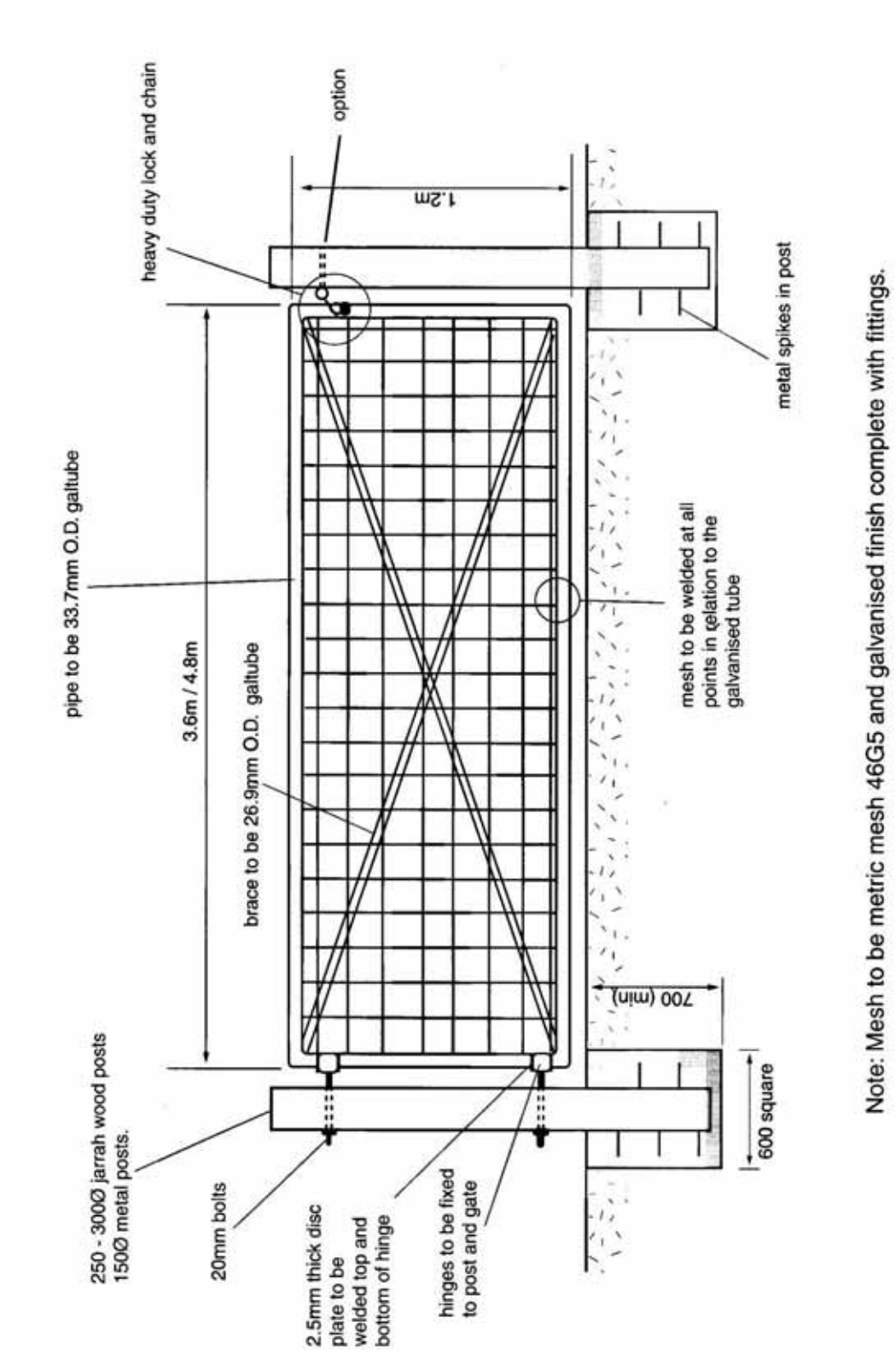
## BLUE RAISED RETROREFLECTIVE PAVEMENT MARKER & HYDRANT INDICATING GUIDLINES

The implementation of the blue raised retro reflective pavement marker (RRPM's) and new hydrant indicating regime is designed to provide greater ability for fire fighters to readily identify fire hydrant locations, particularly at night or where smoke affects visibility.




**Blue raised retro-reflective pavement marker**

## Appendix C Gate Standard



# APPENDIX B

PLANTING SUMMARY WITHIN THE PARKS AND RECREATION RESERVE, AVON RIDGE ESTATE

Planting summary within the Parks and Recreation Reserve, Avon Ridge - Spring 2013 (Biannual Monioring Report, Spring 2013 (Tranen 2014))

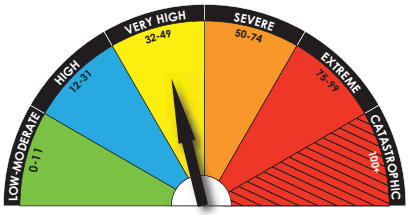
| Site | 1A | 2 | 3 | 4 | Sales Office A | Sales Office B | Subtotal |
|---|---|---|---|---|---|---|---|
| Installation date | 8/08/2011 | 9/08/2012 | 9/07/2013 | 19/07/2013 | 5/06/2013 | 8/07/2013 | |
| Number of seedlings planted | 30,775 | 24,000 | 2,610 | 10,340 | 6,150 | 14,380 | 88,255 |
| Installation date (infill) | 12/07/2012 | 11/06/2013 | | | | | |
| Number of seedlings planted | 12,000 | 6,520 | | | | | 18,520 |
| Planting spacing (lm) along rip lines 1.8m apart | 2 | 1 | 1 | 1 | 1 | 1 | |
| Area (ha) | 13.4 | 4.7 | 0.3 | 2.8 | 0.8 | 2.3 | |
| Planting density ($m^2$) | 0.32 | 0.65 | 0.87 | 0.37 | 0.77 | 0.63 | |
| Number of species | 30 | 20 | 12 | 16 | 11 | 15 | |
| **Total** | | | | | | | **106,775** |
| Species list | *Acacia lasiocarpa*<br>*Acacia saligna*<br>*Allocasuarina fraseriana*<br>*Allocasuarina humilis*<br>*Banksia grandis*<br>*Banksia illicifolia*<br>*Banksia menziesii*<br>*Banksia prionotes*<br>*Callistemon phoeniceus*<br>*Calothamnus hirsutus*<br>*Calothamnus quadrifidus*<br>*Corymbia calophylla*<br>*Eucalyptus marginata*<br>*Eucalyptus rudis*<br>*Eucalyptus wandoo*<br>*Gastrolobium calycinum*<br>*Gompholobium tomentosum*<br>*Hakea cyclocarpa*<br>*Hakea incrassata*<br>*Hakea lissocarpha*<br>*Hakea prostata*<br>*Hakea ruscifolia*<br>*Hakea trifurcata*<br>*Hakea undulata*<br>*Hakea varia*<br>*Hypocallymma robustum*<br>*Kennedia coccinea*<br>*Kennedia prostrata*<br>*Leptospermum erubescens*<br>*Macrozamia redlei* | *Acacia saligna*<br>*Allocasuarina fraseriana*<br>*Banksia grandis*<br>*Banksia menziesii*<br>*Banksia prionotes*<br>*Banksia sessilis*<br>*Callistemon phoeniceus*<br>*Corymbia calophylla*<br>*Eucalyptus marginata*<br>*Eucalyptus rudis*<br>*Eucalyptus wandoo*<br>*Hakea cyclocarpa*<br>*Hakea incrassata*<br>*Hakea lissocarpha*<br>*Hakea prostrata*<br>*Hakea ruscifolia*<br>*Hakea trifurcata*<br>*Hakea undulata*<br>*Hakea varia*<br>*Hypocallymma robustum* | *Acacia saligna*<br>*Banksia nivea*<br>*Banksia sessilis*<br>*Callistemon phoeniceus*<br>*Calothamnus quadrifidus*<br>*Corymbia calophylla*<br>*Eucalyptus rudis*<br>*Eucalyptus wandoo*<br>*Hakea lissocarpha*<br>*Hakea trifurcata*<br>*Hakea ruscifolia*<br>*Hakea undulata* | *Acacia saligna*<br>*Banksia grandis*<br>*Banksia nivea*<br>*Banksia sessilis*<br>*Hakea undulata*<br>*Callistemon phoeniceus*<br>*Calothamnus quadrifidus*<br>*Corymbia calophylla*<br>*Eucalyptus marginata*<br>*Eucalyptus rudis*<br>*Hakea prostrata*<br>*Eucalyptus wandoo*<br>*Hakea lissocarpha*<br>*Hakea ruscifolia*<br>*Hakea trifurcata*<br>*Hakea varia* | *Acacia saligna*<br>*Banksia grandis*<br>*Callistemon phoeniceus*<br>*Corymbia calophylla*<br>*Eucalyptus wandoo*<br>*Hakea lissocarpha*<br>*Hakea prostrata*<br>*Hakea ruscifolia*<br>*Hakea trifurcata*<br>*Hakea varia*<br>*Hakea undulata* | *Acacia saligna*<br>*Banksia grandis*<br>*Banksia nivea*<br>*Banksia sessilis*<br>*Callistemon phoeniceus*<br>*Calothamnus quadrifidus*<br>*Corymbia calophylla*<br>*Eucalyptus marginata*<br>*Eucalyptus marginata*<br>*Eucalyptus rudis*<br>*Eucalyptus wandoo*<br>*Hakea prostrata*<br>*Hakea ruscifolia*<br>*Hakea trifurcata*<br>*Hakea undulata* | |

# APPENDIX C

emerge ASSOCIATES
Integrated Science & Design

## CITY OF SWAN 2014-15 FIREBREAK NOTICE

# Your Guide to the 2014/15 **Fire Season**


Fire Danger Rating is supplied daily by the Bureau of Meteorology at **www.bom.au** and also available from the Telstra Weather Service by calling **1196**.

**No fire may be lit on a day when the forecast fire danger rating for the district is Very High or above.**

### City of Swan

For seasonal regulations, information and Harvest and Vehicle Movement Ban declarations call the **City of Swan Fire Information line: 9267 9326** or visit www.swan.wa.gov.au

For general enquiries during business hours and after hours, contact the **City of Swan Customer Services on 9267 9267**.

### Department of Fire & Emergency Services

Emergency Information Line (Alerts & Warnings): **1300 657 209**

Total Fire Ban Information Line: **1800 709 355**

For Alerts & Warnings, Total Fire Ban Activation and general Fire Safety Information visit www.dfes.wa.gov.au



# Your Guide to the 2014/15 **Fire Season**

**Firebreaks and Hazard Reduction measures must be carried out by November 2 and maintained up to April 30 inclusive.**

| FIRE SEASON QUICK GUIDE | | | | | |
|---|---|---|---|---|---|
| BURNING RESTRICTIONS | | | | | |
| RESTRICTED BURNING PERIOD | | PROHIBITED BURNING PERIOD | | RESTRICTED BURNING PERIOD | |
| Permits Required to Burn | | Burning Prohibited | | Permits Required to Burn | |
| From Oct 1 | Until Nov 30 | From Dec 1 | Until Mar 31 | From Apr 1 | Until May 31 |
| FIREBREAKS AND HAZARD REDUCTION REQUIREMENT PERIOD | | | | | |
| Install by November 2 | | | Maintain until April 30 | | |

All burning is prohibited on days of Very High or above Fire Danger Ratings and whenever a Total Fire Ban or a Harvest and Vehicle Movement Ban has been declared. Restricted and Prohibited Period dates may be altered according to seasonal conditions, these changes will be advertised.

**Call 000 for all fires and life threatening emergencies.**

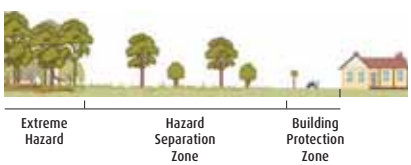
## City of Swan
## Bushfire Hazard Regulations

**Property owners are advised to read and familiarise themselves with the Annual Firebreak Notice contained on pages 13–24 of this booklet and ensure that requirements contained within the notice are carried out and maintained during the regulated firebreak periods.**

**Property owners who are unsure of their responsibilities may contact the City of Swan for further information.**

The 2014/15 Firebreak Notice incorporates the following:

- Building Protection Zones
- Fire hazard reduction requirements for land uses and sizes under and over 5,000m²
- Grassland Management
- Bush Fuel Load Requirements
- Plantation Requirements
- Emergency Access Ways
- Compliance Advice.




**Building Protection Zone (BPZ)** is a low fuel area that is reduced of flammable vegetation and materials surrounding habitable buildings including attached and nearby structures, and essential infrastructure to minimise the likelihood and impact that direct flame contact, radiant heat and ember attack may have on buildings and assets in the event of a bushfire.

This area must extend out from the external walls of a building or asset a minimum of 20 metres. Building Protection Zones do not require complete removal of native vegetation but outline the minimum criteria for clearance of vegetation from building and separation between plants to minimise the intensity of a bushfire within proximity of a building. BPZs also outline the requirements for slashing grass and managing the build-up of flammable materials near buildings.

Refer to the 2014/15 Annual Firebreak Notice on pages 13–24 of this booklet for Building Protection Zone specification relating to flammability, arrangement, density and separation of vegetation and materials around habitable buildings. Permanent clearing of vegetation beyond the requirements of the annual firebreak notice, unless exempted under the *Environmental Protection Act 1986*, is not permitted and requires approval from the Department of Environmental Regulation and the City of Swan.

**Compliance with Building Protection Zone requirements** is essential in order to protect buildings in bushfire risk areas and to increase the safety of residents and fire fighters that are involved in defending buildings during a bushfire.

- Building Protection Zones (BPZ) are now a legislative requirement within the City of Swan.
- The City will be taking an educational approach to equipping property owners to effectively create and maintain a BPZ around their dwellings this fire season. However, similar to previous years, where fire hazards are unacceptably high, property owners may still receive a subsequent notice in writing to reduce specific hazards around buildings to achieve an acceptable level of safety.
- Property owners are therefore urged to become familiar with, and carry out the BPZ requirements detailed within the Annual Firebreak Notice around their buildings.
- Property owners who do not have adequate BPZs may receive a written notice outlining specific directions relevant to their property.



### Land 5,001m² and over

- Maintain a Building Protection Zone around habitable buildings (an area reduced of flammable materials).
- Install 3 metre firebreaks immediately inside and adjacent to all external property boundaries with a 4 metre vertical height clearance free from overhanging branches.
- Properties over 100 hectares require additional firebreaks to divide the land into areas not exceeding 100 hectares.
- Slash or mow unmanaged grass (grass over 50cm high) to a height no greater than 10cm immediately adjacent firebreaks to a minimum 3 metre wide strip.
- Where depicted within a Fire Management Plan, property owners and occupiers are required to install and maintain Hazard Separation Zones (HSZ) in addition to and extending out from a Building Protection Zone a minimum distance of 80 metres unless otherwise specified by the Fire Management Plan. Fuel loads in HSZs must be maintained at or below 6 tonnes per hectare.
- Native vegetation consisting of forest, woodland, shrub or scrubland must be maintained at or below 8 tonnes per hectare.



- Property owners affected by an approved Fire Management Plan are required to maintain a Hazard Separation Zone in addition to and extending out from a BPZ a minimum of 80 metres unless otherwise specified within the Fire Management Plan.


## Fire Safety on Your Property

Property owners are required to reduce fire hazards and install firebreaks prior to **November 2, 2014** and maintain their property in that condition until **April 30, 2015**. The bushfire safety strategies outlined below are minimum legal requirements developed to reduce the likelihood and impact a bushfire may have on life, property and the environment within the City of Swan.

### Land up to 5,000m²

- Maintain a Building Protection Zone around habitable buildings (an area reduced of flammable materials).
- Maintain all grass to or under 5cm high.
- If the land predominantly consists of dense native vegetation, firebreaks or additional understorey maintenance may be required.
- Native vegetation consisting of forest, woodland, shrub or scrubland must be maintained at or below 8 tonnes per hectare.



## Firebreak and Strategic Access

Firebreaks and other strategic firebreaks and access ways must be constructed to the specification listed in the table below:

**Firebreaks and Strategic Access Specifications**

| Type | Width | Trafficable surface | Vertical Height Clearance | Alignment | Access and Security |
|---|---|---|---|---|---|
| Firebreak | 3 metres | 3 metres<br>Suitable for 4 x 4 vehicles | 4 metres | Inside and adjacent boundary | No Requirement |
| Alternative Firebreak | 3 metres | 3 metres<br>Suitable for 4 x 4 vehicles | 4 metres | Approved Alignment | No Requirement |
| Strategic Firebreak | 6 metres | 4 metres<br>Suitable for 4 x 4 vehicles | 4 metres | Designated Alignment | Fire Service Access –<br>Only City of Swan Fire Service (FS1) Padlocks Permitted |
| Emergency Access Way | 6 metres | 6 metres<br>Suitable for all types of 2 x 4 vehicles | 4 metres | Designated Alignment | Local, Public and Emergency Services Access – Must Remain Unlocked |

**Alternative Firebreaks and Hazard Reduction**
If it is impractical to install firebreaks along your boundary or to carry out hazard reduction prescribed within the City of Swan annual firebreak notice, you may apply to install firebreaks in an alternative position or take alternative measures to abate a fire hazard.

Your request must be received by **October 15** to be considered. Contact the City of Swan for application forms.

**Fire Management Plans** are not a legal requirement and do not provide property owners with any exemptions unless specifically referenced by the City's Annual Firebreak Notice.

Similarly the City may require additional work to the responsibilities outlined within a Fire Management Plan.

Property owners must ensure their property complies with the City's Annual Firebreak Notice and contact the City if they are unsure of their responsibilities.

**Fuel Reduction within Natural Vegetation** means the partial reduction of flammable material that will support the spread of a fire during summer months. This may include the removal of dead materials including leaf litter, twigs, branches, trash layer, dead trees and scrub as well as partial reduction of live scrub foliage.

Fuel reduction may be achieved by burning, raking, pruning, weed management, removal of dead materials or any other approved method.

If burning is used, it is recommended that the property owners engage the services of their Local Bush Fire Brigade to undertake the work (Brigade details on the inside back cover of this booklet), or if capable, the property owner or person undertaking the work must comply with all the requirements of the *Bush Fires Act 1954* and the City's *Consolidated Local Laws*.

Permanent clearing of areas of native vegetation is only permitted in accordance with the minimum requirements of the annual firebreak notice and exemptions outlined in the *Environmental Protection Act 1986*, or with the approval of the Department of Environmental Regulation and the City of Swan.

**Fuel loads in natural vegetation must not exceed 8 tonnes per hectare.**



## Restricted and Prohibited Burning Times

**Burning is Restricted from October 1 to November 30 and April 1 to May 31 inclusive**. During this period you are not permitted to burn without burning permit. You may request a permit from your local Fire Control Officer—see details on the inside back cover of this booklet.

**Burning is Prohibited December 1 to March 31 inclusive. Burning is also prohibited on any day when the Fire Danger Index reaches Very High or above.**

## Local Law Burning Restrictions

Due to the impact smoke may have on densely built-up areas, burning of refuse or garden waste is not permitted on land with an area less than 2,000m² (½ acre) unless a licence has been issued by the City.

**Exemptions** include the operation of a barbeque, solid fuel heaters, water heater, space heater, stove, oven or incinerator fired with dry paper, dry wood, synthetic char or charcoal type fuel provided no nuisance arises from burning such materials. **Some exemptions are subject to Seasonal Bans (see Seasonal Bans on pages 10–12 of this booklet).**

### Burning of Garden Refuse

Garden refuse **may not** be burned during the **prohibited burning period**, however may be burned during the **restricted burning period** after 6pm without a burning permit. This is subject to conditions within the *Bush Fires Act 1954*, *Health Act 1911* and compliance with the City's *Consolidated Local Laws 2005*.

Conditions of burning include:

- A 5 metre wide area clear of flammable material surrounds the pile.
- The fire is only lit between 6pm and 11pm and completely extinguished by midnight.
- The fire must not be lit if the Fire Danger Rating is



Very High or above, or if a Total Fire Ban or Harvest and Vehicle Movement Ban is declared.

- At least one person capable of controlling the fire is in attendance at all times and adequate means of extinguishing the fire is available at all times (e.g. garden hose or a fire appliance).
- You notify your neighbours of your intention to burn and the smoke from your fire doesn't cause a nuisance to neighbours or obscure the vision of motorists.
- You do not burn household or commercial waste, any noxious materials or any damp, wet or green material which could cause excessive smoke at any time.

### Alternatives to Burning

Consider the environment and the effect smoke may have on the surrounding community, and whenever practical use alternative methods of fuel reduction like composting, mobile mulching services, utilising green waste collections or the Red Hill Waste Transfer Station, slashing grass or the application of herbicides.

## Seasonal Bans

**Total Fire Bans** are declared by the Department of Fire & Emergency Services (DFES) during times of extreme weather conditions or when the possibility of widespread bushfires may impact heavily on resources.

**Harvest and Vehicle Movement Bans** are declared by the Local Authority and limits the operation of machinery and plant equipment likely to cause a fire when operated over or near flammable material, dry grass, stubble or bush. Similarly, conducting 'hot works' like operating abrasive cutters, welders or any other activity in the open air that may cause sparks and ignite vegetation are also not permitted during a Harvest and Vehicle Movement Ban.

### Total Fire Bans and Harvest and Vehicle Movement Bans

When a Total Fire Ban or a Harvest and Vehicle Movement Ban has been declared it is illegal to carry out any activity that is likely to cause a fire.



The responsibility remains on the individual to ensure that the activity undertaken will not cause a fire, and that a ban is not currently in place.

**When a ban has been declared you must not:**

- Light a fire in the open air.
- Cook outside in the open air using an open fire (this includes under verandas and patios).
- Move vehicles or plant equipment in bushland or paddocks (see necessary agricultural activities*)
- Harvesting (see necessary agricultural activities*)
- Undertake 'hot works' such as welding, grinding or activity that may cause a spark or ignition unless you have an exemption issued by DFES.
- Use fireworks or hot air balloons.

**When a ban has been declared you may:**

- Use a gas cooker or barbeque with an enclosed flame on your own property or in a public recreational area designated for that purpose.
- Undertake essential feeding and watering of stock.
- Use mowers, chainsaws, line and hedge trimmers and similar plant in built up urban environments which are clear of flammable materials or surrounded by green grass etc.
- Smoke, provided cigarettes or cigars are properly extinguished and discarded.
- Conduct any work that has been covered by a current and relevant exemption, and provided that all conditions on that exemption are adhered to.

***Necessary Agricultural Activities** are activities that cannot be postponed until after a Total Fire Ban ends without consequence to livestock or crops. These

activities are permitted to continue with caution during a Total Fire Ban but harvesting of crops or movement across paddocks are not permitted if a Harvest and Vehicle Movement Ban has been declared.

During a Harvest and Vehicle Movement Ban, vehicles may be used or operated on or across a paddock only if it is for the prevention of an immediate or serious risk to a person or livestock, and only if reasonable precautions have been taken for that activity to prevent causing a bushfire.

**Total Fire Ban Exemptions** may be granted if you are able to demonstrate you are taking adequate precautions to prevent the ignition or spread of a fire, and you have suitable personnel and resources to extinguish a fire that may start. Exemptions for Total Fire Bans must be obtained from DFES in writing and are specific to activities, times and locations.

### Total Fire Ban Activation and Additional Information

Activation and additional information is available on the DFES website: **www.dfes.wa.gov.au** or by calling the DFES Total Fire Ban information line: **1800 709 355** and broadcast on ABC local Radio frequency 720AM and other media outlets.

### Harvest and Vehicle Movement Ban Activation and Additional Information

For additional information visit the City of Swan website: **www.swan.wa.gov.au**
Activations are available by calling the City's Fire & Emergency Information Line on **9267 9326** and broadcast on ABC Local Radio frequency 720AM and other media outlets.

## Penalties Apply

You could be fined up to $25,000 or imprisoned for 12 months, or both, if you ignore or commit an offence in relation to Total Fire Bans and Harvest and Vehicle Movement Bans.



**BUSH FIRES ACT 1954**

# City of Swan
# Firebreak Notice

Notice to Owners and/or Occupiers of land situated within the City of Swan.

As a measure to assist in the control of bush fires, and pursuant to Section 33 of the *Bush Fires Act 1954*, all owners and occupiers of land within the City of Swan are required on or before **2 November 2014**, or within 14 days of becoming an owner or occupier of land if after that date, to clear firebreaks or take measures in accordance with this notice and maintain those firebreaks and measures to the required condition up to and including the **30th day of April, 2015**.

### 1. All Land with an area under 5,001m² (land under ½ Hectare)

1) Maintain grass to a height of no greater than 5cm.
2) Install and maintain a Building Protection Zone, in accordance with the requirements specified in clause 13 of this notice.
3) Any parcel of land having an area less than 5,001m² that is substantially developed that may include land that:
   a) Predominantly consists of non-flammable managed vegetation, reticulated lawns and gardens and other non-flammable features; or
   b) Areas that are sufficiently Parkland Cleared may maintain grass to a height of no greater than 5cm, or remove all flammable materials in lieu of clearing firebreaks.
4) Areas of natural vegetation to be maintained at or below 8 tonnes per hectare.
5) Where a property is affected by an approved Bushfire Management Plan as a condition of subdivision or development, property owners shall comply with all requirements and responsibilities outlined within that plan.



### 2. All land with an area of 5,001 m² or greater (land over ½ Hectare)

1) Install a 3 metre firebreak immediately inside and adjacent to all external property boundaries.
2) Properties over 100 hectares require additional firebreaks to divide the land into areas not exceeding 100 hectares.
3) Slash or mow unmanaged grass (grass that is 50cm or higher) to a height no greater than 10 cm immediately adjacent firebreaks to a minimum width of 3 metres.
4) Install and maintain a Building Protection Zone, in accordance with the requirements specified in clause 13 of this notice.
5) Natural Vegetation within 100 metres of Buildings, Attached and Adjacent Structures and Essential Infrastructure shall be maintained at or below 8 tonnes per hectare, by **passive** methods of fuel reduction that does not permanently remove or reduce the quantity or occurrence of the native plants, shrubs and trees within the subject area.
6) Where a property is affected by an approved Bushfire Management Plan as a condition of subdivision or development, property owners shall comply with all requirements and responsibilities outlined within that plan.

### 3. Plantations

1) Install and maintain external and internal firebreaks, firebreaks that form compartments (cells), firebreaks and hazard reduction measures that protect neighbouring communities and essential infrastructure in accordance with the requirements of a Fire Management Plan approved in writing by the City; or
2) Where no such approved Fire Management Plan exists:
   a) Unless the City approves an alternative plan in writing in accordance with clause 3(2)(b), install and maintain external and internal firebreaks and firebreaks that form compartments (cells), and carry out all other firebreaks and



hazard reduction measures which are required in accordance with the requirements and specifications within the Department of Fire & Emergency Services *Guidelines for Plantation Fire Protection* 2011 publication; or
   b) If it is considered impractical for any reason to carry out the plantation requirements outlined above in clause 3(2)(a), plantation owners and managers may apply in writing to the City to implement an alternative plan or measures in accordance with clause 4 of this notice. A Fire Management Plan may be required to be developed and submitted as part of the application.

### 4. Application to Vary Firebreak and Hazard Reduction Requirements

1) If it is considered impractical for any reason to clear firebreaks in a manner or location required by this notice, or to carry out on the land any fire hazard reduction work or measures required by this notice, you may apply in writing on or before the **15th day of October, 2014** for approval to provide firebreaks in alternative positions or to take alternative measures to abate fire hazards on the land.
2) If permission is not granted in writing by the City prior to the **2nd day of November, 2014** you shall comply with the requirements of this notice.
3) When permission to provide alternative firebreaks or fire hazard reduction measures has been granted, you shall comply with all conditions on the endorsed permit and maintain the land to the required standard throughout the period specified by this notice.
4) Where the City has in writing approved a Bushfire Management Plan as a condition of subdivision and the Bushfire Management Plan depicts an array of alternative firebreak positions and alignments, a property owner may, as an alternative to general boundary firebreaks, elect to provide an alternative firebreak(s) depicted on the Bushfire Management Plan. However, if the alternative firebreak is not

constructed by the date required by this notice, then general firebreak requirements shall apply.

**5. Fuel Dumps and Depots**

Remove all inflammable material within 10 metres of fuel dumps, fuel ramps or where fuel drums, whether containing fuel or not, are stored.

**6. Hay Stacks**

Clear and maintain a firebreak completely surrounding any haystack on the land, within 60 metres of the haystack.

**7. Strategic Firebreaks**

1) Where under a written agreement with the City, or where depicted on an approved Bushfire Management Plan strategic firebreaks are required on the land, you are required to clear and maintain strategic firebreaks a minimum of 6 metres wide along the agreed alignment to provide restricted vehicular access to emergency and authorised vehicles, unimpeded by obstructions including boundary fences unless fitted with gates and signage approved in writing by the City.
2) Gates may only be secured with City of Swan Fire Service padlocks.
3) Strategic firebreaks shall be graded to provide a continuous 4 wheel drive trafficable surface a minimum of 4 metres wide.
4) All branches must be pruned and obstacles removed to maintain a 4 metre vertical height clearance above the full 6 metre width of the firebreak.

**8. Emergency Access Ways**

1) Where under a written agreement with the City, or where depicted on a Bushfire Management Plan Emergency Access Ways are required on private land, you are required to clear and maintain a vehicular access way a minimum of 6 metres wide along the agreed alignment.
2) Emergency access ways must be unimpeded by obstructions including boundary fences unless



fitted with gates and signage approved in writing by the City.
3) Gates on Emergency Access Ways must remain unlocked at all times.
4) Emergency Access Ways shall be graded and have suitable drainage to provide a minimum 6 metre wide continuous trafficable surface suitable for all types of 2 wheel drive vehicles.
5) All branches must be pruned and obstacles removed to maintain a 4 metre vertical height clearance above the full 6 metre width of the trafficable surface.

**9. Firebreak Construction**

1) Firebreaks are to be developed and maintained clear of all obstacles and flammable materials to create a minimum of 3 metre wide trafficable surface suitable for 4 wheel drive vehicles.
2) Overhanging branches must be pruned to provide a 4 metre vertical clearance above the full width of the firebreak surface.
3) Boundary Firebreaks must be aligned immediately inside and adjacent to the external property boundaries.
4) Alternative Firebreaks that are approved in writing by the City, or as depicted within a Bushfire Management Plan approved in writing by the City, are to be constructed to the same standard as general firebreaks and must be constructed along the specified alignment.
5) Firebreaks must not terminate in a dead end.
6) Firebreaks may be constructed by ploughing, grading, raking, burning, chemical spraying or any other approved method that achieves the required standard.

**10. Driveways**

Where building sites are situated more than 50 metres from a public road:

1) Driveways must be maintained clear of all permanent obstacles and flammable materials to create a minimum 3 metre wide trafficable surface



suitable for all types of 2 wheel drive vehicles.
2) Overhanging branches must be pruned to provide a 4 metre vertical clearance above a minimum 3 metre width over the driveway.

**11. Fuel Reduction – Unmanaged Grasses**

1) All grass within Building Protection Zones, and on all land less than 5,001m² in area, is required to be mowed and maintained under 5cm in height over the entire area.
2) On land 5,001m² or greater, and not including Building Protection Zone areas:
   a) Maintain grass under 10cm within Hazard Separation Zones.
   b) Slash or mow unmanaged grass (grass that is 50cm or higher) to a height no greater than 10cm immediately adjacent firebreaks to a minimum width of 3 metres.
   c) If the land described above in 10(2)(b) is stocked, the grass must be reduced to a height of no greater than 10cm high by the **1st day of December 2014**.

   Subject to clause c), all grassed areas required by this notice to be maintained at or below a required height must be maintained in that condition between **2 November until the 30 April the following year**.

**12. Fuel Reduction – Natural Vegetation**

1) Available bushfire fuels must be maintained at or below:
   a) Building Protection Zones – 2 tonnes per hectare.
   b) Hazard Separation Zones – 8 tonnes per hectare. **This requirement only applies where HSZs are depicted within a Fire Management Plan approved in writing by the City.*
   c) Natural Vegetation – 8 tonnes per hectare for areas of natural vegetation within 100 metres of Buildings, Attached and Adjacent Structures and essential infrastructure.
2) Passive Fuel Reduction within natural vegetation



may be achieved by burning, raking, pruning, weed management, removal of dead materials and any other approved method.
3) Permanent removal or partial clearing of natural vegetation including individual or groups of native grasses, shrubs or trees may only be carried out in accordance with the minimum requirements of this notice.
4) Permanent clearing of natural vegetation structures including individual plants, shrubs or trees, that exceeds the requirements of this notice or the specifications outlined within a Bushfire Management Plan approved in writing by the City, is only permitted in accordance with the provisions and exemptions outlined within the *Environmental Protection Act 1986*, or with the approval of the Department of Environment Regulation and the City of Swan.

*Note: Advice and resources on how to measure and manage native vegetation fuel loads are available from the Department of Fire and Emergency Services or the City of Swan.*

**13. Building Protection Zones Specification**

The Building Protection Zone for habitable buildings and related structures must meet the following requirements:

1) Building Protection Zones for habitable buildings must extend a minimum of 20 metres out from any external walls of the building, attached structures, or adjacent structures within 6 metres of the habitable building, unless varied under an approved Bushfire Management Plan.
2) On sloping ground the Building Protection Zone distance shall increase at least 1 metre for every degree in slope on the sides of the building/ structure that are exposed to down slope natural vegetation.
3) Recommendation Only – Building Protection Zones predominantly consist of non-flammable managed vegetation, reticulated lawns and gardens and other non-flammable features.

4) All grass is maintained to or under 5cm.
5) Fuel loads must be reduced and maintained at 2 tonnes per hectare or lower.
6) The crowns of trees are to be separated where possible to create a clear separation distance between adjoining or nearby tree crowns. The separation distance between tree crowns is not required to exceed 10 metres. Clearing or thinning existing trees to create distances greater than 10 metres separation between tree crowns within a Building Protection Zone is not required or supported by this notice and requires approval from the Department of Environment and Regulation and the City of Swan.
7) A small group of trees within close proximity to one another may be treated as one crown provided the combined crowns do not exceed the area of a large or mature crown size for that species.
8) Trees are to be low pruned (or under pruned) to at least a height of 2 metres from ground.
9) No tree, or shrub over 2 metres high is planted within 2 metres of a building, especially adjacent to windows.
10) There are no tree crowns or branches hanging over buildings.
11) Clear and prune scrub to reduce to a sparse density (able to walk through vegetation with relative ease with minimal deviation around trees and shrubs).
12) Install paths or clear flammable or dry vegetation, debris and materials immediately adjacent to the building.
13) Wood piles and flammable materials stored a safe distance from buildings.

## 14. Burning

If the requirements of this notice are carried out by burning, such burning must be carried out in accordance with the relevant provisions of the *Bush Fires Act 1954*.

## 15. Compliance

1) In addition to the requirements of this notice, further works which are considered necessary by



an Authorised Officer of the City may be required as specified in writing in a subsequent notice addressed to the land owner.
2) Where the owner or occupier of the land fails or neglects to comply with the requirements of this notice or a subsequent notice addressed to the land owner, the City of Swan may enter onto the land with workmen, contractors, vehicles and machinery to carry out the requisitions of the notice at the expense of the land owner.
3) Failure to comply with this notice and subsequent written notices may result in a penalty not exceeding $5,000, or the issue of a $250 infringement notice and liability for any costs incurred by the City in relation to works undertaken on behalf of the land owner.
4) Adherence to measures outlined within an approved Bushfire Management Plan developed as a condition of subdivision does not provide land owners and occupiers with any exemptions to the requirements of this notice unless this notice specifically states otherwise.

## 16. Definitions

**'Alternative Firebreak'** is a firebreak that is in an alternative position or alignment to the external boundaries of a property.

**'Alternative Firebreak Application'** is an application that may be made by a land owner to install firebreaks in an alternative position, or to carry out an alternative measures in lieu of general firebreaks.

**'Available Fuel'** is the bush fuel consisting of live and dead vegetation and debris that will actually burn under prevailing conditions. Fuel available for burning depends on temperature, moisture in the air and within the vegetation and curing of vegetation. In summer there is a significant increase in available fuel.

**'City'** means the City of Swan.

**'Buildings, Attached and Adjacent Structures'** means habitable buildings that are used as a dwelling, workplace, place of gathering or assembly, a building that is a car park, or a building used for the storage



or display of goods or produce for sale by whole sale in accordance with classes 1–9 of the *Building Code of Australia*. The term building includes attached and adjacent structures like garages, carports verandas or similar roofed structure(s) that are attached to, or within 6 metres of the dwelling or primary building.

**'Building Protection Zone (BPZ)'** is a low fuel area that is reduced of flammable vegetation and materials surrounding buildings and essential infrastructure to minimise the likelihood and impact that direct flame contact, radiant heat or ember attack may have on buildings and assets in the event of a bushfire. This area must extend out from the external walls of a building or asset a minimum of 20 metres.

**'Bushfire Management Plan'** or **'Fire Management Plan'** is a comprehensive plan that may be placed on the certificate of title(s) of land, that has been developed as a condition of development or subdivision primarily for the purpose of determining the land suitability, design features and infrastructure that will increase bushfire safety within the location. Bushfire Management Plans may become outdated with regards to property owner fire safety advice and responsibilities due to seasonal changes and evolving fire safety strategies. Up to date advice and strategies are administered within local government areas as a legal requirement through the annual firebreak notice regulation. Fire Management Plans are not a legal requirement unless specifically referenced as a requirement within this notice, or a written notice addressed directly to a land owner.

**'Emergency Access Way'** is a two wheel drive trafficable, 6 metre wide access route to provide local residents, general public and emergency services alternative links to road networks at the end of cul-de-sacs or areas where access is limited during an emergency incident.

**'Essential Infrastructure'** or **'Critical Infrastructure'** means assets, infrastructure, systems and networks that provide essential services necessary for social and economic wellbeing and is typically public infrastructure. Assets and infrastructure, usually of a



public nature, that generate or distribute electricity, water supply, telecommunications, gas and dams are typical assets that are essential to society and are often located in, or traverse areas that are prone to bushfires.

**'Firebreak'** is an area of land cleared of flammable material to minimise the spread or extension of a bushfire. For the purpose of this notice the term firebreak is a strip of land 3 metres wide that also provides a trafficable surface and 4 metres vertical clearance for emergency and authorised vehicle access. Boundary firebreaks are installed immediately adjacent the external boundaries of a property.

**'Fire Hazard or Bushfire Hazard'** means accumulated fuel (living or dead) such as leaf litter, twigs, trash, bush, dead trees and scrub capable of carrying a running fire, but excludes standing living trees and isolated shrubs.

**'Hazard Separation Zone (HSZ)'** if required by this notice and in accordance with a Fire Management Plan, means an area extending out from a Building Protection Zone a distance of 80 metres unless otherwise specified, to create a graduated fuel reduction and separation from natural vegetation that is unmodified in structure and density.

**'Natural Vegetation'** means natural areas of forest, woodland, shrubland, scrub, mallee and mulga.

**'Parkland Clearing'** means areas of natural vegetation that have been significantly cleared of understorey and tree density reduced to create a grassland or low vegetation area that can be walked through unimpeded with isolated, grouped or well spaced trees.

**'Passive Fuel Reduction'** means lowering the amount of available fuel that will burn under prevailing conditions by means that will not **permanently** reduce or modify the structure or life cycle of plant, shrub, scrub or tree communities within an treated area. This is typically achieved by undertaking a cool, controlled burn of an area during cooler, damper months, or by physical removal of built up leaf litter, dead materials, weeds and slashing long dry grasses without damaging live native plants within the area.

**'Plantation'** is any area of native or exotic planted trees that exceeds three hectares in a gazetted town site, or elsewhere a stand of trees of 10 hectares or larger that has been planted and managed intensively for their commercial and environmental value. A plantation includes roads, firebreaks and small areas of native vegetation.

**'Strategic Firebreak'** is a firebreak that is 6 metres wide established to provide strategic access and links to road networks whilst providing a wider control/ containment line to protect town sites, estates and similar exposures during bushfire operations.

**'Unmanaged Grasses'** is undisturbed or very lightly grazed grasses with a height of 50cm or greater.

By order of the Council,

**MJ Foley**
**Chief Executive Officer**
**City of Swan**



## Permits and Local Fire Control Officers

**Please note: Bush Fire Control Officers from the Brigades are volunteers and their ability to issue permits may vary in some instances, including attending emergency incidents within your community. Please assist them by planning your permit requirements early.**

### Metro

Permits are issued by Community Safety Advocates subject to a site inspection. **9267 9267**

### Gidgegannup East

For Permits & Brigade enquiries: **9574 6000**
Saturday 8.30 – 10.00 am
Fire Station, Toodyay Road, Gidgegannup

### Gidgegannup West

For Permits & Brigade enquiries: **9574 6536**
Saturday 8.30 – 10.00 am
Fire Station, Toodyay Road, Gidgegannup

### East Swan

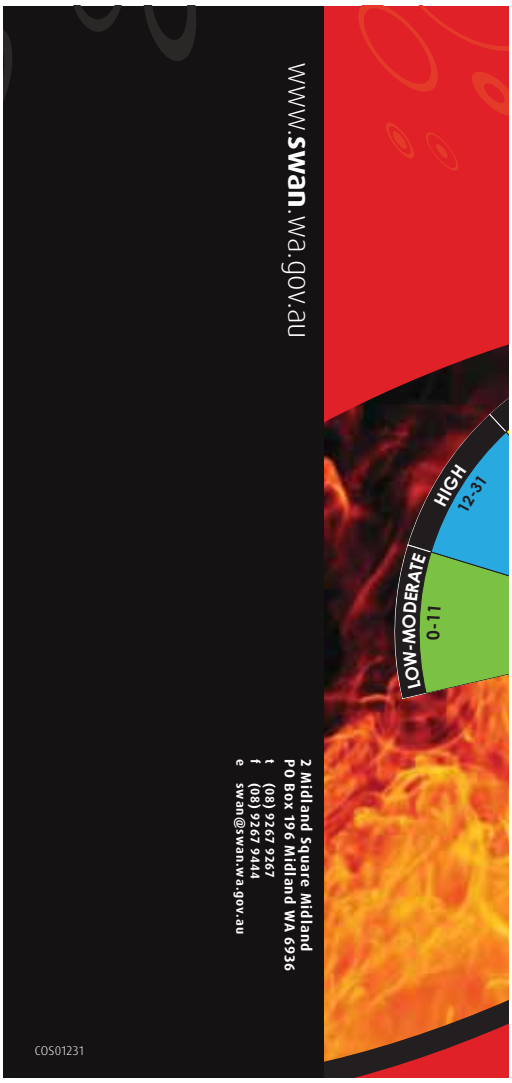
For Permits & Brigade enquiries: **9296 1288**
Sunday 9.00 – 11.00 am
Fire Station, Cathedral Avenue, Brigadoon

### Bullsbrook

For Permits & Brigade enquiries: **9571 2099**
Sunday 9.00 – 11.00 am
Fire Station, Chittering Road, Bullsbrook

### West Swan

Membership and controlled burn enquiries only: **9296 4580**
Permits within the Metropolitan Fire District are issued by the City of Swan (see Metro).



# APPENDIX D

emerge ASSOCIATES
Integrated Science & Design

## ROLE OF FIRE MANAGEMENT CONSULTANT IN THE VEGETATION MODIFICATION PROCESS


Peet
Clears vegetation for roads. services, strategic firebreaks and lot firebreaks
Road centrelines are investigated to retain significant vegetation including foraging habitat and habitat trees for Black Cockatoos.
Vegetation is preserved where possible within the 20-23m road reserves.
Construction Management Plans are prepared and implemented.
Peet
Creates lots and places Notification on Title showing:
Location of habitat trees.
Protective Covenants over the Title.
Landowner
Purchases Lot
Notification on Title alerts owner of habitat trees.
Protective Covenants restrict clearing on the lot (other than what is required for the building envelope and fire management).
Landowner
Informs Peet of house design and proposed building envelope on the lot.
Peet arranges inspection by the Fire Management Consultant.
Peet
Inspection by Fire Management Consultant
Deems building envelope is in the correct location, completes BAL assessment and
Identifies vegetation modification required for the Building Protection Zone (pre-clearing checklist).
Quantifies vegetation clearing required (estimated no. trees) (pre-clearing checklist).
Peet
Inspection by Fire Management Consultant
Deems building envelope is not in correct location.
Landowner
Chooses building envelope in consultation with the Fire Management Consultant and undertakes house design if necessary .
Peet
Inspection by Fire Management Consultant
Deems building envelope is in correct location and completes assessment and
Identifies vegetation modification required for Building Protection Zone (pre-clearing checklist).
Quantifies vegetation clearing required (estimated no. trees) (pre-clearing checklist).
Landowner
Submits application for Building Licence to the City of Swan and must show the
Position of building envelope.
Location of vegetation.
Adherence to the Fire Management Plan.
Completed BAL assessment.
City of Swan
Considers the Building License and ensures its consistency with
The approved Local Structure Plan (including building envelopes which restricts building to a maximum of 10% of the gross lot area).
Australian Standard 3959 as per Fire Management Plan.
Landowner
Receives approval
From City of Swan and the Landowner commences building.
Clears vegetation
In accordance with Building Licence Approval, adherence to the Protective Covenants and advice from the Fire Management Consultant.
City of Swan
Building Inspector/ Fire Control Officer
Inspects compliance with Building Licence.
Any additional clearing
Requires a clearing permit from Department of Environment Regulation.
Landowner
Additional buildings requires building licence applications.
Peet
Inspection by Fire Management Consultant
Confirms vegetation modification has been completed in accordance with advice (post-clearing checklist).
Peet
Inspects compliance with Protective Covenants.

# APPENDIX E

LOCATIONS OF POTENTIAL BLACK COCKATOO HABITAT TREES OF 500MM DBH OR GREATER (CARDNO 2010B)

## *Habitat Trees GPS Data Coordinates*

| Tree No. | mE (MGA Z50) | mN (MGA Z50) | TREE TYPE | HEIGHT (m) | HEIGHT TO HOLLOW (m) | CIRCUMFERENCE AT BREASTHEIGHT (m) | DEPTH OF HOLLOW (cm) | ENTRANCE FACING | HOLLOW ENTRANCE SIZE 1 (cm) | HOLLOW ENTRANCE SIZE 2 (cm) | FLOOR SIZE 1 (cm) | FLOOR SIZE 2 (cm) | COMMENTS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2 | 412316 | 6485638 | Wandoo | 20 | 6 | 3.7 | | STH | ~60 | | | | No signs |
| 3 | 412328 | 6485696 | Wandoo | 9 | 5 | 3.1 | 60 | UP | 50 | 60 | 40 | 40 | No signs |
| 4 | 412373 | 6485730 | Wandoo | 7 | 7 | 1.8 | | S | ~45 | | | | No signs |
| 5 | 412429 | 6485557 | Wandoo | 13.6 | 7.2 | 2.8 | | W | ~60 | | | | Bees |
| 6 | 412458 | 6485561 | Wandoo | 13 | 5 | 3.8 | | E | ~40 | | | | No signs |
| 7 | 412525 | 6485603 | Wandoo | 17.6 | 6.2 | 2.45 | | N | ~40 | | | | No signs |
| 8 | 412524 | 6485617 | Wandoo | 17.4 | 8.4 | 2.2 | | N | ~30 | | | | Boobook |
| 9 | 412706 | 6485566 | Marri | 18.6 | 10.2 | 3.3 | | UP | ~90 | | | | No signs |
| 10 | 412718 | 6485602 | Marri | 15.2 | 14.2 | 4.25 | | UP | ~100 | | | | No signs |
| 12 | 412251 | 6484609 | Dead | 4.6 | 4.6 | 2.1 | 20 | UP | 70 | 70 | 70 | 70 | No signs |
| 13 | 412317 | 6484659 | Marri | 13 | 5 | 2.95 | | N | ~25 | | | | No signs |
| 14 | 412344 | 6484733 | Wandoo | 9.4 | 6 | 3.05 | 0 | UP | ~100 | | | | Not hollow |
| 15 | 412281 | 6484729 | Wandoo | 12.6 | 6 | 2.8 | | W | ~25 | | | | Bees |
| 16 | 412285 | 6484336 | Wandoo | 15.6 | 4 | 2.35 | 220 | UP | 15 | 15 | | | No signs |
| 17 | 412348 | 6484312 | Dead | 5.4 | 5.4 | 2.3 | | UP | ~30 | | | | No signs |
| 18 | 412360 | 6484310 | Dead | 20.4 | 5 | 1.75 | 45 | S | 15 | 18 | 10 | 13 | Too small |
| 19 | 412400 | 6484340 | Marri | 14 | 4 | 3.4 | 30 | UP | 57 | 66 | 50 | 60 | Possum |
| 20 | 412441 | 6484343 | Dead | 5.2 | 5.2 | 3.3 | | UP | ~90 | | | | No signs |
| 21 | 412319 | 6484414 | Dead | 10.8 | 6.4 | 2.5 | | UP | ~25 | | | | No signs |
| 22 | 412280 | 6484381 | Wandoo | 10.4 | 4.2 | 3 | 5 | NW | 25 | 17 | | | No signs |
| 23 | 412263 | 6484374 | Wandoo | 12.6 | 5 | 2.5 | 80 | W | 45 | 20 | | | No signs |
| 24 | 413564 | 6486219 | Dead | 25.4 | 22.4 | 3.4 | | UP | ~40 | | | | No signs |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 25 | 413640 | 6486050 | Dead | 8.4 | 8.4 | 2.7 | | UP | ~50 | | | | No signs |
| 26 | 413829 | 6486556 | Wandoo | 20.4 | 4.4 | 2.5 | | SE | ~40 | | | | No signs |
| 27 | 413824 | 6486515 | Marri | 17.8 | 8.2 | 2.9 | | ESE | ~30 | | | | No signs |
| 28 | 413856 | 6486486 | Jarrah | 24.4 | 9 | 3.4 | | UP | ~40 | | | | No signs |
| 29 | 413907 | 6486641 | Wandoo | 15 | 7.4 | 3.7 | | UP | ~30 | | | | No signs |
| 30 | 414080 | 6486754 | Dead | 9.4 | 6 | 2.7 | | S | ~100 | | | | No signs |
| 31 | 414082 | 6486745 | Wandoo | 20.6 | 9.4 | 2.35 | | NW | ~100 | | | | No signs |
| 32 | 414108 | 6486745 | Dead | 13.4 | 5.2 | 3.1 | | SE | ~200 | | | | Minor chew marks - Galah? |
| 33 | 413970 | 6486653 | Wandoo | 12 | 5.2 | 2.3 | | UP | ~80 | | | | No signs |
| 34 | 413904 | 6486607 | Marri | 28.4 | 18.4 | 3.1 | | S | ~70 | | | | No signs |
| 35 | 414063 | 6486911 | Wandoo | 20 | 5 | 2.5 | 240 | UP | 20 | 30 | | | No signs |
| 36 | 414136 | 6486007 | Jarrah | 16.8 | 7.2 | 3.6 | | NW | ~15 | | | | No signs |
| 37 | 413739 | 6486522 | Marri | 25.2 | 14.2 | 3.95 | | UP | ~40 | | | | No signs |
| 38 | 413797 | 6486438 | Marri | 16.2 | 14.8 | 2.6 | | UP | ~40 | | | | No signs |
| 39 | 413674 | 6486379 | Wandoo | 9.8 | 3.8 | 3.1 | | S | ~30 | | | | No signs |
| 40 | 413679 | 6486366 | Dead | 4.8 | 6 | 2.4 | | UP | ~70 | | | | No signs |
| 41 | 413711 | 6486342 | Marri | 9.2 | 7.2 | 3.1 | | UP | ~90 | | | | No signs |
| 42 | 413730 | 6486323 | Marri | 4.6 | 3.6 | 1.9 | | UP | ~60 | | | | No signs |
| 43 | 413677 | 6486288 | Marri | 10 | 7 | 5.3 | | UP | ~100 | | | | No signs |
| 44 | 413644 | 6486299 | Dead | 19.4 | 9.4 | 4.4 | | W | ~50 | | | | No signs |
| 45 | 413575 | 6486287 | Marri | 16.8 | 16.8 | 4.3 | | UP | ~90 | | | | No signs |
| 47 | 413339 | 6486654 | Wandoo | 16.6 | 5.4 | 2.5 | | N | ~35 | | | | No signs |
| 48 | 413235 | 6486633 | Wandoo | 24.6 | 13.6 | 3.6 | | N | ~40 | | | | No signs |
| 49 | 413239 | 6486630 | Marri | 12.2 | 2.2 | 2.9 | 290 | S | 50 | 27 | | | Rub marks - Possum |
| 50 | 413227 | 6486536 | Wandoo | 12.4 | 5 | 2.5 | | UP | ~90 | | | | No signs |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 51 | 413219 | 6486510 | Dead | 11 | 5 | 2.8 | | S | ~80 | | | | No signs |
| 52 | 413225 | 6486486 | Marri | 8.8 | 4.8 | 2.04 | | S | ~40 | | | | No signs |
| 53 | 413244 | 6486471 | Marri | 21 | 6 | 4 | | N | ~45 | | | | No signs |
| 54 | 413157 | 6486469 | Dead | 29 | 24 | 2.8 | | NW | ~35 | | | | No signs |
| 55 | 413155 | 6486479 | Wandoo | 22.6 | 14.6 | 3.3 | | UP | ~40 | | | | No signs |
| 56 | 413139 | 6486474 | Wandoo | 21 | 9 | 2 | | UP | ~35 | | | | No signs |
| 57 | 413190 | 6486560 | Wandoo | 11 | 5 | 2.3 | | UP | ~35 | | | | No signs |
| 58 | 412988 | 6486524 | Marri | 7.4 | 7.4 | 2.4 | | UP | ~40 | | | | No signs |
| 59 | 412943 | 6487156 | Wandoo | 17.4 | 8.4 | 3.9 | | UP | ~35 | | | | No signs |
| 60 | 412975 | 6487206 | Wandoo | 22 | 6 | 2.5 | 50 | N | 30 | 30 | | | No signs |
| 61 | 413051 | 6487192 | Dead | 10.6 | 10.6 | 2.55 | | UP | ~100 | | | | No signs |
| 62 | 412906 | 6486211 | Marri | 9.6 | 6.2 | 2.1 | | SE | ~100 | | | | No signs |
| 63 | 412867 | 6486237 | Dead | 16.6 | 7.6 | 3.7 | | E | ~50 | | | | No signs |
| 65 | 413327 | 6485619 | Jarrah | 11.8 | 6.8 | 2.5 | | UP | ~40 | | | | No signs |
| 66 | 413193 | 6485553 | Marri | 14.6 | 10 | 3.6 | | UP | ~50 | | | | No signs |
| 67 | 414115 | 6486788 | Wandoo | 16.4 | 5.4 | 2.8 | | SE | ~40 | | | | Bees |
| 68 | 413310 | 6484737 | Marri | 8 | 6 | 3.9 | | UP | ~90 | | | | No signs |
| 69 | 413242 | 6484767 | Marri | 15.6 | 8 | 3.2 | | S | ~15 | | | | No signs |
| 70 | 412803 | 6485273 | Marri | 10.2 | 6.8 | 3.9 | | S | ~50 | | | | No signs |
| 71 | 413199 | 6485484 | Jarrah | 16.2 | 7.6 | 3.8 | | S | ~40 | | | | No signs |
| 73 | 412708 | 6486406 | Wandoo | 9.4 | 6 | 3.9 | | S | ~35 | | | | No signs |
| 74 | 413188 | 6485535 | Marri | 9.8 | 9.8 | 2.5 | | UP | ~50 | | | | No signs |
| 79 | 413217 | 6486554 | Wandoo | 14 | 5.5 | 2.1 | 300 | S | 23 | 24 | | | No signs |

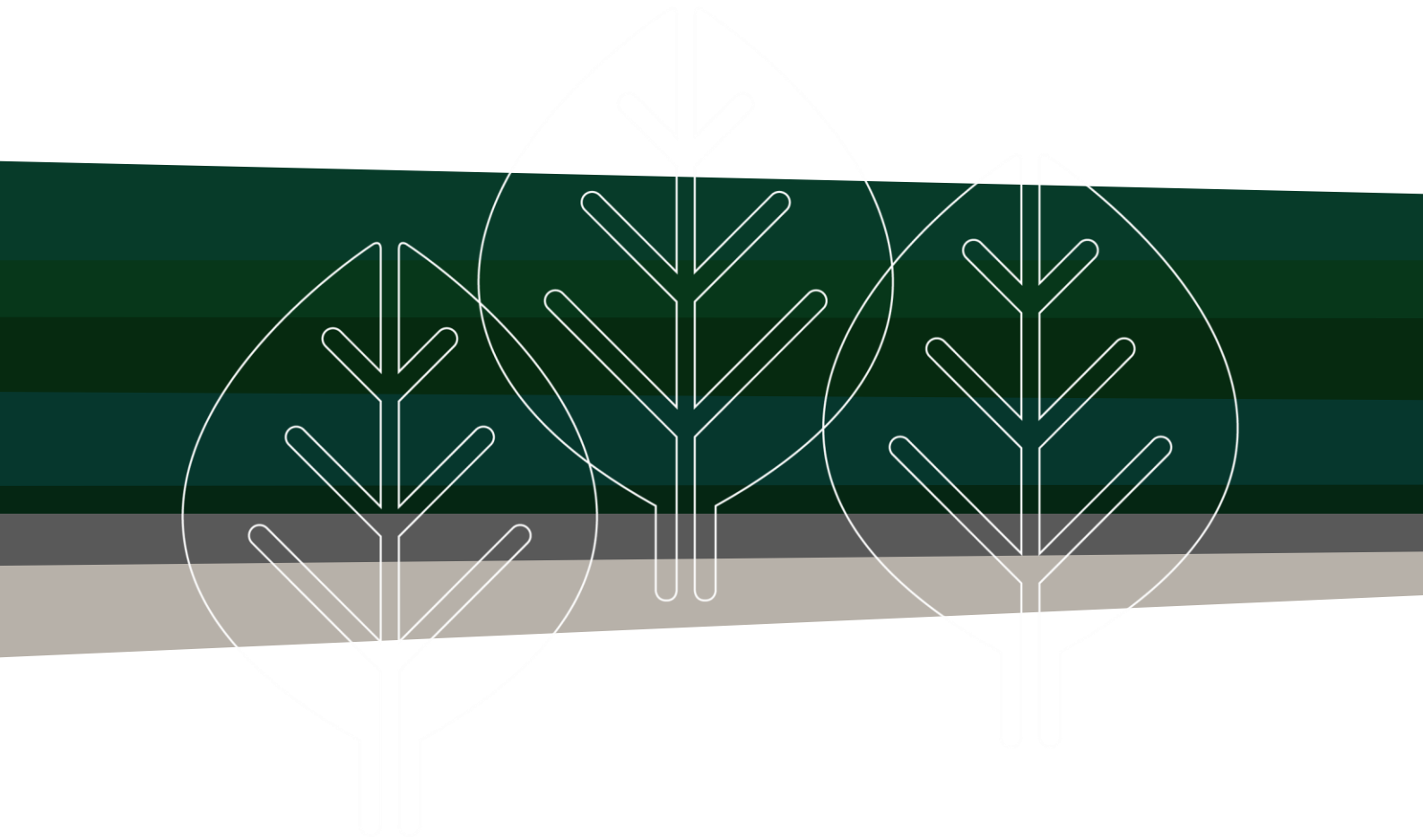
# APPENDIX B

emerge ASSOCIATES
Integrated Science & Design

## BIANNUAL REVEGETATION MONITORING REPORTS

revegetating
rehabilitating
restoring

tranen
revegetation systems



# Avon Ridge Estate
# Bi-annual Monitoring Report – Spring 2014

Emerge Associates

P496-04-Rev00

**February 2015**

## Disclaimer



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# 1 SUMMARY

Tranen was engaged to undertake revegetation work at PEET's Brigadoon Park and Recreation Reserve in winter 2011. Further revegetation works have been undertaken in 2012, 2013 and 2014 with the aim of contributing to the target of 214,000 seedlings required as part of the offset package for the development.

Six revegetation sites were established between 2011 and 2013. A total of 88,255 seedlings were initially installed into these six sites. Infill planting has also occurred in 2012, 2013 and 2014 to replace dead plants, which is a pro-active approach to achieve the 90% survivorship criteria before the end of the three-year monitoring period. The infill plants do not count towards the 214,000 seedlings required to be planted, and future survivorship observations are calculated against the original number of seedlings planted. Hence, prior to the spring 2014 monitoring, a total of 144,675 seedlings (initial plantings plus infill) had been installed in the six sites.

- Site 1A: 52,075 seedlings installed in 2011, 2012 and 2014;
- Site 2: 32,520 seedlings installed in 2012, 2013 and 2014;
- Site 3: 6,410 seedlings installed in 2013 and 2014;
- Site 4: 25,140 seedlings installed in 2013 and 2014;
- Sales Office A (SO-A): 6,150 seedlings installed in 2013; and
- Sales Office B (SO-A): 22,380 seedlings installed in 2013 and 2014.

The approval given to PEET under the *Environment Protection Biodiversity Conservation Act 1999* requires a survivorship rate of 90% of all installed seedlings at the end of the three year maintenance period. Other completion criteria, as set out in the *Avon Ridge Estate, Brigadoon: Revegetation and Fire Management Plan* (Cardno 2012) are:

- Plants are healthy in appearance and diverse in species with no mass losses;
- At least 65% of the species planted have survived (a measure of species richness);
- The average seedling height has increased between assessments; and
- Weed presence is minimal and not inhibiting native plant survival and growth.

Following the spring 2014 monitoring, the following survival rates have been observed (based on original numbers planted into each site):

- Site 1A: 94%;
- Site 2: 140%;
- Site 3: 130%;
- Site 4: 121%;
- Sales Office A (SO-A): 27%; and
- Sales Office B (SO-A): 76%.

Table 1 summarises the progress of each site against the selection criteria. Site 1A has now reached three years since establishment, and has met all the criteria. Revegetation works at Site 1A can therefore be considered complete. Site 2 has one year remaining before it is to be finally assessed against the criteria, while all other sites have two years remaining.

**Table 1 Revegetation Progress Against the Completion Criteria**

| Completion Criteria | Site 1A | Site 2 | Site 3 | Site 4 | Sales Office A | Sales Office B | Actions Required |
|---|---|---|---|---|---|---|---|
| Survivorship rate must be at least 90% | ✓ | ✓ | ✓ | ✓ | X | X | Consider infill planting in 2015[1] |
| Plants are healthy in appearance and diverse in species with no mass losses | ✓ | ✓ | ✓ | ✓ | X | ✓ | None |
| Species richness is ≥ 65% | ✓ | ✓ | ✓ | ✓ | X | ✓ | None |
| The average seedling height has increased between assessments | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | None |
| Weed presence is minimal and not inhibiting native plant survival and growth | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | Continue weed control as needed |
| **No. years until assessment complete** | **0** | **1** | **2** | **2** | **2** | **2** | n/a |

[1] Infill planting may be required for Sales Office B

# 2 INTRODUCTION

Tranen was engaged to undertake revegetation work at PEET's Brigadoon Park and Recreation Reserve in winter 2011. Further revegetation works have been undertaken in 2012, 2013 and 2014 with the aim of contributing to the target of 214,000 seedlings required as part of the offset package for the development as per the conditions under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

## 2.1 EPBC Approval Conditions (Section 2b)

The revegetation measures to create additional Black Cockatoo habitat across the project site, including in the Parks and Recreation Reserve, specifically are:

- Revegetating all vegetation condition classes (excluding pristine and excellent classes) and vegetation complexes;
- Designing species mix: numbers and density to be planted;
- Timing the proposed planting (must be following the annual winter rain period);
- Implementing weed management measures;
- The survivorship rate of all revegetation measures must be at least 90% after three years. If after three years of the date of the planting, a survival rate of 90% of the planted trees is not achieved, all dead trees must be replaced with other Black Cockatoo habitat species within 12 months and maintained for at least an additional two years;
- Annual monitoring measures within the project area undertaken by an appropriately qualified and experienced ecologist and must commence within 12 months of the completion of revegetation and continue for at least three years after the initial revegetation planting in any given area (given that revegetation will be staged across the development); and
- Annual monitoring measures undertaken by an appropriately qualified and experienced specialist must commence in the Parks and Recreation Reserve within 12 months of completion of revegetation and continue for at least three years after the initial planting in the Parks and Recreation reserve for the purpose of establishing the survivorship rates and replanting efforts within the project area.

## 2.2 Monitoring Program Objectives

The main objectives of the bi-annual monitoring program are to:

- Demonstrate the success of the revegetation against the completion criteria specified by the EPBC approval conditions; and
- Identify issues affecting the revegetation program, such as weeds, pathogens or acts of vandalism.

## 2.3 Completion Criteria

At the end of the three year maintenance period for each revegetation area, the following completion criteria are required to be met (from the *Revegetation and Fire Management Plan*, Cardno 2012):

- Survivorship rate must be at least 90% (nb: this is a condition of the EPBC Act approval);
- Plants are healthy in appearance and diverse in species with no mass losses;
- At least 65% of the species planted have survived (a measure of species richness);
- The average seedling height has increased between assessments; and
- Weed presence is minimal and not inhibiting native plant survival and growth.

# 3 REVEGETATION SITES AND WORKS TO DATE

Six revegetation sites have been established (for a map of their locations, refer to Appendix 1):

- Site 1A: established in 2011;
- Site 2: established in 2012;
- Site 3: established in 2013 as an unfenced trial site, which was subsequently fenced prior to the 2014 planting works;
- Site 4: established in 2013;
- Sales Office A: established in 2013 as an unfenced trial site; and
- Sales Office B: established in 2013.

A summary of the planting years, total area and number of seedlings planted up until spring 2014 for each revegetation site is presented in Table 2. The total number of seedlings planted to date is 144,675.

**Table 2 Revegetation Sites**

| Site Name | Area (ha) | Fenced or Unfenced | 2011 Seedlings | 2012 Seedlings | 2013 Seedlings | 2014 Seedlings | Total Seedlings |
|---|---|---|---|---|---|---|---|
| **1A** | 13.4 | Fenced | **30,775** | 12,000 | - | 9,300 | **52,075** |
| **2** | 4.7 | Fenced | - | **24,000** | 6,520 | 2,000 | **32,520** |
| **3** | 0.3 | Fenced[1] | - | - | **2,610** | 3,800 | **6,410** |
| **4** | 2.8 | Fenced | - | - | **10,340** | 14,800 | **25,140** |
| **Sales Office A** | 0.8 | Unfenced[2] | - | - | **6,150** | - | **6,150** |
| **Sales Office B** | 2.3 | Fenced | - | - | **14,380** | 8,000 | **22,380** |
| **TOTAL** | **24.3** | - | **30,775** | **36,000** | **40,000** | **37,900** | **144,675** |
| **Blue = initial planting number for each site** | | | | | **TOTAL of initial planting** | | **88,255** |
| **Black = infill planting numbers** | | | | | | | |

[1] Site 3 was initially not fenced to investigate whether fences were necessary to protect seedlings. Results indicated kangaroos were eating seedlings, so a fence was erected prior to 2014 planting.
[2] Sales Office A was initially not fenced to investigate whether fences were necessary to protect seedlings. This area was abandoned as a trial area because of the proximity to houses (fire risk) and deleterious effects on the aesthetics of the area if a fence were to be established.

## 3.1 Site 1A

The 2011 initial revegetation program at Site 1A consisted of:

- Deep ripping (not undertaken by Tranen);
- Installation of a kangaroo fence with rabbit proof skirt measuring 1,545 m long and 1.8 m high,
- Pre-planting weed control program of herbicide application (glyphosate and simazine) in July 2011 and manual removal of olive trees (August 2011); and
- Planting of 30,775 seedlings into rip lines between July and August 2011.

Since the initial installation the following maintenance activities have been undertaken at Site 1A:

- Additional planting:
  - 12,000 seedlings in August 2012;
  - 9,300 seedlings in July and August 2014;
- Fencing repair (2013);
- Weed control maintenance:
  - Spring 2011;
  - Summer, autumn and spring 2012;
  - Winter 2013;
  - Autumn and spring 2014.

**Figure 1 Site 1A – Transect #40 Shows the Developing Plants Installed in 2011**

## 3.2 Site 2

The 2012 revegetation program at Site 2 consisted of:

- Deep ripping (not undertaken by Tranen);
- Installation of a kangaroo fence with rabbit proof skirt measuring 1,000 m long and 1.8 m high;
- Pre-planting weed control program of herbicide application (glyphosate and Simazine) in July 2012; and
- Planting of 24,000 seedlings in August 2012.

Since the initial installation the following maintenance activities have been undertaken at Site 2:

- Fencing repair (2012);
- Additional planting:
  - 6,520 seedlings in June and July 2013;
  - 2,000 seedlings in July 2014;
- Weed control maintenance:
  - Spring 2012;
  - Summer 2012/13;
  - Autumn 2013; and
  - Autumn 2014.

**Figure 2 Site 2 – Transect # 19**

## 3.3 Site 3

Site 3 was established in 2013 without a kangaroo-proof fence as a trial to determine whether grazing by kangaroos was an impacting factor on the seedlings. Results of seedling survival after the first year indicated that seedling survival was very poor compared with fenced sites (survival of 7% compared with > 30% in fenced sites). Hence, a fence was established prior to planting in 2014.

Revegetation at Site 3 commenced in 2013 and consisted of:

- Deep ripping (not undertaken by Tranen);
- Pre-planting weed control program of herbicide application (glyphosate and Oust® pre-emergent) in July 2013; and

- Planting of 2,610 seedlings in July 2013.

Since the initial installation the following maintenance activities have been undertaken at Site 3:

- Installation of a kangaroo fence with rabbit proof skirt measuring 259 m long and 1.8 m high in autumn 2014;
- Weed control in autumn 2014; and
- Planting of 3,800 seedlings in July 2014.

**Figure 3 Site 3 – Transect # 4**

## 3.4 Site 4

Revegetation at Site 4 commenced in 2013 and consisted of:

- Deep ripping (not undertaken by Tranen);
- Installation of a kangaroo fence with rabbit proof skirt measuring 572 m long and 1.8 m high;
- Pre-planting weed control program of herbicide application (glyphosate and Oust® pre-emergent) in July 2013; and
- Planting of 10,340 seedlings in July 2013.

Since the initial installation the following maintenance activities have been undertaken at Site 4:

- Fence repairs (August 2013);
- Weed control in autumn 2014;

- Additional fencing was erected on both sides of the middle track during April 2014. This was necessary because members of the public were leaving the gates open on the middle track through which kangaroos were entering the site; and
- Planting of 14,800 seedlings in July 2014.

**Figure 4 Site 4 – Transect # 3**

## 3.5 Sales Office A

Sales Office A was established without a kangaroo-proof fence as a trial to determine whether grazing by kangaroos was an impacting factor on the seedlings.

Revegetation at Sales Office A commenced in 2013 and consisted of:

- Deep ripping (not undertaken by Tranen); and
- Planting of 6,150 seedlings in June 2013.

Since the initial installation the following maintenance activities have been undertaken at Sales Office A:

- Weed control maintenance:
  - Winter 2013;
  - Spring 2013; and
  - Summer 2013/14 (two events).

**Figure 5 Sales Office A – Quadrat # 2 Showing Strong Growth of Eucalypts**

## 3.6 Sales Office B

Revegetation at Sales Office B commenced in 2013 and consisted of:

- Deep ripping (not undertaken by Tranen);
- Installation of a kangaroo fence with rabbit proof skirt measuring 825 m long and 1.8 m high;
- Pre-planting weed control program of herbicide application (glyphosate and Oust® pre-emergent) in July 2013; and
- Planting of 14,380 seedlings in July 2013.

Since the initial installation the following maintenance activities have been undertaken at Sales Office B:

- Weed control in autumn 2014; and
- Planting of 8,000 seedlings in July 2014.

**Figure 6 Sales Office B – Quadrat # 3 Showing Good Plant Growth**

# 4 MONITORING METHODOLOGY

This report presents results from the field survey conducted between 26 September and 21 November 2014 (spring monitoring).

## 4.1 Plant Survival

Plant survival was assessed in each of the six sites using transects along rip-lines or 10 m × 10 m quadrats that covered several rip-lines. The initial survey for each site, undertaken in the spring following seedling installation, determines the baseline data which is a count of the number of seedlings planted within the monitoring plot. Percentage survival is assessed against this figure for future monitoring events.

Survivorship at all sites has been calculated against the initial planting numbers, and therefore can be greater than 100% where the additional planting has increased plant numbers above the original number installed.

## 4.2 Monitoring Plot Establishment and Survival Calculations

Transects, quadrats or a combination of both, were used to assess percentage survival of seedlings at each site. The method employed for assessing survival was dependent on the characteristics of each site, as described below. Different methods were necessary because of the nature of the rip-lines (i.e. long, easily identifiable rip-lines compared with short rip-lines in multiple directions), and difficulties with being able to observe dead plants during the first survey after planting (because of herbivory or rapid decay).

In some transects, there are seedlings that appear to have germinated naturally (i.e. natural recruitment). These have been included in total seedling counts because they contribute to the total number of plants that are present at the site, and are a direct result of the site preparation activities (i.e. soil cultivation, weed management, etc.).

### 4.2.1 Site 1A

Fifty transects were established at Site 1A in spring 2011. Since autumn 2013, two of these transects could not be re-located. Hence, 48 transects were surveyed in spring 2014.

### 4.2.2 Site 2

The initial survey at Site 2 was a random sample of rip-lines throughout the site, and this was continued until the spring 2013 survey was undertaken when permanent transects were established. With previous surveys being random, there was no baseline data against which survival could be assessed. To determine baseline seedling numbers, the following was undertaken:

- Twenty transects were established in spring 2013 across the site.

- For each transect, living plants were counted.
- It was assumed that the living plants represented 66% of the original number of seedlings planted in 2012, based on the mean percentage survival that was calculated during the autumn 2013 survey (Tranen 2013).

### 4.2.3 Site 3

Nine permanent transects were established along rip-lines in Site 3 during the initial spring 2013 survey. Baseline data were collected of live and dead plants on each transect to determine the total number of seedlings planted, and to enable percentage survival to be calculated.

The same rip-lines were assessed in spring 2014 to determine the percentage survival.

### 4.2.4 Site 4

Fifteen permanent transects were established along rip-lines in Site 4 during the initial spring 2013 survey. Baseline data were collected of live and dead plants on each transect to determine the total number of seedlings planted, and to enable percentage survival to be calculated.

The same rip-lines were assessed in spring 2014 to determine the percentage survival.

### 4.2.5 Sales Office A

Six quadrats measuring 10 ×10 m were established across the site during the spring 2013 survey. Quadrats were used instead of transects as this site had been ripped in multiple directions, rather than having parallel rip-lines installed across the slope.

Due to impacting factors at the site, the most severe being kangaroo herbivory, it was not possible to obtain counts of dead plants during the baseline survey, as there was little evidence of any dead plants remaining. To determine the baseline data and enable future calculations of percentage survival, the following steps were undertaken for each quadrat:

- Number of living plants was counted;
- The density of plants in each quadrat was calculated as:
  - [number of living plants] / 100 $m^2$;
- The density in each quadrat was compared against the average density for the site, which was calculated as:
  - Total number of seedlings planted for the site divided by the area of the site = 6,150 seedlings / 8,000 $m^2$ = 0.77 plants / $m^2$;
- The proportion of seedlings surviving was therefore calculated as: [quadrat stem density] / 0.77.

In the spring 2014 survey, the quadrats were re-assessed for number of surviving plants to determine % survival.

### 4.2.6 Sales Office B

A combination of quadrats and transects was employed at Sales Office B, as there were wide areas with clear rip-lines in some places, and small areas where multiple rip-lines had been installed in several directions. Ten transects and five 10 x 10 m quadrats were established during the initial spring 2013 survey to obtain a representative survey of the site. Baseline data were collected of live and dead plants on each transect or in each quadrat to determine the total number of seedlings planted, and to enable percentage survival to be calculated.

In the spring 2014 survey, the quadrats and transects were re-assessed for number of surviving plants to determine percentage survival.

## 4.3 Other Observations

At each revegetation site, observations were made of weed species and cover, seedling health (including pest attack, drought stress etc.), species diversity, maximum plant height along transects, occurrence of erosion or soil disturbance, and the health or occurrence of remnant vegetation.

Species richness was calculated as the number of species observed across the site divided by the number of species planted into the site and expressed as a percentage. This was done by observations on transects and by a walk-through across the site.

# 5 RESULTS

Site 1A was established three years ago and is therefore being formally assessed against the completion criteria in this report, with a view to completing revegetation works at this site.

Site 2 was established two years ago and therefore will be formally assessed against the completion criteria after surveying in spring 2015. The remainder of sites were established in 2013 and will therefore be formally assessed against the completion criteria in spring 2016. For sites 2, 3, 4 and Sales Office A and B, the data presented in this report is a progress report to determine whether the sites are progressing towards the completion criteria or whether remedial works should be considered to improve performance.

Raw data for all quadrats and transects at all sites are presented in Appendix 2. A description of the results for each site is presented in the sections below.

A summary of the data for all sites as assessed in spring 2014 is presented in Table 3 for assessment against the completion criteria of percentage plant survival and species diversity.

Progress of each site against the completion criteria are presented in the sections to follow.

**Table 3 Plant Survival and Species Richness Measured Against Completion Criteria**

Text is **green** if meeting criteria or **red** if not meeting criteria

| Measurement | Season & Year | Site | | | | | |
|---|---|---|---|---|---|---|---|
| | | 1A | 2 | 3 | 4 | SO-A | SO-B |
| **% Survival** | **Completion Criteria** | **90%** | **90%** | **90%** | **90%** | **90%** | **90%** |
| | Spring 2014 | 94% | 140% | 130% | 121% | 27% | 76% |
| **Species Richness[A]** | **Completion Criteria** | **65%** | **65%** | **65%** | **65%** | **65%** | **65%** |
| | Spring 2014 | 81% | 93% | 83% | 93% | 36% | 96% |

[A] Species richness is calculated as the number of species observed divided by the total number of species planted

## 5.1 Site 1A (Established in 2011)

Site 1 has reached the end of the three-year revegetation period, and is therefore being assessed against the completion criteria in this report.

### 5.1.1 Survival and Condition of Revegetation

Mean survival rate across the 48 transects measured at Site 1A was 94% (± 53% standard deviation) of original numbers planted in 2011 (Table 3), which is an increase from a survival rate of 60% recorded in autumn 2014. This survival rate exceeds the 90% completion criterion required after three years (Figure 7).

The previous monitoring report (autumn 2014) noted the death of some plants due to the severe drought experienced in the summer of 2013/14. There were some saplings that have resprouted since that time.

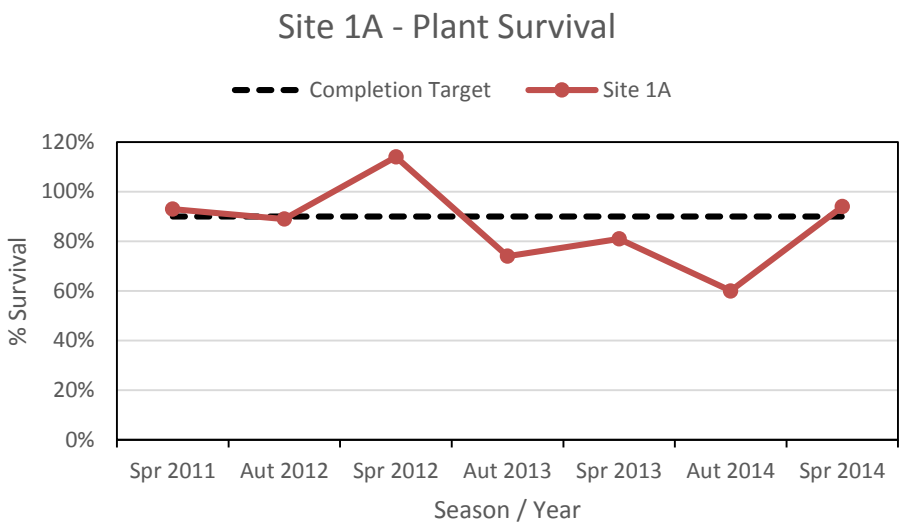


**Figure 7 Site 1A – Plant Survival Since Site Establishment**

### 5.1.2 Plant Heights

Maximum plant heights along transects at Site 1A were as high as 6.5 m, and as low as 1.0 m (mean of 4.4 m ± 1.2). Mean maximum plant height across the site has increased 0.4 m between autumn and spring 2014, and has increased between every monitoring assessment, as required to meet this completion criterion (Figure 8).

Of the 48 transects that were surveyed in spring 2014, *Acacia saligna* was the tallest species for 31 of them, with *E. rudis* the tallest in most others.

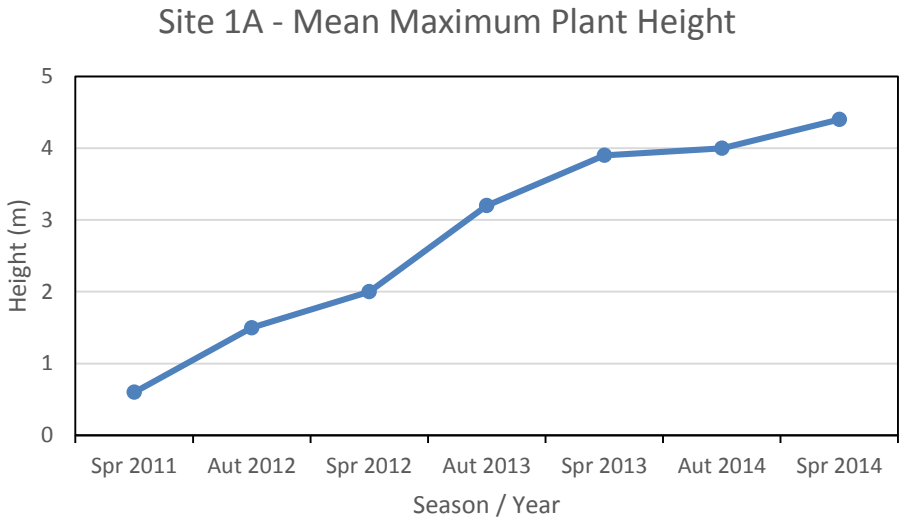


**Figure 8 Site 1A – Plant Heights Since Site Establishment**

### 5.1.3 Remnant Vegetation

Site 1A contained a number of areas of remnant vegetation, mainly *E. rudis* and *E. wandoo* trees, as well as a shrubland of *Leptospermum erubescens* in the north-eastern corner of the site.

A number of seedlings have germinated from the soil-stored seed bank since the beginning of the project, and these plants are further increasing the density of plants in the area. *Eucalyptus rudis* dominates the natural recruits, while *Corymbia calophylla, Hibbertia commutata*, *Hibbertia subvaginata, Daviesia ?triflora, Daviesia* sp., *Juncus pallidus* and *Banksia sessilis* recruitment has also been observed. All but *B. sessilis* were observed along the rip-lines, while *E. rudis* and *H. commutata* are common recruits throughout the site (including on and off the rip-lines).

### 5.1.4 Weeds

Weed cover was relatively high at the time of survey for this site (mean cover of 54% ± 24%). This was due to the survey occurring prior to spring weed control. Since the survey has been undertaken, weed cover has reduced and is not inhibiting native plant survival and growth, which meets the completion criterion for weeds.

### 5.1.5 Species Richness

A total of 36 species were planted in Site 1A between 2011 and 2014. Of these 36 species, 29 were observed (81% of the total) either during the transect scoring or while walking across the site (Appendix 2). This value for species richness exceeds the completion criterion required after three years, which is for 65% of all species planted to be represented on site. Figure 9 shows that species richness has remained above 65% for the duration of the project.

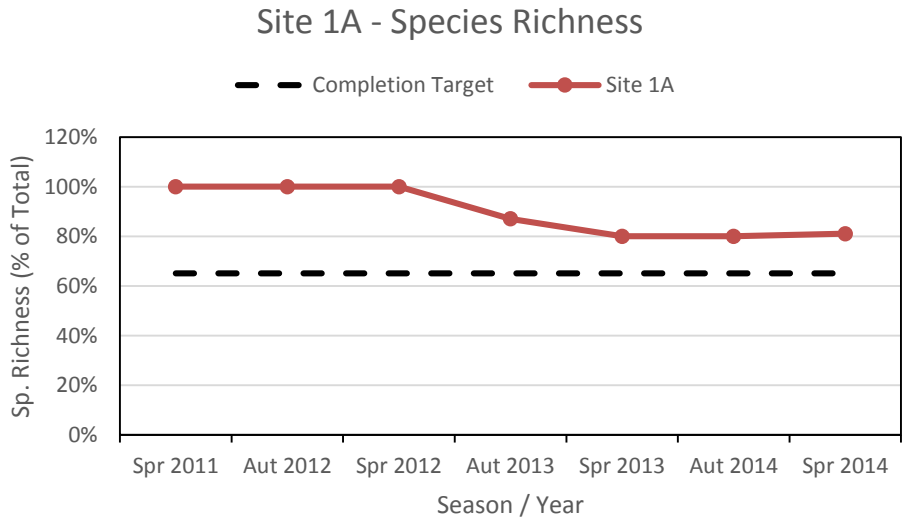


**Figure 9 Site 1A – Species Richness Since Site Establishment**

### 5.1.6 Fauna

Minor signs of herbivory were observed during the monitoring, but are of no great concern.

### 5.1.7 Surface Stability and Erosion

Soil surface was stable across the site, with little or no sign of erosion.

## 5.2 Site 2 (Established in 2012)

### 5.2.1 Survival and Condition of Revegetation

Mean survival rate across the 20 transects at Site 2 was estimated at 140% (± 152% standard deviation) of the original number of seedlings planted in 2012 (Table 3).

Site 2 has had very high survival rates since the initial planting 2012, with the last three assessments all showing survival to be higher than the required 90% survival rate (Figure 10).

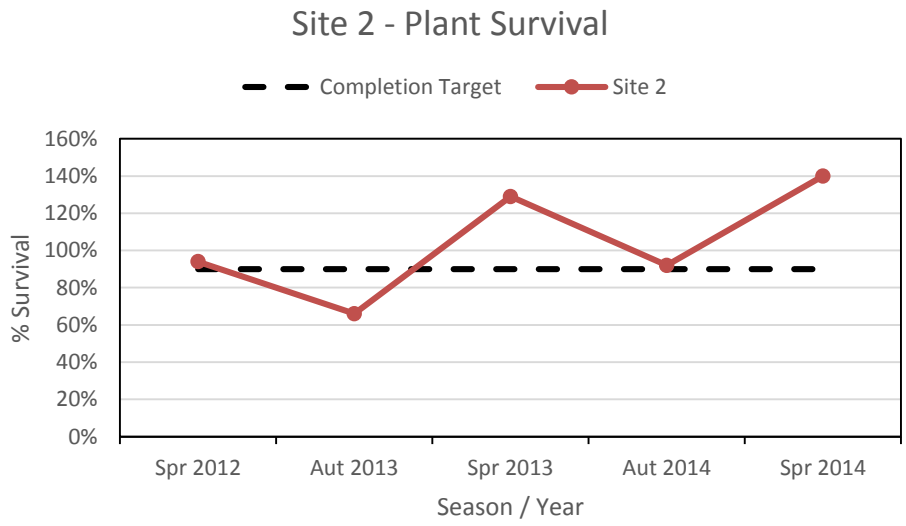


**Figure 10 Site 2 – Plant Survival Since Site Establishment**

### 5.2.2 Plant Heights

Maximum plant heights increased by 0.8 m on average since autumn 2014. Mean maximum plant height for transects was 2.9 m (± 1.2 m).

Plant heights have continued to increase at Site 2 since the initial site establishment in 2012 (Figure 11).

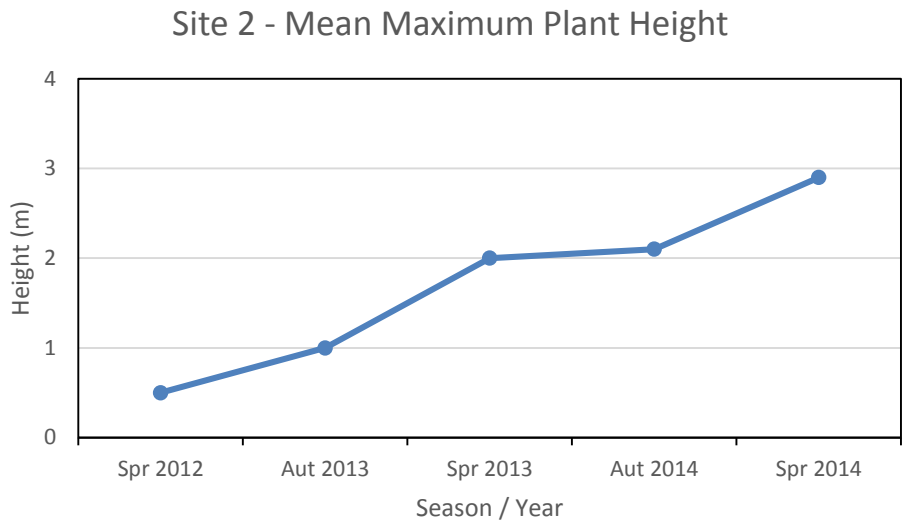


**Figure 11 Site 2 – Plant Heights Since Site Establishment**

### 5.2.3 Remnant Vegetation

Site 2 contained several patches of remnant vegetation, with *Corymbia calophylla* and *Eucalyptus wandoo* trees scattered throughout the site.

Seedlings of *E. wandoo* and *C. calophylla* were observed on site, while the native grass *Austrostipa flavescens* occurred in high densities in some areas.

### 5.2.4 Weeds

Weed cover was generally low across the whole site, with mean weed cover 37% (± 24%). Most weeds observed were not likely to be competing with the older plants on the site.

### 5.2.5 Species Richness

A total of 27 species were planted at Site 2 over the three planting years. Of these, 25 species were observed either on transects or during a walk-through of the site (93% of the total species) (Table 3). Species diversity has remained above the 65% completion criterion for the duration of the project so far (Figure 12).

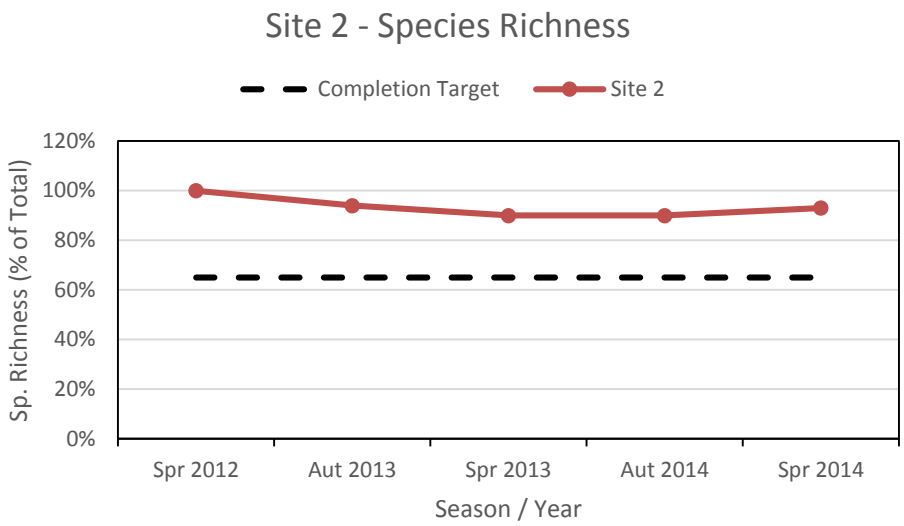


**Figure 12 Site 2 – Species Richness Since Site Establishment**

### 5.2.6 Fauna

No signs of herbivory, digging or utilisation by birds was observed during the monitoring.

### 5.2.7 Surface Stability and Erosion

The soil surface was stable across the site, with little or no signs of erosion.

## 5.3 Site 3 (Established in 2013)

### 5.3.1 Survival and Condition of Revegetation

Mean survival of seedlings relative to the number initially planted into Site 3 was 130% (± 22%) across the nine transects (Table 3). This is a significant increase from autumn 2014 when only 7% survival was recorded (Figure 13). Survival has increased above 100% because more seedlings were planted into the site in 2014 than were originally installed in 2013.

Plant condition was excellent, with no herbivory or damage noted.

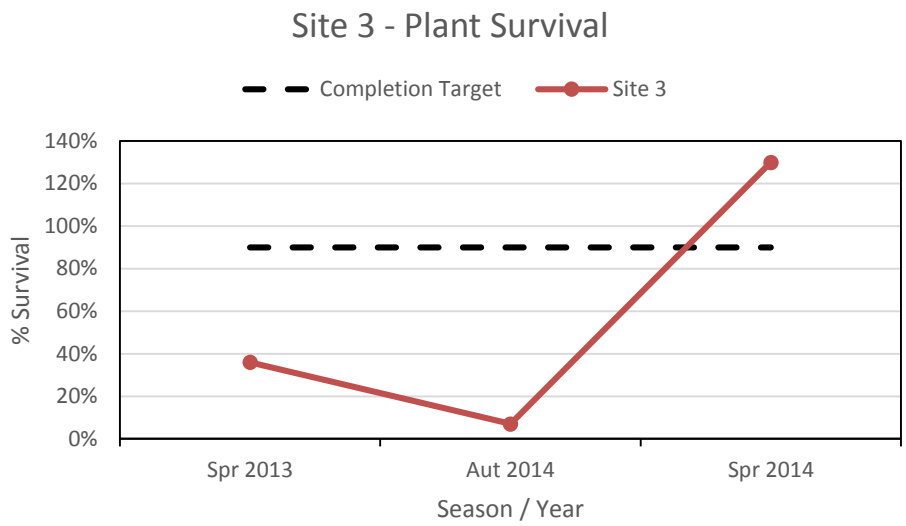


**Figure 13 Site 3 – Plant Survival Since Site Establishment**

### 5.3.2 Plant Heights

Maximum plant heights at Site 3 ranged between 0.3 m and 0.5 m, with a mean height of 0.4 m. This represents a slight increase from the previous assessment in autumn 2014 (Figure 14).

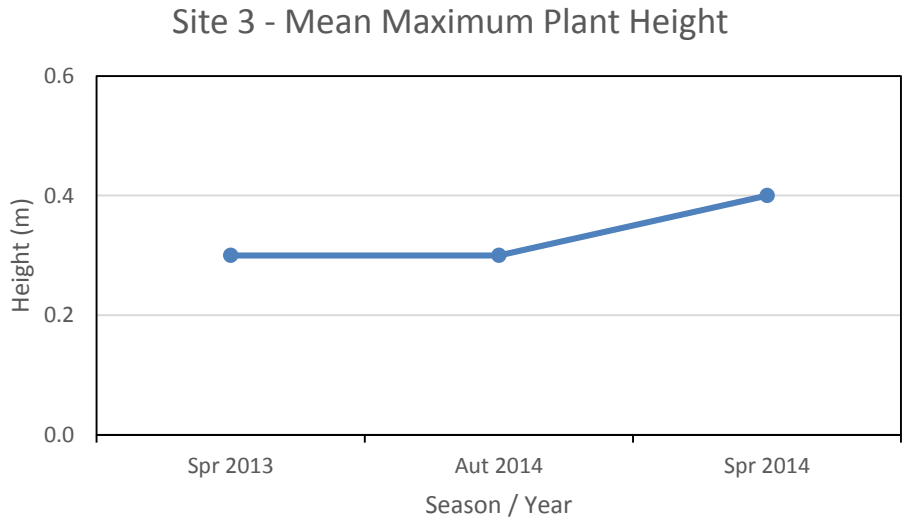


**Figure 14 Site 3 – Plant Heights Since Site Establishment**

### 5.3.3 Remnant Vegetation

Site 3 was established within a clearing surrounded by *E. wandoo* and *C. calophylla* trees. The site contains a few seedlings and saplings of *E. wandoo* and remnant vegetation remains in a good condition.

No natural germinants were observed in the transect lines in spring 2014.

### 5.3.4 Weeds

Weed cover was generally low across the whole site, with mean weed cover 36% (± 16%). Most weeds observed were winter annuals that were dying off and were therefore not likely to be competing with the seedlings.

### 5.3.5 Species Richness

A total of 24 species was planted at Site 3 over 2013 and 2014. Twenty of these species were observed in spring 2014 (83% of the total species, which is above the completion target required by the third year) (Figure 15).

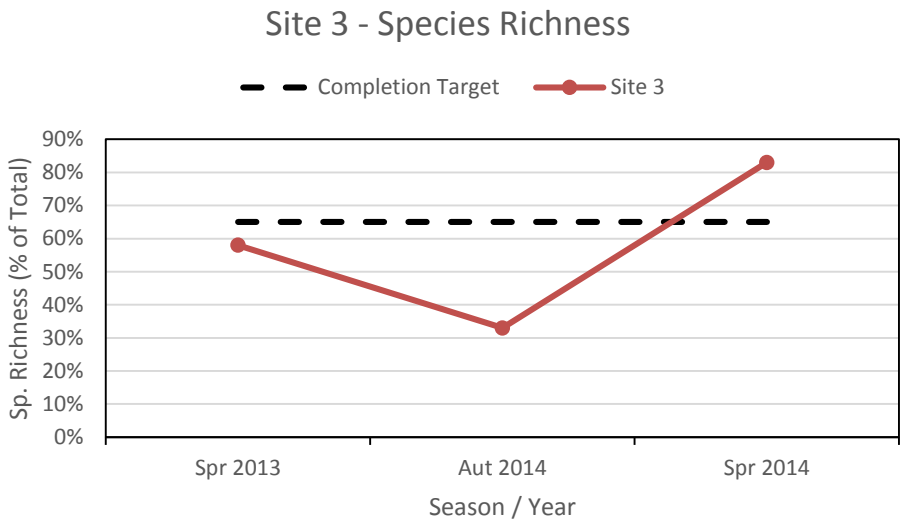


**Figure 15 Site 3 – Species Richness Since Site Establishment**

### 5.3.6 Fauna

Prior to the fence being erected, the site was significantly affected by vertebrate herbivores, with kangaroo presence at the site noted through dung and resting sites. Since installation of the fence, there is no evidence of kangaroo or rabbit presence on site.

### 5.3.7 Surface Stability and Erosion

The site showed only minor evidence of erosion. All rip-lines have been installed across the slope parallel to the contours, which reduces the erosion potential from surface water runoff.

## 5.4 Site 4 (Established in 2013)

### 5.4.1 Survival and Condition of Revegetation

Mean survival of seedlings relative to the initial number installed for Site 4 was 121% (± 55%) across the 15 transects (Table 3; and for raw data see Appendix 2). This is a significant increase in survival rates compared with autumn 2014 when survival was measured at 6% (Figure 16).

Plant condition was good, with strong growth noted for *Corymbia calophylla* in particular. Plant condition last year was generally poor, which was most likely due to heavy grazing from kangaroos that were able to come through the gates which were frequently left open. The improvements to the fence around the site appears to have prevented kangaroos from accessing the site.

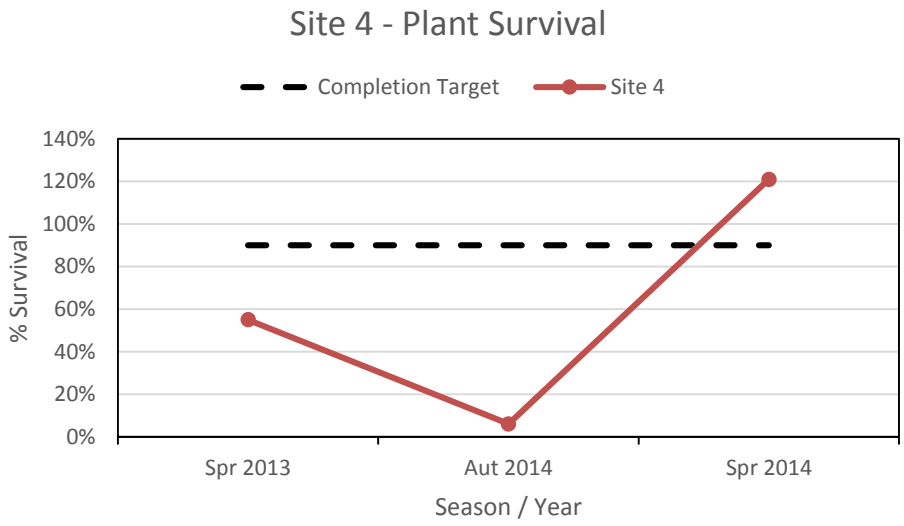


**Figure 16 Site 4 – Plant Survival Since Site Establishment**

### 5.4.2 Plant Heights

Maximum plant heights at Site 4 ranged between 0.2 m and 1.5 m, with a mean plant height of 0.6 m (± 0.3 m). This is an increase from previous surveys.

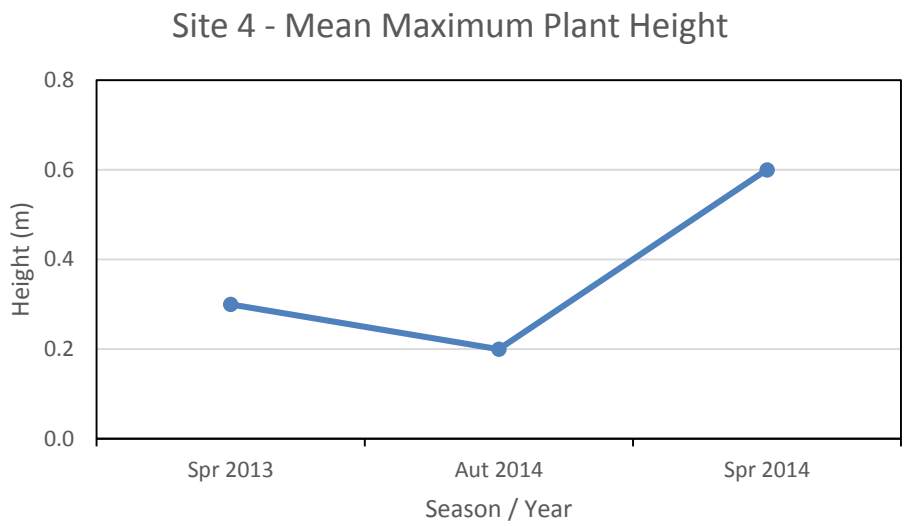


**Figure 17 Site 4 – Plant Heights Since Site Establishment**

### 5.4.3 Remnant Vegetation

Site 4 contains patches of remnant vegetation which consist almost entirely of *E. wandoo* mature trees. These are scattered throughout the site, but are only small in area. Trees appear healthy.

No natural germination was observed on transects in spring 2014.

### 5.4.4 Weeds

Weed foliar cover averaged 44% (± 24%) across the site. Most weeds observed were winter annuals that were dying off and were therefore not likely to be competing with the seedlings and were generally outside the rip-lines.

### 5.4.5 Species Richness

A total of 27 species was planted at Site 4 over two seasons in 2013 or 2014. Of these, 25 were observed during the spring 2014 assessment. This represents 93% of the total number planted (Table 3), which is well above the completion target required after three years (Figure 18).

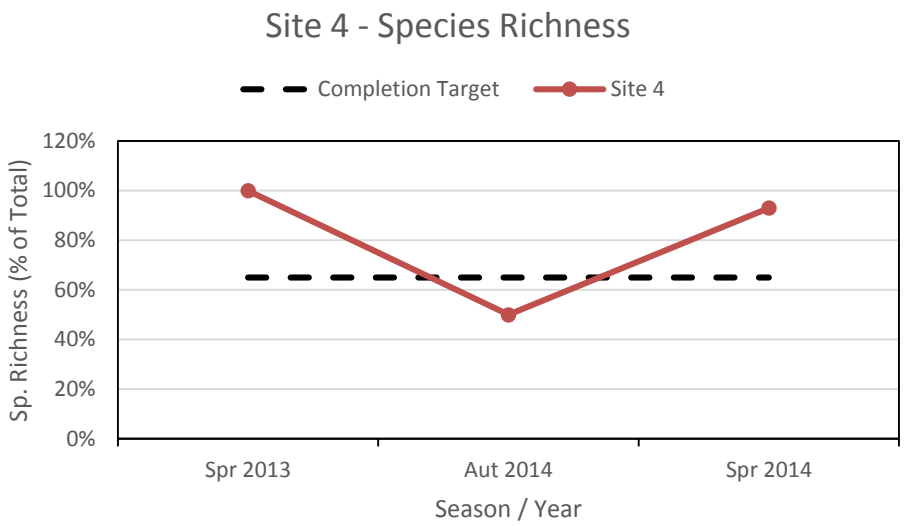


**Figure 18 Site 4 – Species Richness Since Site Establishment**

### 5.4.6 Fauna

Prior to the fence being altered in autumn 2014, the site was significantly affected by vertebrate herbivores, with kangaroos the most likely cause of poor plant survival and health. Since adding additional fencing on either side of the track so that recreational users of the track cannot leave gates open, there is no evidence of kangaroo or rabbit presence on site.

### 5.4.7 Surface Stability and Erosion

The slopes on the eastern side of the site do have some erosion channels forming, some of which may be a result of the direction of ripping that was undertaken on the site.

## 5.5 Sales Office A (Established in 2013)

### 5.5.1 Survival and Condition of Revegetation

Mean survival of seedlings relative to the initial number installed at Sales Office A was 27% (± 15%) across the six quadrats (Table 3). Survival has remained unchanged from the previous assessment, and is currently below the completion target to be met after three years (Figure 19).

The condition of most surviving plants was good, with the majority being *Eucalyptus wandoo* or *Corymbia calophylla* that appear to be left alone by the kangaroos.

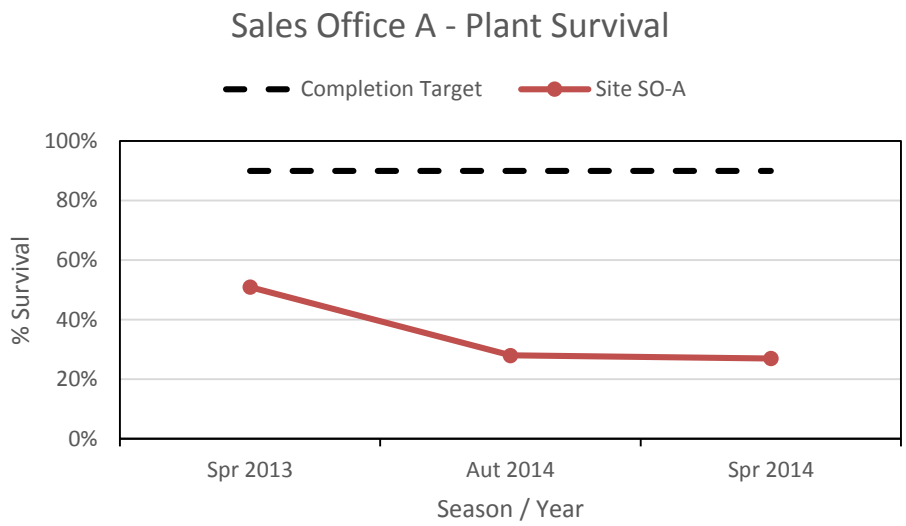


**Figure 19 Sales Office A – Plant Survival Since Site Establishment**

### 5.5.2 Plant Heights

Maximum plant heights at Sales Office A ranged between 0.6 m and 1.5 m, with a mean plant height of 1.5 m. This represents an increase since previous surveys (Figure 20).

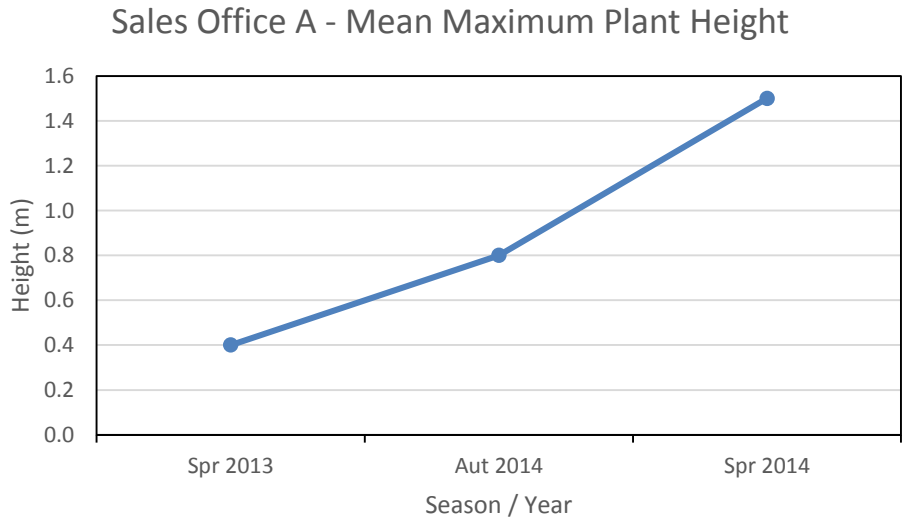


**Figure 20 Sales Office A – Plant Heights Since Site Establishment**

### 5.5.3 Remnant Vegetation

There is no remnant vegetation within Sales Office A. This was a bare paddock prior to revegetation works commencing.

### 5.5.4 Weeds

Weed cover was relatively low throughout the site at the time of survey, with an average weed cover of 15% (± 8%). Most of these weeds were winter annuals which have shallow root systems and are completing their life cycles, and are therefore not competing with the seedlings.

Sales Office A has the potential to be very weedy given the large population of Narrow-leaf Cotton Bush that was previously on the road verge immediately up-hill of the site (physically removed by Tranen following planting). However, the above-ground biomass and the root systems of these weeds can reduce the potential for erosion on steep slopes; hence weed control must be considered against potential for soil erosion.

### 5.5.5 Species Richness

Eleven species were originally planted into Sales Office A in 2013. Only four of these were observed during the survey: *Callistemon phoeniceus, Corymbia calophylla, Eucalyptus wandoo* and *Hakea lissocarpha*. The shrubs were severely grazed upon, while *E. wandoo* and *C. calophylla* were healthy and largely untouched by vertebrate herbivores.

Species richness relative to the total number of species installed is therefore very low (36%; Table 3) and not currently meeting the completion target required after three years (Figure 21).

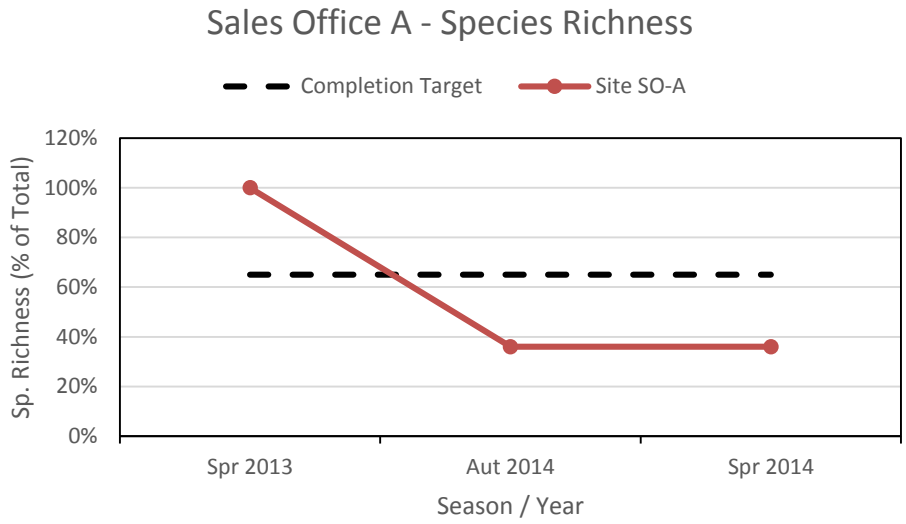


**Figure 21 Sales Office A – Species Richness Since Site Establishment**

### 5.5.6 Fauna

The site appears to have been significantly affected by vertebrate herbivores, with kangaroo presence at the site noted through the presence of dung. There was no evidence that rabbits had been on the site, but it is possible.

Seedlings of *E. wandoo* and *C. calophylla* appear to have reached a stage where they are no longer being grazed.

### 5.5.7 Surface Stability and Erosion

There was some evidence of erosion occurring on this site. The site occurs on a relatively steep hillside, and when ripped, some rip-lines were installed perpendicular to the contours rather than parallel (by contractors not organised by Tranen), which channels and increases the speed and volume of surface flows, leading to erosion.

## 5.6 Sales Office B (Established in 2013)

### 5.6.1 Survival and Condition of Revegetation

Mean survival of seedlings installed at Sales Office B was 76% (± 26%) across the five quadrats and ten transects (Table 3). Survival ranged from 42% to 133% across the plots, and is an increase compared with autumn 2014 (Figure 22). However, this is below the target survival rate of 90% to be met after three years (Figure 22).

The condition of surviving plants was generally very good, with strong growth and few signs of stress.

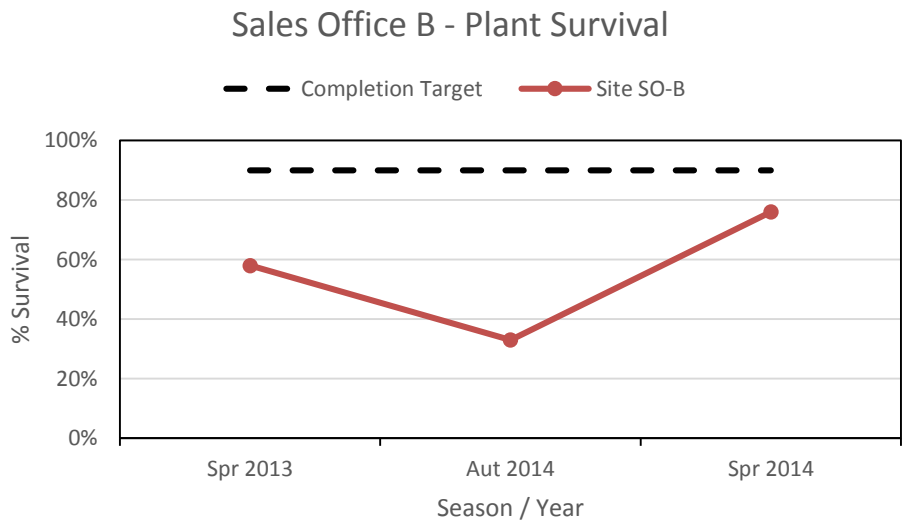


**Figure 22 Sales Office B – Plant Survival Since Site Establishment**

### 5.6.2 Plant Heights

Maximum plant heights at Sales Office B ranged between 0.4 m and 2.0 m, with a mean height of 1.2 m. This represents an increase on previous measurements at the site (Figure 23).

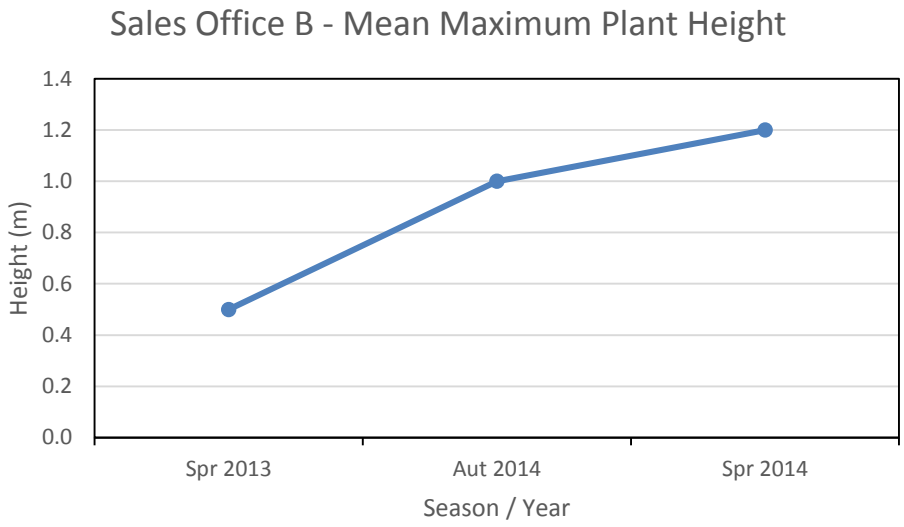


**Figure 23 Sales Office B – Plant Heights Since Site Establishment**

### 5.6.3 Remnant Vegetation

Sales Office B contains patches of remnant vegetation which consist almost entirely of *E. wandoo* mature trees. These are scattered throughout the site, but mainly occur on rocky breakaways. All trees appear to be healthy.

No natural germination was observed on transects or quadrats in spring 2014.

### 5.6.4 Weeds

Weed cover was relatively low throughout the site at the time of survey, with an average weed cover of 13% (± 14%). Most weeds were winter annuals that were dying off and are unlikely to be competing with seedlings.

### 5.6.5 Species Richness

A total of 26 species was planted in Sales Office B over 2013 and 2014. Twenty-five of these were observed during the survey (equivalent to 96% of the total installed; Table 3), which is above the 65% required to meet the completion criterion (Figure 24).

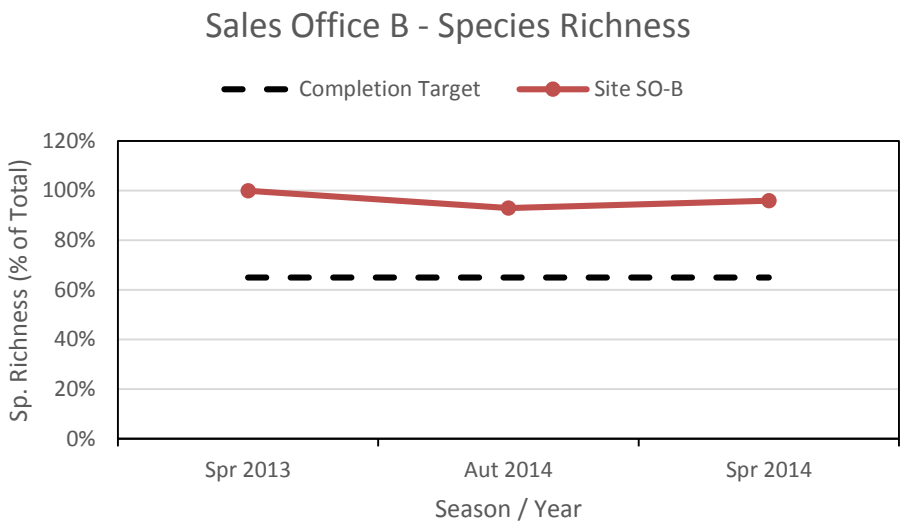


**Figure 24 Sales Office B – Species Richness Since Site Establishment**

### 5.6.6 Fauna

It appeared that there was some grazing of plants at Sales Office B, with evidence of kangaroo and rabbit scats. It is unclear how the kangaroos are able to gain access to the site.

### 5.6.7 Surface Stability and Erosion

There was minor erosion evident in some of the rip-lines that were installed with a slight downhill orientation, and this erosion may have led to some plant deaths. It is not a great concern across this site.

# 6 DISCUSSION

A total of 144,675 seedlings have been planted for the Avon Ridge project out of a total of 214,000 stipulated in the offset package prepared by Peet. Of these, 88,255 seedlings represent initial plantings into the sites, and 56,420 have been planted to account for losses or to increase plant numbers above the 90% survival target. These have been planted across six separate revegetation sites over a three year time frame beginning in 2011. Survivorship of plants installed into the revegetation sites must be 90% or greater after three years to meet Condition 3 of the EPBC approval, and the *Revegetation and Fire Management Plan* (Cardno 2012) presents further completion criteria that must be met:

- Survivorship rate must be at least 90%;
- Plants are healthy in appearance and diverse in species with no mass losses;
- At least 65% of the species planted have survived (a measure of species richness);
- The average seedling height has increased between assessments; and
- Weed presence is minimal and not inhibiting native plant survival and growth.

## 6.1 Assessment Against Completion Criteria

During the spring 2014 survey, survival of planted tubestock relative to the number initially planted in each site was:

- 94% at Site 1A (three years after initial planting);
- 140% at Site 2 (two years after initial planting);
- 130% at Site 3 (one year after initial planting);
- 121% at Site 4 (one year after initial planting);
- 27% at Sales Office A (one year after initial planting); and
- 76% at Sales Office B (one year after initial planting).

Plant survival in some sites was greater than 100% owing to extra numbers being installed in winter 2014 to account for future attrition.

Site 1A was established three years ago and is therefore at a point where it can be finally assessed against the completion criteria. Following collection of data for the spring 2014 survey, the site meets all completion criteria (Table 1):

- Survival of 93% (target: 90%);
- Plants are healthy in appearance and diverse in species;
- Species richness is 81% of the total number planted (target: 65%);
- Average seedling height has increased between assessments; and
- Weed presence is minimal and not inhibiting native plant survival and growth.

Site 2 has one year to run on revegetation activities before it is to be finally assessed against the completion criteria. It currently meets all the criteria (Table 1).

Site 3 has two years to run on revegetation activities before it is to be finally assessed against the completion criteria. It currently meets all the criteria (Table 1).

Site 4 has two years to run on revegetation activities before it is to be finally assessed against the completion criteria. It currently meets all the criteria (Table 1).

Sales Office A has two years to run on revegetation activities before it is to be finally assessed against the completion criteria. It currently does not meet all the criteria (Table 1). In particular, plant survival and species richness measures are below the levels required. However, this site has not been considered for further tubestock planting because kangaroo herbivory will substantially affect survival rates. Installation of a fence is not considered an option because the site is in a highly visible area to residents and sits directly below a lookout to the Avon River which is popular with tourists. Therefore, construction of a fence would impact the aesthetic qualities of the area. Instead, plants that would have been installed at this site to account for deaths have been installed into other sites. Analysis of surviving plant numbers across the other sites where survival is greater than 90% demonstrates that an additional 17,480 plants are alive after accounting for the requirement to meet 90% survivorship of initial plantings (Table 4). This is approximately 4.5 times the number of seedlings required in Sales Office A to make up the numbers to reach 90% survival at this site (3,874 seedlings required), and also accounts for the 2,013 seedlings that are required at Sales Office B to increase survivorship to 90%. Thus, total seedling numbers across all the remaining sites currently accounts for losses at the Sales Office sites, though this should be assessed again in autumn 2015, after the summer period.

**Table 4 Total Seedling Numbers at Each Site**

| Site | Initial No. installed | Survival (Spring 2014) | No. seedlings survived (Spring 2014) | No. seedlings on site to meet 90% survival | No. seedlings in excess of 90% target |
|---|---|---|---|---|---|
| SO-A | 6,150 | 27% | 1,661 | 5,535 | -3,874 |
| 1A | 30,775 | 94% | 28,929 | 27,698 | 1,231 |
| 2 | 24,000 | 140% | 33,600 | 21,600 | 12,000 |
| 3 | 2,610 | 130% | 3,393 | 2,349 | 1,044 |
| 4 | 10,340 | 121% | 12,511 | 9,306 | 3,205 |
| SO-B | 14,380 | 76% | 10,929 | 12,942 | -2,013 |
| **TOTAL** | **88,255** | | **91,023** | **79,430** | **11,593** |
| **Total for sites with >90% survival (1A + 2 + 3 + 4)** | | | | | **17,480** |

Sales Office B has two years to run on revegetation activities before it is to be assessed against the completion criteria. It currently meets all the criteria except for plant survival (76%) which is below the 90% required (Table 1). It appears that survival has been affected by the ability of kangaroos and rabbits to enter the site, even with fences and gates in place.

## 6.2 Plant Health, Species Richness and Growth of Revegetation

The condition and growth of revegetation works is good across all sites, with the exception of Sales Office A which has had its species composition altered from kangaroo herbivory killing most species apart from *Eucalyptus wandoo* and *Corymbia calophylla*.

Plant heights have increased at all sites since the previous assessment. This indicates that the fence installed at Site 3, and the improvements to fencing at Site 4 have had a positive impact at preventing kangaroos from impacting the seedlings.

Species richness currently meets the completion criteria of ≥ 65% for all sites except Sales Office A, which was the only site that did not receive infill planting in 2014. Infill planting at Sites 3 and 4 replaced many species that were significantly impacted by kangaroo herbivory. Some new species were also added to all sites but Sales Office A in 2014 which increased species richness across the project.

## 6.3 Weeds

Weed cover was relatively low across most of the sites at the time of survey. Most weeds occurred outside the rip-lines, and hence were unlikely to be competing with native seedlings.

## 6.4 Remnant Vegetation and Natural Recruitment

Sites 1A and 2 have both shown improvement in condition through natural recruitment. Hundreds of *E. rudis* seedlings have been observed at Site 1A, including in transects, where they have been counted towards the plant numbers and therefore the survival figures. Other species that have been observed germinating at Site 1A are *Corymbia calophylla, Banksia sessilis, Hibbertia commutata, H. subvaginata, Allocasuarina fraseriana* and *Juncus pallidus*, of which *C. calophylla, B. sessilis* and *A. fraseriana* are all Black Cockatoo foraging species (Valentine and Stock, 2008; Groom, 2011).

Species that have been observed germinating at Site 2 over the course of the revegetation activities include *C. calophylla, E. rudis*, *H. commutata* and *Hypocalymma* sp. A large population of the native grass *Austrostipa flavescens* has also established in the centre of Site 2, and in less dense populations in other areas throughout the site. It is likely that the natural recruitment of these species has benefitted significantly from the exclusion of kangaroos, particularly the native grass and shrub species.

The younger sites (Sites 3, 4 and Sales Office A and B) have shown little or no natural recruitment to date. However, this may change as the exclusion of kangaroos and continuing weed control improve conditions for germination and establishment.

## 6.5 Fauna

Installation of a fence at Site 3 and improvements to the fence at Site 4 have prevented kangaroos from impacting seedlings at these sites. Kangaroos do seem to be able to access Sales Office B, which may have impacted survival rates. The gates at this site will be improved to prevent kangaroos being able to get underneath them.

## 6.6 Surface Stability and Erosion

Surface erosion was noted at Sales Office A and B, and at Site 4, all of which have relatively steep slopes. Erosion at Sales Office B was minimal, but it is more severe at Sales Office A and Site 4.

# 7 CONCLUSIONS, RECOMMENDATIONS AND FURTHER WORK

Revegetation works at Avon Ridge are progressing well. Site 1A has met all the completion criteria at the conclusion of its third year, and most other sites are on track to do the same.

Sales Office A will not meet completion criteria after three years of revegetation works are completed in 2016, as it has not been considered for infill planting or other remedial works. Fencing is the only feasible option to protect seedlings from kangaroos, which would go against the aesthetics of the area. Further, installing understorey shrubs would increase the fire hazard posed by this vegetation to residents. It is recommended that no further revegetation works be undertaken at this Site (other than weed control, if required), and that where survival is less than the 90% completion criterion, replacement seedlings are planted into the other revegetation areas.

The need for infill planting at Sites 2, 3, 4 and Sales Office B will be determined following the autumn 2015 survey. Currently, only Sales Office B is below the required 90% survival target. At a minimum, this site may require further planting in 2015.

# 8 REFERENCES

Cardno (2012) *Avon Ridge Estate, Brigadoon: Revegetation and Fire Management Plan* (Revised 2012). Report prepared for Peet Pty Ltd, June 2012.

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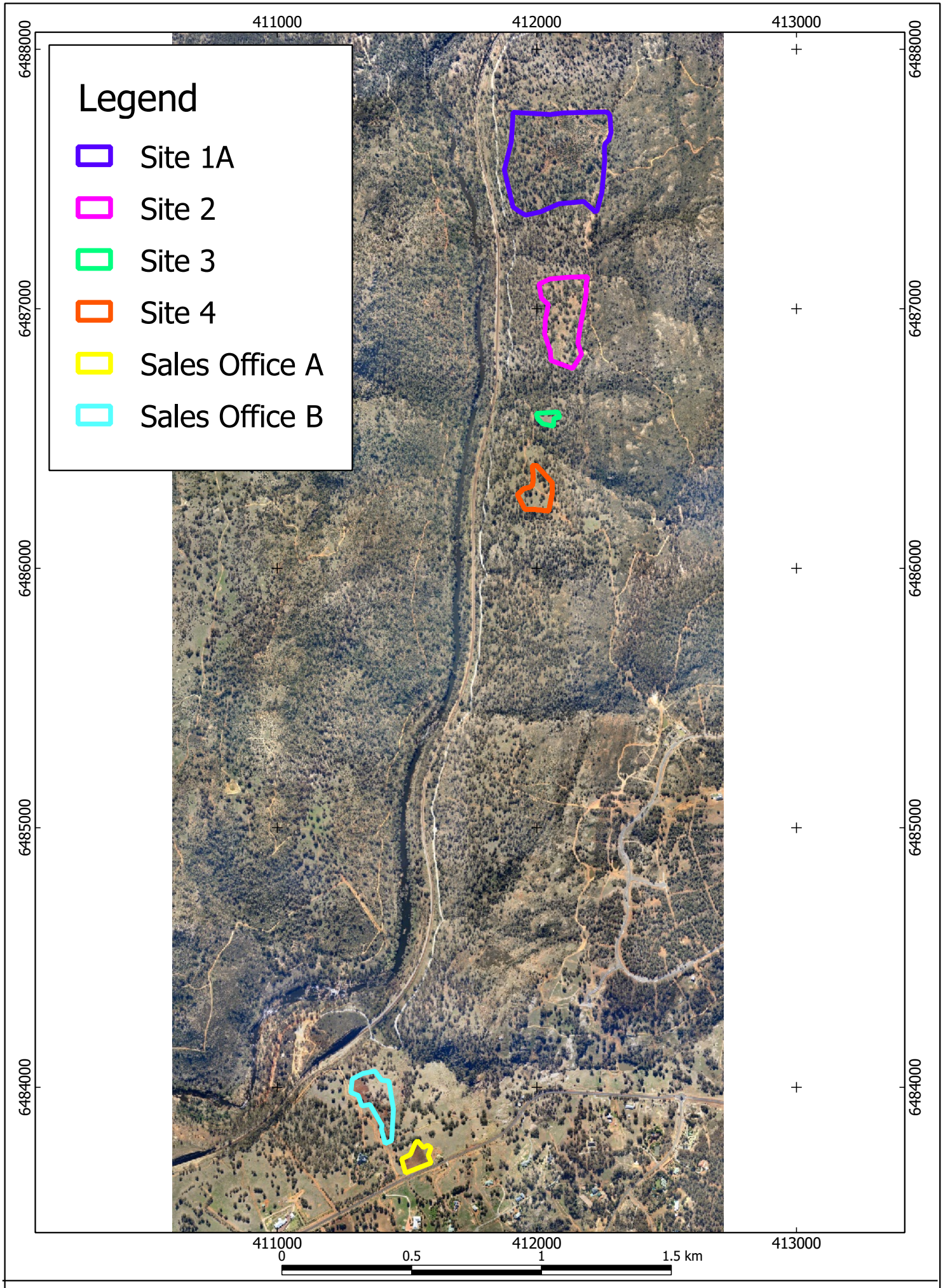
Valentine, L.E. and Stock, W. (2008) *Food Resources of Carnaby's Black Cockatoo (*Calyptorhynchus latirostris*) in the Gnangara Sustainability Strategy Study Area*. http://ro.ecu.edu/ecuworks/6147

# Appendix 1 Revegetation Site Locations




tranen revegetation systems

Project: Avon Ridge Revegetation
Project Number: P496
Client: Emerge Associates

Drawing: Revegetation Sites
Drawing Number: P496A-02
Revision: 0

Date: 10/02/2014
Drawn By: RSW

# Appendix 2 Raw Data

**Avon Ridge Site 1A** 9,300 planted in 2014

Planted in 2011, 2012, 2014

| Transect No. | Original no planted in '11 (Baseline) | No. alive Spr 14 (from prev yrs) | No. alive Spr 14 from 2014 infill | % Survival of Original nos | Tallest sp. observed | Height (m) | Weed cover (%) | Comments |
|---|---|---|---|---|---|---|---|---|
| 1 | 31 | 18 | 8 | **84%** | *Acacia saligna* | 4.0 | 75 | Two E. rudis recruits included |
| 2 | 39 | 19 | 29 | **123%** | *Acacia saligna* | 4.0 | 60 | |
| 3 | 26 | 15 | 31 | **177%** | *Acacia saligna* | 4.0 | 40 | |
| 4 | 44 | 20 | 40 | **136%** | *Acacia saligna* | 3.0 | 20 | |
| 5 | 73 | 44 | 32 | **104%** | *Acacia saligna* | 5.5 | 25 | Two dead A. saligna. Also ~100 natural E. rudis recruits within 10 - 20 m of transect |
| 6 | 26 | 29 | 22 | **196%** | *Acacia saligna* | 5.0 | 25 | Incl. 4 E. rudis recruits. Not counted were ~ 3 A. saligna seedlings |
| 7 | 34 | 27 | 5 | **94%** | *Acacia saligna* | 4.5 | 75 | 8 E. rudis recruits included |
| 8 | 41 | 24 | 6 | **73%** | *Acacia saligna* | 4.5 | 40 | |
| 9 | 50 | 26 | 0 | **52%** | *Acacia saligna* | 5.0 | 80 | *A. saligna* seedling also noted |
| 10 | 42 | 24 | 0 | **57%** | *Eucalyptus rudis* | 5.0 | 80 | Dead *A. saligna* 3.0 m tall |
| 11 | 40 | 21 | 8 | **73%** | *Eucalyptus rudis* | 5.0 | 75 | |
| 12 | 20 | 12 | 1 | **65%** | *Eucalyptus rudis* | 5.5 | 60 | Marri 5.0 m tall also on this transect |
| 13 | 20 | 8 | 0 | **40%** | *Eucalyptus rudis* | 5.0 | 30 | E. rudis and A. saligna affected by last year's drought are resprouting |
| 14 | 55 | 19 | 0 | **35%** | *Eucalyptus rudis* | 5.0 | 60 | Dead A. saligna |
| 15 | 35 | 18 | 0 | **51%** | *Eucalyptus rudis* | 5.0 | 25 | Dead shrubs and saplings from drought in 2013-14 |
| 16 | 94 | 54 | 0 | **57%** | *Eucalyptus rudis* | 6.5 | 30 | Dead shrubs, A. saligna |
| 17 | 69 | 40 | 0 | **58%** | *Eucalyptus rudis* | 6.0 | 25 | Dead shrubs, A. saligna |
| 18 | 94 | 58 | 0 | **62%** | *Eucalyptus rudis* | 6.5 | 50 | Dead shrubs, A. saligna |
| 19 | 136 | 83 | 0 | **61%** | *Eucalyptus rudis* | 6.0 | 25 | Several dead A. saligna |
| 20 | 51 | 17 | 5 | **43%** | *Acacia saligna* | 5.5 | 80 | Several dead A. saligna |
| 21 | 36 | 20 | 16 | **100%** | *Eucalyptus rudis* | 3.0 | 75 | |
| 22 | 55 | 37 | 0 | **67%** | *Acacia saligna* | 5.5 | 25 | 12 *Acacia saligna* seedlings on this transect |
| 23 | 37 | 31 | 0 | **84%** | *Acacia saligna* | 5.5 | 25 | 1 *Acacia saligna* seedling on this transect |
| 24 | 49 | 32 | 0 | **65%** | *Eucalyptus rudis* | 6.0 | 25 | |
| 25 | 14 | 11 | 2 | **93%** | *Acacia saligna* | 5.0 | 50 | |
| 26 | 23 | 11 | 0 | **48%** | *Acacia saligna* | 4.0 | 75 | |
| 27 | 41 | 40 | 2 | **102%** | *Acacia saligna* | 4.5 | 75 | |
| 28 | 37 | 21 | 0 | **57%** | *Acacia saligna* | 5.0 | 75 | No steel marker to designate transect. Dead shrubs and A. saligna |
| 29 | 42 | 33 | 0 | **79%** | *Acacia saligna* | 5.0 | 75 | *E. rudis* and *Daviesia ? triflora* recruits |
| 30 | 44 | 19 | 0 | **43%** | *Acacia saligna* | 4.0 | 75 | |
| 31 | 35 | 17 | 0 | **49%** | *Acacia saligna* | 4.0 | 75 | |
| 32 | 46 | 67 | 0 | **146%** | *Acacia saligna* | 4.0 | 75 | Includes E. rudis recruits |
| 33 | 52 | 39 | 1 | **77%** | *Acacia saligna* | 4.5 | 75 | Includes E. rudis recruits |
| 34 | 55 | 29 | 15 | **80%** | *Eucalyptus rudis* | 4.5 | 75 | 15 new plants are all new E. rudis seedlings |
| 35 | 46 | 49 | 2 | **111%** | *Eucalyptus rudis* | 2.0 | 80 | 49 new includes E. rudis seedlings and Hibbertia seedling |
| 36 | 59 | 50 | 10 | **102%** | *Acacia saligna* | 4.5 | 60 | Old incl E. rudis saplings from natural recruitment |
| 37 | 26 | 8 | 1 | **35%** | *Acacia lasiocarpa* | 1.0 | 90 | |
| 38 | 31 | | | **-** | | | | |
| 39 | 30 | 23 | 15 | **127%** | *Acacia saligna* | 3.5 | 20 | 15 new includes 6 E. rudis recruits |
| 40 | 42 | 25 | 38 | **150%** | *Acacia saligna* | 4.0 | 10 | 38 new includes 12 E. rudis recruits. Deaths of some shrubs form previous reveg. |

| Transect No. | Original no planted in '11 (Baseline) | No. alive Spr 14 | | % Survival of Original nos | Tallest spp observed | Height (m) | Weed cover (%) | Comments |
|---|---|---|---|---|---|---|---|---|
| 41 | 25 | 4 | 24 | 112% | *Acacia saligna* | 3.5 | 10 | 24 new includes 6 E. rudis and 1 A. saligna seedlings |
| 42 | 27 | 7 | 50 | 211% | *Eucalyptus rudis* | 3.0 | 40 | Some dead shrubs and basal sprouting of others |
| 43 | 22 | 8 | 52 | 273% | *Acacia saligna* | 4.5 | 40 | 52 new includes 5 E. rudis seedlings |
| 44 | 14 | 16 | 9 | 179% | *Acacia saligna* | 3.0 | 90 | A. saligna showing dead branches but resprouting. Also new A. saligna recruits |
| 45 | 22 | 5 | 3 | 36% | *Acacia saligna* | 3.0 | 50 | 3 new incl E. rudis recruits |
| 46 | 24 | 4 | 8 | 50% | *Acacia saligna* | 3.5 | 50 | |
| 47 | 10 | 7 | 3 | 100% | *Acacia saligna* | 5.0 | 50 | |
| 48 | 4 | 4 | 4 | 200% | *Eucalyptus rudis* | 2.0 | 80 | |
| 49 | 17 | 12 | 3 | 88% | *Acacia saligna* | 2.0 | 90 | 3 drought deaths. |
| 50 | 32 | | | - | | | | |
| Total | 2,017 | | | | | | | |
| | | | | 94% | Mean | 4.4 | 54 | |
| | | | | 79% | Median | 4.5 | 60 | |
| | | | | 35% | Min | 1.0 | 10 | |
| | | | | 273% | Max | 6.5 | 90 | |
| | | | | 53% | St. dev. | 1.2 | 24 | |

## Avon Ridge Site 1A

**Original 21 spp (2011 planting):**

| Species | Observed? |
|---|---|
| *Acacia lasiocarpa* | Y |
| *Acacia saligna* | Y |
| *Allocasuarina humilis* | Y |
| *Banksia grandis* | Y |
| *Banksia illicifolia* | N |
| *Calothamnus hirsutus* | Y |
| *Calothamnus quadrifidus* | Y |
| *Corymbia calophylla* | Y |
| *Eucalyptus rudis* | Y |
| *Eucalyptus wandoo* | Y |
| *Gastrolobium calycinum* | Y |
| *Gompholobium tomentosum* | Y |
| *Hakea cyclocarpa* | N |
| *Hakea lissocarpha* | Y |
| *Hakea ruscifolia* | N |
| *Hakea undulata* | Y |
| *Kennedia coccinea* | N |
| *Kennedia prostrata* | Y |
| *Leptospermum erubescens* | Y |
| *Macrozamia redlei* | Y |
| *Hypocallymma robustum* | Y |

| | |
|---|---|
| Total no. spp planted: | 36 |
| No. spp observed: | 29 |
| % spp observed: | 81% |

**Additional spp - Infill 2012**

| | |
|---|---|
| *Allocasuarina fraseriana* | Y |
| *Banksia menziesii* | N |
| *Banksia prionotes* | N |
| *Callistemon phoeniceus* | Y |
| *Eucalyptus marginata* | Y |
| *Hakea incrassata* | N |
| *Hakea prostrata* | Y |
| *Hakea trifurcata* | Y |
| *Hakea varia* | Y |

**Additional spp - Infill 2014**

| | |
|---|---|
| *Acacia pulchella* | Y |
| *Banksia nivea* | Y |
| *Banksia sessilis* | Y |
| *Hibbertia subvaginata* | Y |
| *Hypocalymma robustum* | Y |
| *Kennedia prostrata* | Y |

**Avon Ridge Site 2** 24,000 planted 2012 2000 planted in 2014
6,520 planted in 2013

| Transect No | Est. Total no. planted in 2012 | No. alive Spr 14 (from prev. yrs) | No. alive Spr 14 (from 2014 infill) | % survival of 2012 no.s planted | Tallest sp. observed | Height (m) | Weed cover (%) | Comments |
|---|---|---|---|---|---|---|---|---|
| 1 | 68 | 57 | 5 | **91%** | *Acacia saligna* | 3.0 | 20 | Capeweed and annual grasses |
| 2 | 9 | 19 | 9 | **311%** | *Acacia saligna* | 2.0 | 10 | Capeweed; herbivory noted on A. saligna |
| 3 | 8 | 14 | 0 | **175%** | *Acacia saligna* | 2.5 | 10 | Capeweed |
| 4 | 36 | 17 | 25 | **117%** | *Eucalyptus rudis* | 3.0 | 5 | 25 new inclues 2 E. rudis recruits |
| 5 | 36 | 19 | 21 | **111%** | *Eucalyptus rudis* | 3.0 | 5 | |
| 6 | 18 | 10 | 12 | **122%** | *Eucalyptus rudis* | 2.5 | 5 | |
| 7 | 23 | 12 | 17 | **126%** | *Acacia saligna* | 2.0 | 20 | 17 new includes 2 Eucalyptus sp recruits |
| 8 | 15 | 6 | 0 | **40%** | *Eucalyptus rudis* | 2.0 | 10 | No new planting on this transect |
| 9 | 86 | 56 | 2 | **67%** | *Acacia saligna* | 4.5 | 70 | 2 new incl *Hibbertia* seedlings |
| 10 | 42 | 41 | 2 | **102%** | *Acacia saligna* | 4.5 | 70 | 2 new incl *Hibbertia* seedlings |
| 11 | 144 | 83 | 0 | **58%** | *Acacia saligna* | 4.0 | 50 | |
| 12 | 123 | 113 | 2 | **93%** | *Acacia saligna* | 3.0 | 50 | 2 new recruits were A. saligna |
| 13 | 71 | 102 | 2 | **146%** | *Acacia saligna* | 4.0 | 40 | 2 new recruits were A. saligna |
| 14 | 36 | 39 | 0 | **108%** | *Eucalyptus rudis* | 1.3 | 60 | |
| 15 | 12 | 15 | 1 | **133%** | *Acacia saligna* | 4.0 | 60 | 1 new Eucalyptus sp. recruit |
| 16 | 9 | 46 | 20 | **733%** | *Eucalyptus rudis* | 1.0 | 50 | New includes Eucalypts and Hibbertia recruits and new tubestock |
| 17 | 41 | 42 | 0 | **102%** | *Eucalyptus rudis* | 1.8 | 50 | |
| 18 | 197 | 83 | 5 | **45%** | *Corymbia calophylla* | 1.8 | 60 | |
| 19 | 117 | 55 | 0 | **47%** | *Acacia saligna* | 4.5 | 60 | |
| 20 | 58 | 37 | 0 | **64%** | *Acacia saligna* | 4.5 | 40 | *Hakea ruscifolia* from 2012 noted at the end of the transect |
| | | | **Mean:** | **140%** | **Mean** | **2.9** | **37.3** | |
| | | | **St. dev.** | **152%** | **st dev** | **1.2** | **23.9** | |
| | | | **Min.** | **40%** | **min** | **1.0** | **5.0** | |
| | | | **Max.** | **733%** | **max** | **4.5** | **70.0** | |

Note: estimated total number planted is based on average survival from autumn 2013 of 66%

## Avon Ridge Site 2

**2012 planting**

| Species | Observed? |
|---|---|
| *Acacia saligna* | Y |
| *Allocasuarina fraseriana* | Y |
| *Banksia grandis* | Y |
| *Banksia menzeisii* | Y |
| *Banksia prionotes* | Y |
| *Callistemon phoeniceus* | Y |
| *Corymbia calophylla* | Y |
| *Eucalyptus marginata* | Y |
| *Eucalyptus wandoo* | Y |
| *Hakea cyclocarpa* | N |
| *Hakea incrassata* | N |
| *Hakea lissocarpha* | Y |
| *Hakea prostrata* | Y |
| *Hakea ruscifolia* | Y |
| *Hakea trifurcata* | Y |
| *Hakea undulata* | Y |
| *Hakea varia* | Y |
| *Hypocalymma robustum* | Y |

| Total no. spp planted: | 27 |
|---|---|
| No. spp observed: | 25 |
| % spp observed: | 93% |

| Additional 2013 spp. | Observed? |
|---|---|
| *Banksia sessilis* | Y |
| *Eucalyptus rudis* | Y |

| Additional 2014 spp. | Observed? |
|---|---|
| *Acacia pulchella* | Y |
| *Allocasuarina humilis* | Y |
| *Banksia nivea* | Y |
| *Calothamnus quadrifidus* | Y |
| *Calothamnus hirsutus* | Y |
| *Hibbertia subvaginata* | Y |
| *Kennedia prostrata* | Y |

**Avon Ridge Site 3** 2,610 planted in 2013

Planted in 2013 3,800 planted in 2014

| Transect No. | Total No. planted 2013 (Baseline) | Alive Spr 2014 (from prev. yrs) | No. alive Spr 14 (from 2014 infill) | % Survival of baseline numbers | Tallest spp observed Aut 2014 | Height (m) | Weed cover (%) | Comments |
|---|---|---|---|---|---|---|---|---|
| 1 | 23 | 0 | 31 | **135%** | *Corymbia calophylla* | 0.3 | 25 | |
| 2 | 50 | 2 | 49 | **102%** | *Corymbia calophylla* | 0.3 | 25 | Difficult to tell 2013 and 2014 plants apart. Lots of Kennedia spp. on this transect |
| 3 | 56 | 3 | 71 | **132%** | *Eucalyptus wandoo* | 0.5 | 40 | *E. wandoo* recruits included on this transect |
| 4 | 55 | 0 | 70 | **127%** | *Eucalyptus wandoo* | 0.3 | 50 | |
| 5 | 49 | 0 | 55 | **112%** | *Corymbia calophylla* | 0.4 | 50 | Lots of *Austrostipa flavescens* (not counted in plant counts) |
| 6 | 55 | 0 | 99 | **180%** | *Banksia sessilis* | 0.3 | 30 | Lots of *Austrostipa flavescens* (not counted in plant counts) |
| 7 | 66 | 0 | 77 | **117%** | *Eucalyptus wandoo* | 0.4 | 60 | |
| 8 | 40 | 0 | 55 | **138%** | *Corymbia calophylla* | 0.4 | 30 | |
| 9 | 42 | 0 | 52 | **124%** | *Corymbia calophylla* | 0.3 | 10 | |
| | | | **Mean** | **130%** | **Mean** | **0.4** | **35.6** | |
| | | | **Min** | **102%** | **Min** | **0.3** | **10.0** | |
| | | | **Max** | **180%** | **Max** | **0.5** | **60.0** | |
| | | | **St. dev.** | **22%** | **St. dev.** | **0.1** | **15.7** | |

## Avon Ridge Site 3

**2013 planting**

| Species | Observed? |
|---|---|
| *Acacia saligna* | N |
| *Banksia nivea* | N |
| *Banksia sessilis* | N |
| *Callistemon phoeniceus* | N |
| *Calothamnus quadrifidus* | N |
| *Corymbia calophylla* | N |
| *Eucalyptus rudis* | N |
| *Eucalyptus wandoo* | Y |
| *Hakea lissocarpha* | N |
| *Hakea ruscifolia* | N |
| *Hakea trifurcata* | N |
| *Hakea undulata* | N |

Total no. spp planted: 24
No. spp observed: 20
% spp observed: 83%

Note: this data demonstrates the only species that appears to have survived since 2013 is Eucalyptus wandoo.

**2014 planting**

| | |
|---|---|
| *Acacia lasiocarpa* | Y |
| *Acacia pulchella* | Y |
| *Allocasuarina humilis* | Y |
| *Banksia lindleyana* | Y |
| *Banksia nivea* | Y |
| *Banksia sessilis* | Y |
| *Callistemon phoeniceus* | Y |
| *Calothamnus quadrifidus* | Y |
| *Calothamnus hirsutus* | Y |
| *Corymbia calophylla* | Y |
| *Eucalyptus wandoo* | Y |
| *Gompholobium tomentosum* | Y |
| *Grevillea bipinnatifida* | Y |
| *Hakea lissocarpha* | Y |
| *Hakea prostrata* | Y |
| *Hakea undulata* | Y |
| *Hibbertia subvaginata* | Y |
| *Hypocalymma robustum* | Y |
| *Kennedia coccinea* | Y |
| *Kennedia prostrata* | Y |

Not all species from 2013 were re-planted in 2014

**Avon Ridge Site 4** 10,340 planted in 2013

Planted in 2013 14,800 planted in 2014

| Transect No. | Total No. planted 2013 (Baseline) | Alive Spr 2014 | % Survival Spr 2014 | Tallest spp observed | Height (m) | Weed cover (%) | Comments |
|---|---|---|---|---|---|---|---|
| 1 | 69 | 71 | **103%** | *Corymbia calophylla* | 0.4 | 50 | |
| 2 | 125 | 195 | **156%** | *Eucalyptus rudis* | 1.5 | 50 | |
| 3 | 50 | 90 | **180%** | *Eucalyptus wandoo* | 0.5 | 10 | Strong growth of all species |
| 4 | 62 | 79 | **127%** | *Corymbia calophylla* | 0.5 | 50 | |
| 5 | 50 | 32 | **64%** | *Eucalyptus rudis* | 0.7 | 50 | |
| 6 | 98 | 70 | **71%** | *Eucalyptus rudis* | 1.0 | 50 | |
| 7 | 50 | 30 | **60%** | *Eucalyptus rudis* | 0.6 | 50 | |
| 8 | 46 | 4 | **9%** | *Hakea prostrata* | 0.2 | 90 | Very few new plants appear to have been installed |
| 9 | 32 | 31 | **97%** | *Corymbia calophylla* | 0.3 | 75 | |
| 10 | 44 | 46 | **105%** | *Corymbia calophylla* | 0.3 | 75 | |
| 11 | 34 | 45 | **132%** | *Eucalyptus rudis* | 1.0 | 30 | |
| 12 | 42 | 66 | **157%** | *Corymbia calophylla* | 0.5 | 25 | |
| 13 | 102 | 198 | **194%** | *Corymbia calophylla* | 0.5 | 30 | 3 Eucalyptus sp. natural recruits included in count |
| 14 | 22 | 35 | **159%** | *Corymbia calophylla* | 0.5 | 10 | |
| 15 | 44 | 86 | **195%** | *Corymbia calophylla* | 0.4 | 20 | |
| | | **Mean** | **121%** | **Mean** | **0.6** | **44.3** | |
| | | **Min** | **9%** | **Min** | **0.2** | **10.0** | |
| | | **Max** | **195%** | **Max** | **1.5** | **90.0** | |
| | | **St. dev.** | **55%** | **St. dev.** | **0.3** | **23.7** | |

Note: it was not possible to distinguish surviving plants from 2013 compared with new plants from 2014

## Avon Ridge Site 4

**2013 planting**

| Species | Observed? |
|---|---|
| *Acacia saligna* | Y |
| *Banksia grandis* | N |
| *Banksia nivea* | Y |
| *Banksia sessilis* | Y |
| *Callistemon phoeniceus* | Y |
| *Calothamnus quadrifidus* | Y |
| *Corymbia calophylla* | Y |
| *Eucalyptus marginata* | Y |
| *Eucalyptus rudis* | Y |
| *Eucalyptus wandoo* | Y |
| *Hakea lissocarpha* | Y |
| *Hakea prostrata* | Y |
| *Hakea ruscifolia* | N |
| *Hakea trifurcata* | Y |
| *Hakea undulata* | Y |
| *Hakea varia* | Y |

| Additional 2014 spp. | Observed? |
|---|---|
| *Acacia lasiocarpa* | Y |
| *Acacia pulchella* | Y |
| *Allocasuarina humilis* | Y |
| *Banksia lindleyana* | Y |
| *Calothamnus hirsutus* | Y |
| *Gompholobium tomentosum* | Y |
| *Grevillea bipinnatifida* | Y |
| *Hibbertia subvaginata* | Y |
| *Hypocalymma robustum* | Y |
| *Kennedia coccinea* | Y |
| *Kennedia prostrata* | Y |

| | |
|---|---|
| Total no. spp planted: | 27 |
| No. spp observed: | 25 |
| % spp observed: | 93% |

Could not distinguish which year the survivors came from

**Avon Ridge Site Sales Office A** 10 x 10 m quadrats 6,150 planted in 2013

Planted in 2013

| Quadrat # | Expected density (plants/m2) (Baseline) | No. plants Spr 2014 | Density (plants / m2) | % Survival Spr 14 | Tallest spp observed | Height (m) | Weed cover (%) | Comments |
|---|---|---|---|---|---|---|---|---|
| 1 | 0.77 | 3 | 0.03 | 4% | *Corymbia calophylla* | 0.6 | 25 | Marri x 2, wandoo x 1 |
| 2 | 0.77 | 23 | 0.23 | 30% | *Eucalyptus wandoo* | 1.8 | 10 | marri x 8, wandoo x 15 |
| 3 | 0.77 | 23 | 0.23 | 30% | *Eucalyptus wandoo* | 2.0 | 25 | Marri x 2, wandoo x 19, Calllistemon phoeneceus x 2. Cotton Bush |
| 4 | 0.77 | 18 | 0.18 | 23% | *Eucalyptus wandoo* | 1.5 | 10 | Marri x 5, wandoo x 9, Callistemon x 4 |
| 5 | 0.77 | 38 | 0.38 | 49% | *Eucalyptus wandoo* | 1.8 | 10 | Marri x 13, wandoo x 23, Callistemon x 2 |
| 6 | 0.77 | 20 | 0.20 | 26% | *Eucalyptus wandoo* | 1.0 | 10 | Marri x 1, wandoo x 17, Callistemon x 2 |
| | | | **Mean** | **27%** | **Mean** | **1.5** | **15.0** | |
| | | | **Min** | **4%** | **Min** | **0.6** | **10.0** | |
| | | | **Max** | **49%** | **Max** | **2.0** | **25.0** | |
| | | | **St. dev.** | **15%** | **St. dev.** | **0.5** | **7.7** | |

## Avon Ridge Sales Office A

**2013 planting**

| Species | Observed? |
|---|---|
| *Acacia saligna* | N |
| *Banksia grandis* | N |
| *Callistemon phoeniceus* | Y |
| *Corymbia calophylla* | Y |
| *Eucalyptus wandoo* | Y |
| *Hakea lissocarpha* | Y |
| *Hakea prostrata* | N |
| *Hakea ruscifolia* | N |
| *Hakea trifurcata* | N |
| *Hakea undulata* | N |
| *Hakea varia* | N |

| | |
|---|---|
| Total no. spp planted: | 11 |
| No. spp observed: | 4 |
| % spp observed: | 36% |

**Avon Ridge Site Sales Office B** Transects and quadrats 14,380 planted in 2013

Planted in 2013 8000 planted in 2014

| Transect / Quadrat # | Total No. planted 2013 (Baseline) | No. alive Spr 2014 from 2013 planting | No. alive Spr 2014 from 2014 infill | % Survival Spr 14 | Tallest spp observed | Height (m) | Weed cover (%) | Comments |
|---|---|---|---|---|---|---|---|---|
| SOBQ1 | 112 | 47 | 46 | 83% | *Acacia saligna* | 1.5 | 5 | Mainly Capeweed; minor erosion rills |
| SOBQ2 | 116 | 79 | 37 | 100% | *Acacia saligna* | 1.8 | 5 | Mainly Capeweed; minor erosion rills |
| SOBQ3 | 168 | 77 | 26 | 61% | *Eucalyptus rudis* | 2.0 | 5 | Mainly Capeweed; minor erosion rills |
| SOBQ4 | 114 | 55 | 73 | 112% | *Acacia saligna* | 1.2 | 7 | Mainly Capeweed; minor erosion rills |
| SOBQ5 | 123 | 55 | 21 | 62% | *Acacia saligna* | 1.8 | 10 | Rabbit scats, kangaroo scats. Weeds mainly wild oats |
| SOBT6 | 65 | 16 | 21 | 57% | *Acacia saligna* | 1.5 | 5 | Minor erosion |
| SOBT7 | 71 | 23 | 30 | 75% | *Acacia saligna* | 1.5 | 5 | |
| SOBT8 | 66 | 6 | 30 | 55% | *Eucalyptus rudis* | 1.0 | 5 | Minor erosion |
| SOBT9 | 63 | 9 | 28 | 59% | *Acacia saligna* | 1.0 | 5 | Rabbit activity and herbivory was noted |
| SOBT10 | 22 | 1 | 20 | 95% | *Eucalyptus rudis* | 0.4 | 50 | Herbivory of weedy grasses noted |
| SOBT11 | 40 | 3 | 15 | 45% | *Eucalyptus rudis* | 1.0 | 40 | |
| SOBT12 | 66 | 20 | 8 | 42% | *Acacia saligna* | 1.2 | 20 | Rocky. Not many new plants installed in 2014 |
| SOBT13 | 39 | 11 | 27 | 97% | *Acacia saligna* | 1.0 | 20 | |
| SOBT14 | 36 | 3 | 45 | 133% | *Acacia saligna* | 0.6 | 10 | |
| SOBT15 | 90 | 3 | 60 | 70% | *Eucalyptus rudis* | 1.0 | 5 | Hibbertia growing well here. |
| | | | | | | | | |
| | | | Mean | 76% | Mean | 1.2 | 13.1 | |
| | | | Min | 42% | Min | 0.4 | 5.0 | |
| | | | Max | 133% | Max | 2.0 | 50.0 | |
| | | | St. dev. | 26% | St. dev. | 0.4 | 14.0 | |

## Avon Ridge Site Sales Office B

**2013 planting**

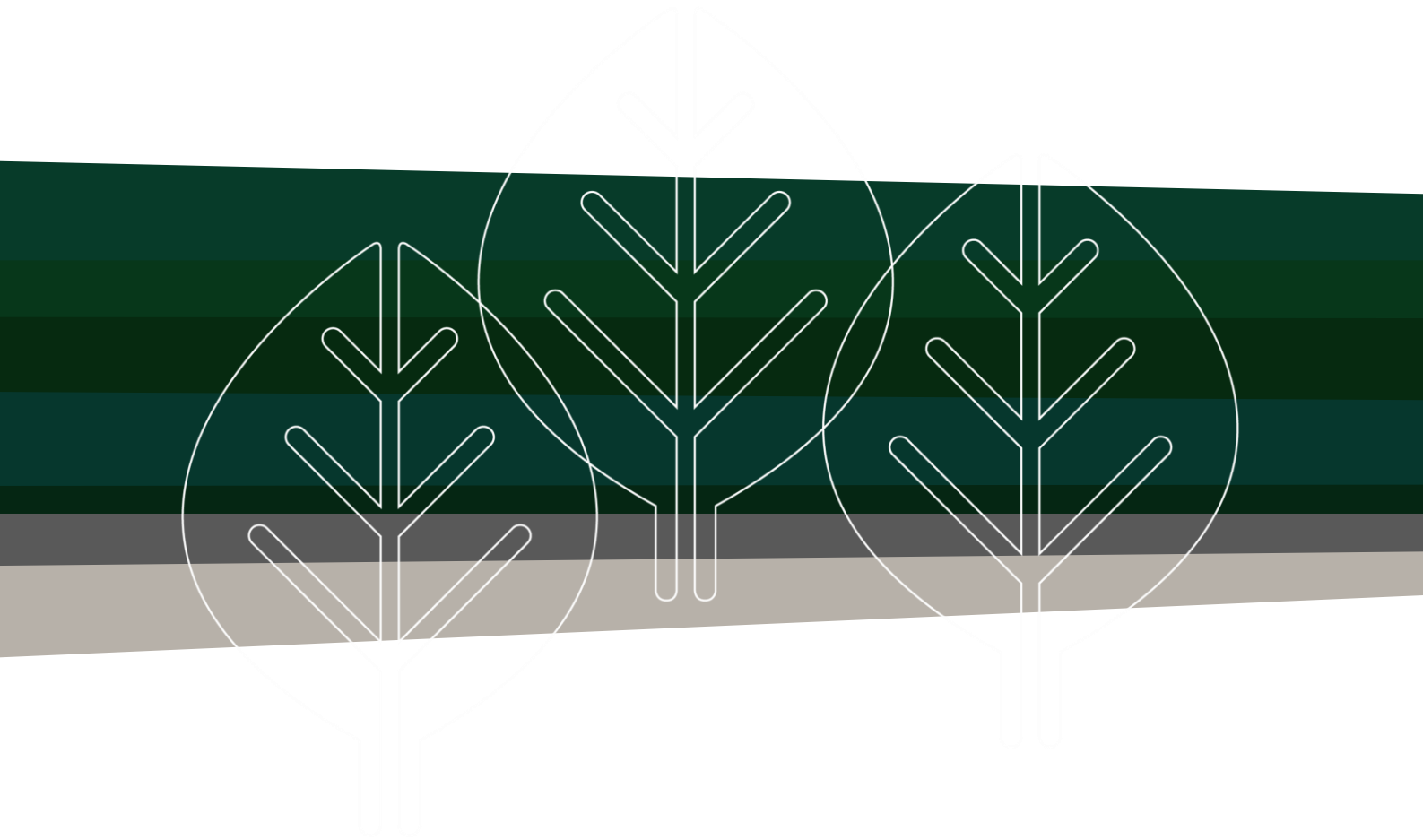
| Species | Observed? |
|---|---|
| *Acacia saligna* | Y |
| *Banksia grandis* | Y |
| *Banksia nivea* | Y |
| *Banksia sessilis* | Y |
| *Callistemon phoeniceus* | Y |
| *Calothamnus quadrifidus* | Y |
| *Corymbia calophylla* | Y |
| *Eucalyptus marginata* | Y |
| *Eucalyptus rudis* | Y |
| *Eucalyptus wandoo* | Y |
| *Hakea lissocarpha* | Y |
| *Hakea prostrata* | Y |
| *Hakea ruscifolia* | N |
| *Hakea trifurcata* | Y |
| *Hakea undulata* | Y |

| | |
|---|---|
| Total no. spp planted: | 26 |
| No. spp observed: | 25 |
| % spp observed: | 96% |

| Additional 2014 spp. | Observed? |
|---|---|
| *Acacia lasiocarpa* | Y |
| *Acacia pulchella* | Y |
| *Allocasuarina humilis* | Y |
| *Banksia lindleyana* | Y |
| *Calothamnus hirsutus* | Y |
| *Gompholobium tomentosum* | Y |
| *Grevillea bipinnatifida* | Y |
| *Hibbertia subvaginata* | Y |
| *Hypocalymma robustum* | Y |
| *Kennedia coccinea* | Y |
| *Kennedia prostrata* | Y |

revegetating
rehabilitating
restoring

tranen
revegetation systems



# Avon Ridge Estate
# Bi-annual Monitoring Report – Autumn 2015

Emerge Associates

P496-05-Rev00

June 2015

## Disclaimer



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# 1 SUMMARY

Tranen was engaged to undertake revegetation work at PEET's Brigadoon Park and Recreation Reserve in winter 2011. Further revegetation works have been undertaken in 2012, 2013 and 2014 with the aim of contributing to the target of 214,000 seedlings required as part of the offset package for the development.

Six revegetation sites were established between 2011 and 2013. A total of 88,255 seedlings were initially installed into these six sites. Infill planting has also occurred in 2012, 2013 and 2014 to replace dead plants, which is a pro-active approach to achieve the 90% survivorship criteria before the end of the three-year monitoring period. The infill plants do not count towards the 214,000 seedlings required to be planted, and future survivorship observations are calculated against the original number of seedlings planted. Hence, prior to the autumn 2015 monitoring, a total of 144,675 seedlings (initial plantings plus infill) had been installed in the six sites:

- Site 1A: 52,075 seedlings installed in 2011, 2012 and 2014;
- Site 2: 32,520 seedlings installed in 2012, 2013 and 2014;
- Site 3: 6,410 seedlings installed in 2013 and 2014;
- Site 4: 25,140 seedlings installed in 2013 and 2014;
- Sales Office A (SO-A): 6,150 seedlings installed in 2013; and
- Sales Office B (SO-A): 22,380 seedlings installed in 2013 and 2014.

The approval given to PEET under the *Environment Protection Biodiversity Conservation Act 1999* requires a survivorship rate of 90% of all installed seedlings at the end of the three year maintenance period. Other completion criteria, as set out in the *Avon Ridge Estate, Brigadoon: Revegetation and Fire Management Plan* (Cardno 2012) are:

- Plants are healthy in appearance and diverse in species with no mass losses;
- At least 65% of the species planted have survived (a measure of species richness);
- The average seedling height has increased between assessments; and
- Weed presence is minimal and not inhibiting native plant survival and growth.

Site 1A achieved all the completion criteria after three years of maintenance, as reported in the spring 2014 report (Tranen 2015). Hence, monitoring for site 1A has been completed and is therefore not reported in this document.

Following the autumn 2015 monitoring, the following survival rates have been observed at the remaining sites (based on original numbers planted into each site):

- Site 2: 125%;
- Site 3: 120%;
- Site 4: 120%;
- Sales Office A (SO-A): 26%; and
- Sales Office B (SO-B): 61%.

Table 1 summarises the progress of each site against the selection criteria. Site 2 can be considered complete in August 2015 (i.e. three years since finishing initial revegetation works). Plant survival and site condition is unlikely to change significantly at Site 2 now that winter has commenced, and therefore the data presented in this report can be used to close off Site 2 as completed. All other sites have approximately 1.5 years remaining until they can be formally assessed against the completion criteria.

**Table 1 Revegetation Progress Against the Completion Criteria**

| Completion Criteria | Site 1A | Site 2 | Site 3 | Site 4 | Sales Office A | Sales Office B | Actions Required |
|---|---|---|---|---|---|---|---|
| Survivorship rate must be at least 90% | ✓ | ✓ | ✓ | ✓ | X | X | Consider infill planting in 2015[1] |
| Plants are healthy in appearance and diverse in species with no mass losses | ✓ | ✓ | ✓ | ✓ | X | ✓ | None |
| Species richness is ≥ 65% | ✓ | ✓ | ✓ | ✓ | X | ✓ | None |
| The average seedling height has increased between assessments | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | None |
| Weed presence is minimal and not inhibiting native plant survival and growth | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | Continue weed control as needed |
| **No. years until assessment complete** | **0** | **0** | **1.5** | **1.5** | **1.5** | **1.5** | n/a |

[1] Infill planting may be required for Sales Office B, though the project as a whole is achieving the 90% survival rate required. No further works are recommended at Sales Office A as kangaroo grazing will limit success and a fence is not a practical option. See text for further details.

# 2 INTRODUCTION

Tranen was engaged to undertake revegetation work at PEET's Brigadoon Park and Recreation Reserve in winter 2011. Further revegetation works have been undertaken in 2012, 2013 and 2014 with the aim of contributing to the target of 214,000 seedlings required as part of the offset package for the development as per the conditions under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

## 2.1 EPBC Approval Conditions (Section 2b)

The revegetation measures to create additional Black Cockatoo habitat across the project site, including in the Parks and Recreation Reserve, specifically are:

- Revegetating all vegetation condition classes (excluding pristine and excellent classes) and vegetation complexes;
- Designing species mix: numbers and density to be planted;
- Timing the proposed planting (must be following the annual winter rain period);
- Implementing weed management measures;
- The survivorship rate of all revegetation measures must be at least 90% after three years. If after three years of the date of the planting, a survival rate of 90% of the planted trees is not achieved, all dead trees must be replaced with other Black Cockatoo habitat species within 12 months and maintained for at least an additional two years;
- Annual monitoring measures within the project area undertaken by an appropriately qualified and experienced ecologist and must commence within 12 months of the completion of revegetation and continue for at least three years after the initial revegetation planting in any given area (given that revegetation will be staged across the development); and
- Annual monitoring measures undertaken by an appropriately qualified and experienced specialist must commence in the Parks and Recreation Reserve within 12 months of completion of revegetation and continue for at least three years after the initial planting in the Parks and Recreation reserve for the purpose of establishing the survivorship rates and replanting efforts within the project area.

## 2.2 Monitoring Program Objectives

The main objectives of the bi-annual monitoring program are to:

- Demonstrate the success of the revegetation against the completion criteria specified by the EPBC approval conditions; and
- Identify issues affecting the revegetation program, such as weeds, pathogens or acts of vandalism.

## 2.3 Completion Criteria

At the end of the three year maintenance period for each revegetation area, the following completion criteria are required to be met (from the *Revegetation and Fire Management Plan*, Cardno 2012):

- Survivorship rate must be at least 90% (nb: this is a condition of the EPBC Act approval);
- Plants are healthy in appearance and diverse in species with no mass losses;
- At least 65% of the species planted have survived (a measure of species richness);
- The average seedling height has increased between assessments; and
- Weed presence is minimal and not inhibiting native plant survival and growth.

# 3 REVEGETATION SITES AND WORKS TO DATE

Six revegetation sites have been established (for a map of their locations, refer to Appendix 1):

- Site 1A: established in 2011;
- Site 2: established in 2012;
- Site 3: established in 2013 as an unfenced trial site, which was subsequently fenced prior to the 2014 planting works;
- Site 4: established in 2013;
- Sales Office A: established in 2013 as an unfenced trial site; and
- Sales Office B: established in 2013.

A summary of the planting years, total area and number of seedlings planted up until autumn 2015 for each revegetation site is presented in Table 2. The total number of seedlings planted to date is 144,675.

**Table 2 Revegetation Sites**

| Site Name | Area (ha) | Fenced or Unfenced | 2011 Seedlings | 2012 Seedlings | 2013 Seedlings | 2014 Seedlings | Total Seedlings |
|---|---|---|---|---|---|---|---|
| **1A** | 13.4 | Fenced | **30,775** | 12,000 | - | 9,300 | **52,075** |
| **2** | 4.7 | Fenced | - | **24,000** | 6,520 | 2,000 | **32,520** |
| **3** | 0.3 | Fenced[1] | - | - | **2,610** | 3,800 | **6,410** |
| **4** | 2.8 | Fenced | - | - | **10,340** | 14,800 | **25,140** |
| **Sales Office A** | 0.8 | Unfenced[2] | - | - | **6,150** | - | **6,150** |
| **Sales Office B** | 2.3 | Fenced | - | - | **14,380** | 8,000 | **22,380** |
| **TOTAL** | **24.3** | - | **30,775** | **36,000** | **40,000** | **37,900** | **144,675** |
| **Blue = initial planting number for each site** | | | | | **TOTAL of initial planting** | | **88,255** |
| **Black = infill planting numbers** | | | | | | | |

[1] Site 3 was initially not fenced to investigate whether fences were necessary to protect seedlings. Results indicated kangaroos were eating seedlings, so a fence was erected prior to 2014 planting.
[2] Sales Office A was initially not fenced to investigate whether fences were necessary to protect seedlings. This area was abandoned as a trial area because of the proximity to houses (fire risk) and deleterious effects on the aesthetics of the area if a fence were to be established.

## 3.1 Site 1A

Site 1A was not monitored in autumn 2015; the site had met all completion criteria after the three year maintenance period, as reported in the spring 2014 monitoring report (Tranen 2015).

## 3.2 Site 2

The 2012 revegetation program at Site 2 consisted of:

- Deep ripping (not undertaken by Tranen);
- Installation of a kangaroo fence with rabbit proof skirt measuring 1,000 m long and 1.8 m high;
- Pre-planting weed control program of herbicide application (glyphosate and Simazine) in July 2012; and
- Planting of 24,000 seedlings in August 2012.

Since the initial installation the following maintenance activities have been undertaken at Site 2:

- Fencing repair (2012);
- Additional planting:
  - 6,520 seedlings in June and July 2013;
  - 2,000 seedlings in July 2014;
- Weed control maintenance:
  - Spring 2012;
  - Summer 2012/13;
  - Autumn 2013; and
  - Autumn 2014.

**Figure 1 Site 2 – Transect # 19**

## 3.3 Site 3

Site 3 was established in 2013 without a kangaroo-proof fence as a trial to determine whether grazing by kangaroos was an impacting factor on the seedlings. Results of seedling survival after the first year indicated that seedling survival was very poor compared with fenced sites (survival of 7% compared with > 30% in fenced sites). Hence, a fence was established prior to planting in 2014.

Revegetation at Site 3 commenced in 2013 and consisted of:

- Deep ripping (not undertaken by Tranen);
- Pre-planting weed control program of herbicide application (glyphosate and Oust® pre-emergent) in July 2013; and
- Planting of 2,610 seedlings in July 2013.

Since the initial installation the following maintenance activities have been undertaken at Site 3:

- Installation of a kangaroo fence with rabbit proof skirt measuring 259 m long and 1.8 m high in autumn 2014;
- Weed control in autumn 2014; and
- Planting of 3,800 seedlings in July 2014.

**Figure 2 Site 3 – Transect # 4**

## 3.4 Site 4

Revegetation at Site 4 commenced in 2013 and consisted of:

- Deep ripping (not undertaken by Tranen);
- Installation of a kangaroo fence with rabbit proof skirt measuring 572 m long and 1.8 m high;
- Pre-planting weed control program of herbicide application (glyphosate and Oust® pre-emergent) in July 2013; and
- Planting of 10,340 seedlings in July 2013.

Since the initial installation the following maintenance activities have been undertaken at Site 4:

- Fence repairs (August 2013);
- Weed control in autumn 2014;
- Additional fencing was erected on both sides of the middle track during April 2014. This was necessary because members of the public were leaving the gates open on the middle track through which kangaroos were entering the site; and
- Planting of 14,800 seedlings in July 2014.

**Figure 3 Site 4 – Transect # 3**

## 3.5 Sales Office A

Sales Office A was established without a kangaroo-proof fence as a trial to determine whether grazing by kangaroos was an impacting factor on the seedlings.

Revegetation at Sales Office A commenced in 2013 and consisted of:

- Deep ripping (not undertaken by Tranen); and
- Planting of 6,150 seedlings in June 2013.

Since the initial installation the following maintenance activities have been undertaken at Sales Office A:

- Weed control maintenance:
  - Winter 2013;
  - Spring 2013; and
  - Summer 2013/14 (two events).

Kangaroo herbivory significantly reduced plant survivorship at Sales Office A during the first year after planting. Due to the location of the site near residences and a lookout for the Avon River, a fence has not been erected to further protect the plants as this would reduce the aesthetic qualities of the area. No further revegetation works have been undertaken on the site, as kangaroos will continue to eat shrubs and therefore continually impede revegetation success. Tree species have established from the initial revegetation efforts and continue to grow without being grazed. The weeds have been allowed to grow on the site to stabilise the topsoil as the site is on a steep slope and erosion was noted in the first year after planting.

**Figure 4 Sales Office A – Quadrat # 2 Showing Strong Growth of Eucalypts**

## 3.6 Sales Office B

Revegetation at Sales Office B commenced in 2013 and consisted of:

- Deep ripping (not undertaken by Tranen);
- Installation of a kangaroo fence with rabbit proof skirt measuring 825 m long and 1.8 m high;
- Pre-planting weed control program of herbicide application (glyphosate and Oust® pre-emergent) in July 2013; and
- Planting of 14,380 seedlings in July 2013.

Since the initial installation the following maintenance activities have been undertaken at Sales Office B:

- Weed control in autumn 2014; and
- Planting of 8,000 seedlings in July 2014.

**Figure 5 Sales Office B – Quadrat # 3 Showing Good Plant Growth**

# 4 MONITORING METHODOLOGY

This report presents results from the field survey conducted between 23 March and 22 April 2015 (autumn monitoring).

## 4.1 Plant Survival

Plant survival was assessed using transects along rip-lines or 10 m × 10 m quadrats that covered several rip-lines. The initial survey for each site, undertaken in the spring following seedling installation, determines the baseline data which is a count of the number of seedlings planted within the monitoring plot. Percentage survival is assessed against this figure for future monitoring events.

Survivorship at all sites has been calculated against the initial planting numbers, and therefore can be greater than 100% where the additional planting has increased plant numbers above the original number installed.

## 4.2 Monitoring Plot Establishment and Survival Calculations

Transects, quadrats or a combination of both, were used to assess percentage survival of seedlings at each site. The method employed for assessing survival was dependent on the characteristics of each site, as described below. Different methods were necessary because of the nature of the rip-lines (i.e. long, easily identifiable rip-lines compared with short rip-lines in multiple directions), and difficulties with being able to observe dead plants during the first survey after planting (because of herbivory or rapid decay).

In some transects, there are seedlings that appear to have germinated naturally (i.e. natural recruitment). These have been included in total seedling counts because they contribute to the total number of plants that are present at the site, and are a direct result of the site preparation activities (i.e. soil cultivation, weed management, etc.).

### 4.2.1 Site 2

The initial survey at Site 2 was a random sample of rip-lines throughout the site, and this was continued until the spring 2013 survey was undertaken when permanent transects were established. With previous surveys being random, there was no baseline data against which survival could be assessed. To determine baseline seedling numbers, the following was undertaken in spring 2013:

- Twenty permanent transects were established across the site.
- For each transect, living plants were counted.
- It was assumed that the living plants represented 66% of the original number of seedlings planted in 2012. This is based on the mean percentage survival that was calculated during the autumn 2013 survey by counting live and dead plants in random transects (Tranen 2013).

### 4.2.2 Site 3

Nine permanent transects were established along rip-lines in Site 3 during the initial spring 2013 survey. Baseline data were collected of live and dead plants on each transect to determine the total number of seedlings planted, and to enable percentage survival to be calculated.

These same rip-lines are assessed for each monitoring event.

### 4.2.3 Site 4

Fifteen permanent transects were established along rip-lines in Site 4 during the initial spring 2013 survey. Baseline data were collected of live and dead plants on each transect to determine the total number of seedlings planted, and to enable percentage survival to be calculated.

These same rip-lines are assessed for each monitoring event.

### 4.2.4 Sales Office A

Six quadrats measuring 10 × 10 m were established across the site during the spring 2013 survey. Quadrats were used instead of transects as this site had been ripped in multiple directions, rather than having parallel rip-lines installed across the slope.

Due to impacting factors at the site, the most severe being kangaroo herbivory, it was not possible to obtain counts of dead plants during the baseline survey, as there was little evidence of any dead plants remaining. To determine the baseline data and enable future calculations of percentage survival, the following steps were undertaken for each quadrat:

- Number of living plants was counted;
- The density of plants in each quadrat was calculated as:
  - [number of living plants] / 100 $m^2$;
- The density in each quadrat was compared against the average density for the site, which was calculated as:
  - Total number of seedlings planted for the site divided by the area of the site = 6,150 seedlings / 8,000 $m^2$ = 0.77 plants / $m^2$;
- The proportion of seedlings surviving was therefore calculated as: [quadrat stem density] / 0.77.

### 4.2.5 Sales Office B

A combination of quadrats and transects was employed at Sales Office B, as there were wide areas with clear rip-lines in some places, and small areas where multiple rip-lines had been installed in several directions. Ten transects and five 10 x 10 m quadrats were established during the initial spring 2013 survey to obtain a representative survey of the site. Baseline data were collected of live and dead plants on each transect or in each

quadrat to determine the total number of seedlings planted, and to enable percentage survival to be calculated.

## 4.3 Other Observations

At each revegetation site, observations were made of weed species and cover, seedling health (including pest attack, drought stress etc.), species diversity, maximum plant height along transects, occurrence of erosion or soil disturbance, and the health or occurrence of remnant vegetation.

Species richness was calculated as the number of species observed across the site divided by the number of species planted into the site and expressed as a percentage. This was done by observations on transects and by a walk-through across the site.

# 5 RESULTS

Site 2 was established in August 2012 and is therefore to be formally assessed against the completion criteria using the results of this assessment. The remainder of sites were established in 2013 and will therefore be formally assessed against the completion criteria in another year's time.

Raw data for all quadrats and transects at all sites are presented in Appendix 2. A description of the results for each site is presented in the sections below.

A summary of the data for all sites as assessed in autumn 2015 is presented in Table 3 for assessment against the completion criteria of percentage plant survival and species diversity.

Progress of each site against the completion criteria are presented in the sections to follow.

**Table 3 Plant Survival and Species Richness Measured Against Completion Criteria**

Text is **green** if meeting criteria or **red** if not meeting criteria

| Measurement | Season & Year | Site | | | | |
|---|---|---|---|---|---|---|
| | | 2 | 3 | 4 | SO-A | SO-B |
| **% Survival** | **Completion Criteria** | **90%** | **90%** | **90%** | **90%** | **90%** |
| | Autumn 2015 | 125% | 120% | 120% | 26% | 61% |
| **Species Richness[A]** | **Completion Criteria** | **65%** | **65%** | **65%** | **65%** | **65%** |
| | Autumn 2015 | 81% | 88% | 85% | 36% | 77% |

[A] Species richness is calculated as the number of species observed divided by the total number of species planted

## 5.1 Site 2 (Established in 2012)

### 5.1.1 Survival and Condition of Revegetation

Mean survival rate across the 20 transects at Site 2 was estimated at 125% of the original number of seedlings planted in 2012 (Table 3).

Site 2 has had very high survival rates since the initial planting in 2012, with the last three assessments all showing survival to be higher than the required 90% survival rate (Figure 6).

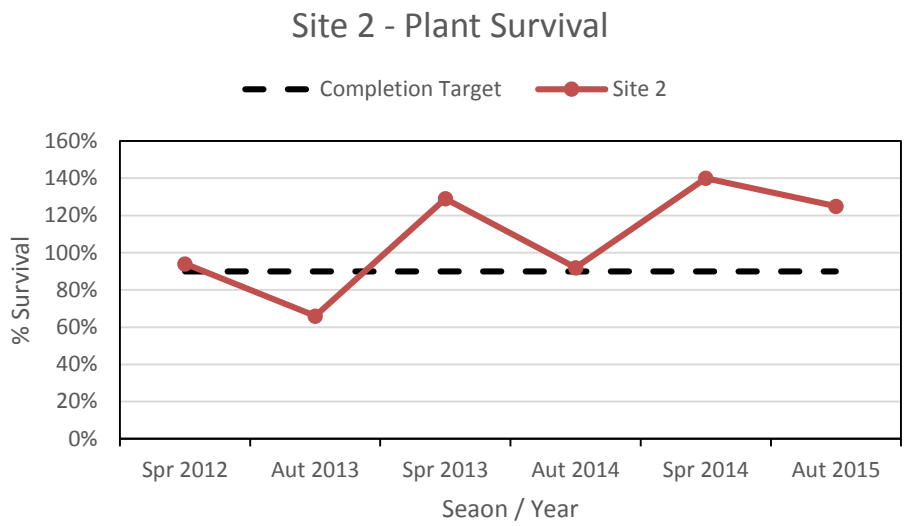



**Figure 6 Site 2 – Plant Survival Since Site Establishment**

### 5.1.2 Plant Heights

Maximum plant heights increased by 1.3m on average since spring 2014. Mean maximum plant height for transects was 4.2 (± 1.6 m).

Plant heights have continued to increase at Site 2 since the initial site establishment in 2012 (Figure 7).

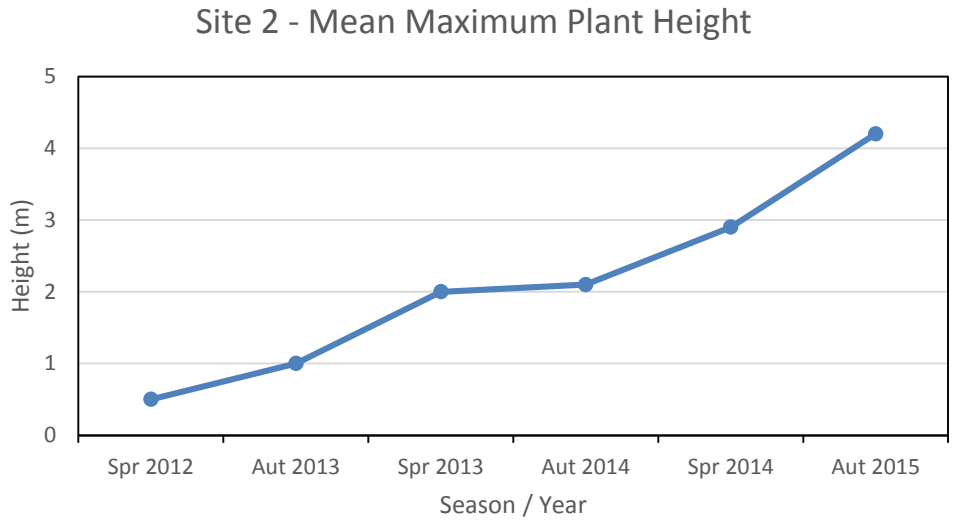



**Figure 7 Site 2 – Plant Heights Since Site Establishment**

### 5.1.3 Remnant Vegetation

Site 2 contained several patches of remnant vegetation, with *Corymbia calophylla* and *Eucalyptus wandoo* trees scattered throughout the site.

Seedlings of *E. wandoo* and *C. calophylla* were observed on site, while the native grass *Austrostipa flavescens* occurred in high densities in some areas.

### 5.1.4 Weeds

Weed cover was very low across the whole site, with mean weed cover 0.9% (± 0.3%). This meets the completion target at present. Most weeds observed were not likely to be competing with the older plants on the site.

### 5.1.5 Species Richness

A total of 27 species were planted at Site 2 over the three planting years. Of these, 22 species were observed either on transects or during a walk-through of the site (81% of the total species) (Table 3). Species diversity has remained above the 65% completion criterion for the duration of the project so far (Figure 8).

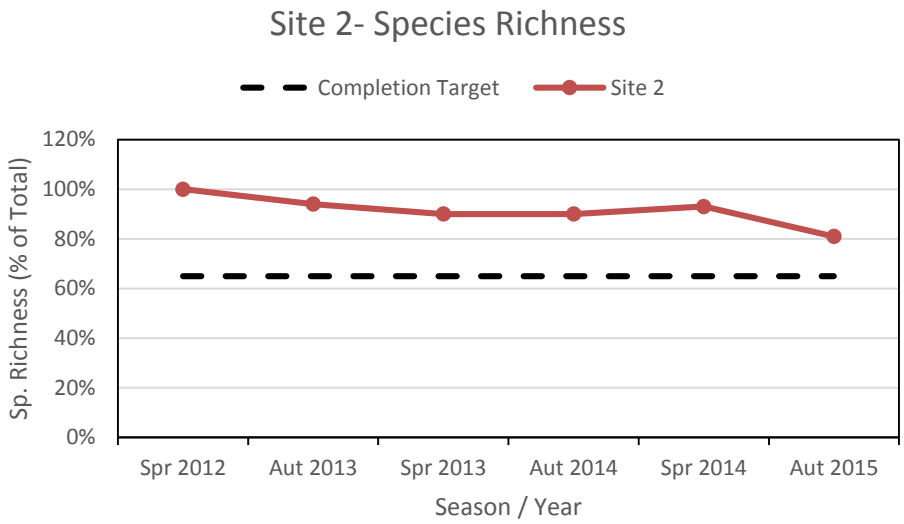



**Figure 8 Site 2 – Species Richness Since Site Establishment**

### 5.1.6 Fauna

Some minor signs of grazing of seedlings were noted, most likely from kangaroos that occasionally enter the site through open gates.

### 5.1.7 Surface Stability and Erosion

The soil surface was stable across the site, with little or no signs of erosion.

## 5.2 Site 3 (Established in 2013)

### 5.2.1 Survival and Condition of Revegetation

Mean survival of seedlings relative to the number initially planted into Site 3 was 120% (± 24%) across the nine transects (Table 3). Survival has increased above 100% because more seedlings were planted into the site in 2014 than were originally installed in 2013 (Figure 9).

Plant condition was excellent, with no herbivory or damage noted.

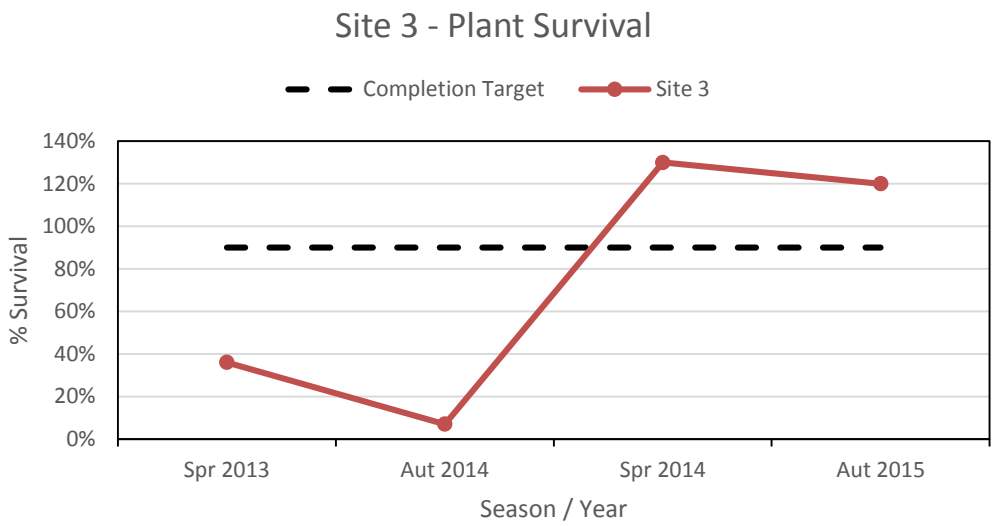



**Figure 9 Site 3 – Plant Survival Since Site Establishment**

### 5.2.2 Plant Heights

Maximum plant heights at Site 3 ranged between 0.5 m and 1.2 m, with a mean height of 0.6 m; representing an increase of 0.2 m from spring 2014. (Figure 10).

### 5.2.3 Remnant Vegetation

Site 3 was established within a clearing surrounded by *E. wandoo* and *C. calophylla* trees. The site contains a few seedlings and saplings of *E. wandoo* and remnant vegetation remains in a good condition.

No natural germinants were observed in the transect lines in autumn 2015.

### 5.2.4 Weeds

Weed cover was very low across the whole site, with mean weed cover 0.0% (± 0%).

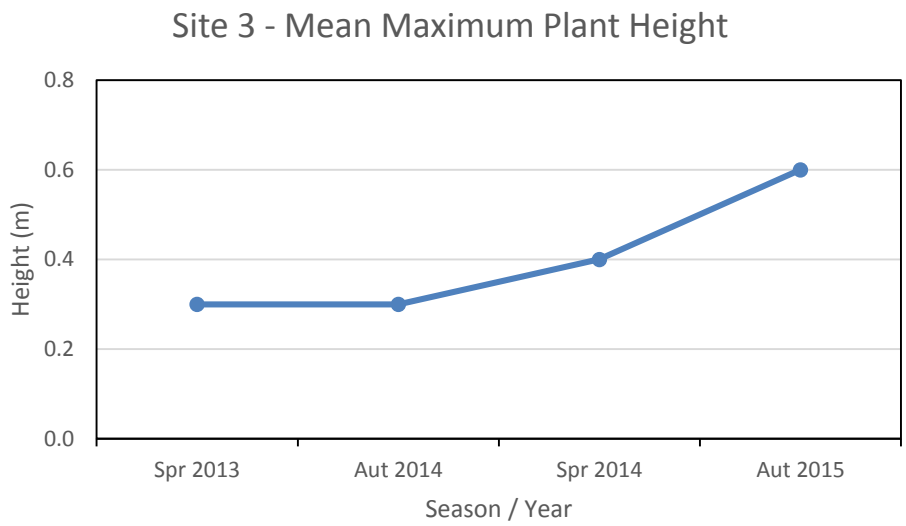



**Figure 10 Site 3 – Plant Heights Since Site Establishment**

### 5.2.5 Species Richness

A total of 24 species was planted at Site 3 over 2013 and 2014. Twenty-one species were observed in autumn 2015 (88% of the total species, which is above the completion target required by the third year) (Figure 11).

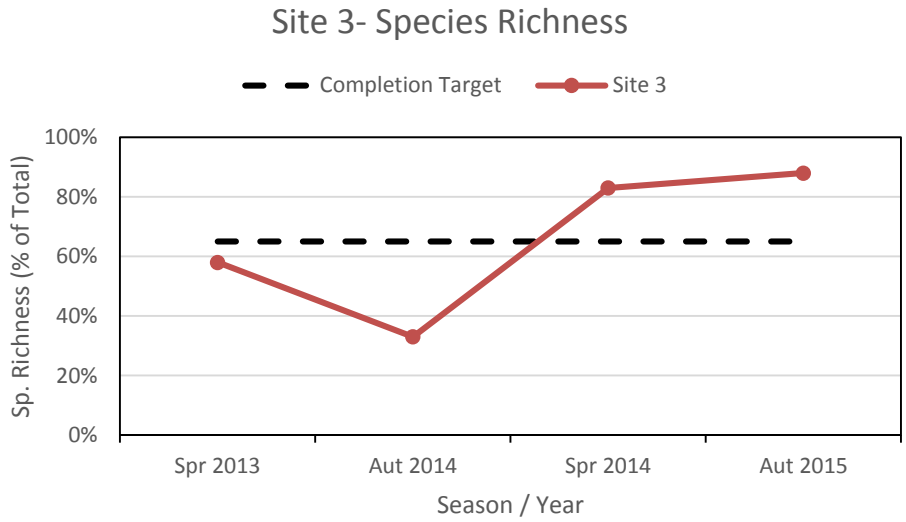



**Figure 11 Site 3 – Species Richness Since Site Establishment**

### 5.2.6 Fauna

Prior to the fence being erected, the site was significantly affected by vertebrate herbivores, with kangaroo presence at the site noted through dung and resting sites. Since installation of the fence, there is no evidence of kangaroo or rabbit presence on site.

### 5.2.7 Surface Stability and Erosion

The site showed only minor evidence of erosion. All rip-lines have been installed across the slope parallel to the contours, which reduces the erosion potential from surface water runoff.

## 5.3 Site 4 (Established in 2013)

### 5.3.1 Survival and Condition of Revegetation

Mean survival of seedlings relative to the initial number installed for Site 4 was 120% (± 55%) across the 15 transects (Table 3; and for raw data see Appendix 2). This is a significant increase in survival rates compared with autumn 2014 when survival was measured at 6% (Figure 12).

Plant condition was good, with strong growth noted for *Corymbia calophylla* in particular. Plant condition last year was generally poor, which was most likely due to heavy grazing from kangaroos that were able to come through the gates which were frequently left open. The improvements to the fence around the site appears to have prevented kangaroos from accessing the site.

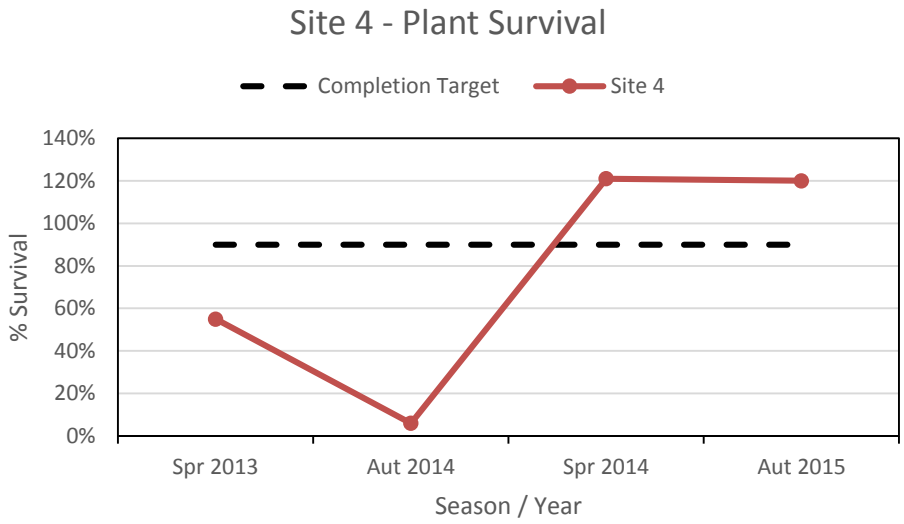



**Figure 12 Site 4 – Plant Survival Since Site Establishment**

### 5.3.2 Plant Heights

Maximum plant heights at Site 4 ranged between 0.5 m and 2.5 m, with a mean plant height of 1.1 m (± 0.7 m). This is an increase of 0.5 m since the previous survey in spring 2014 (Figure 13).

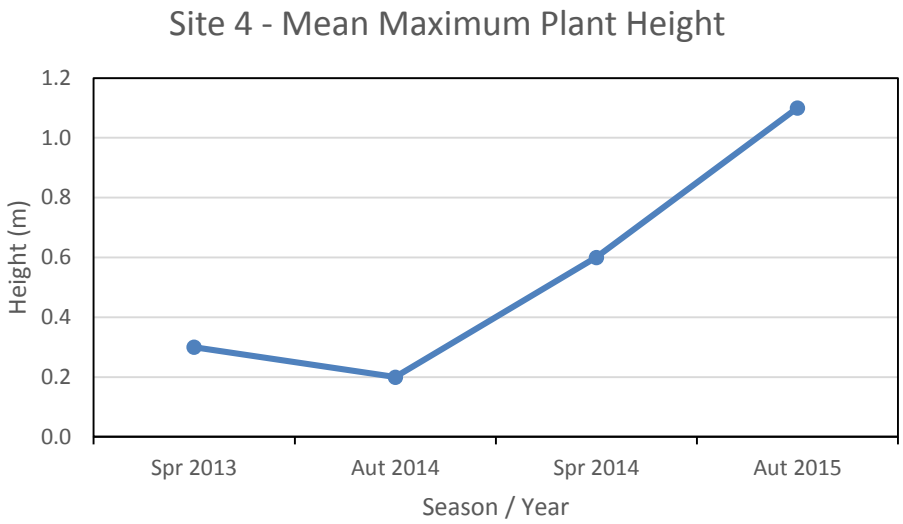



**Figure 13 Site 4 – Plant Heights Since Site Establishment**

### 5.3.3 Remnant Vegetation

Site 4 contains patches of remnant vegetation which consist almost entirely of *E. wandoo* mature trees, which are scattered throughout the site, but are only small in area. These trees appear healthy.

No natural germination was observed on transects in spring 2015.

### 5.3.4 Weeds

Weed foliar cover averaged 0.2% (± 0.4%) across the site. The majority of transects recorded no weed cover.

### 5.3.5 Species Richness

Twenty seven species were planted at Site 4 over two seasons in 2013 or 2014. Of these, 23 were observed during the autumn 2015 assessment, representing 85% of the total number planted (Table 3), which is well above the completion target required after three years (Figure 14).

### 5.3.6 Fauna

Prior to the fence being altered in autumn 2014, the site was significantly affected by vertebrate herbivores, with kangaroos the most likely cause of poor plant survival and health. Since adding additional fencing on either side of the track so that recreational users of the track cannot leave gates open, there is no evidence of kangaroo or rabbit presence on site.

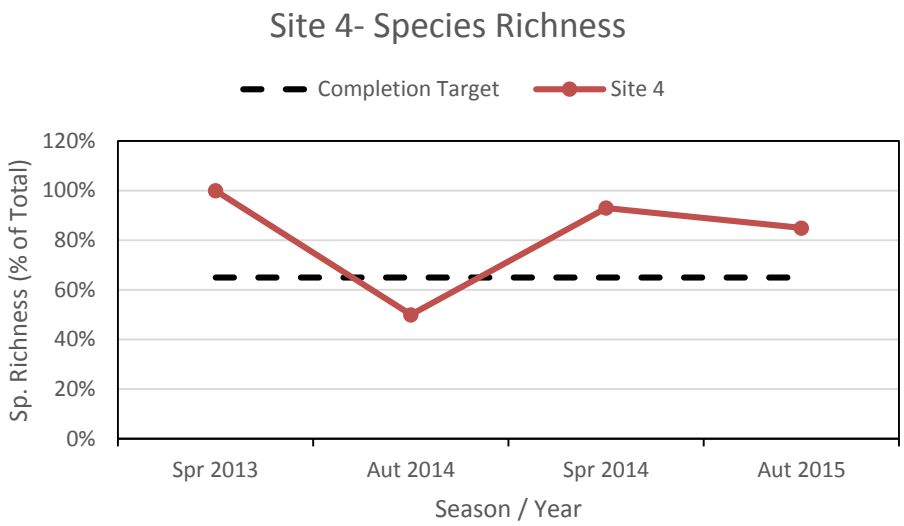



**Figure 14 Site 4 – Species Richness Since Site Establishment**

### 5.3.7 Surface Stability and Erosion

The slopes on the eastern side of the site do have some erosion channels forming, some of which may be a result of the direction of ripping that was undertaken on the site.

## 5.4 Sales Office A (Established in 2013)

### 5.4.1 Survival and Condition of Revegetation

Mean survival of seedlings relative to the initial number installed at Sales Office A was 26% (± 14%) across the six quadrats (Table 3). This is similar to the previous spring assessment, and is currently below the completion target to be met after three years (Figure 15).

The condition of most surviving plants was good, with the majority being *Eucalyptus wandoo* or *Corymbia calophylla* that do not appear to be grazed by the kangaroos.

### 5.4.2 Plant Heights

Maximum plant heights at Sales Office A ranged between 2 m and 2.5 m, with a mean plant height of 2 m, an increase of 0.5 m since the previous assessment (Figure 16).

### 5.4.3 Remnant Vegetation

There is no remnant vegetation within Sales Office A. This was a bare paddock prior to revegetation works commencing.

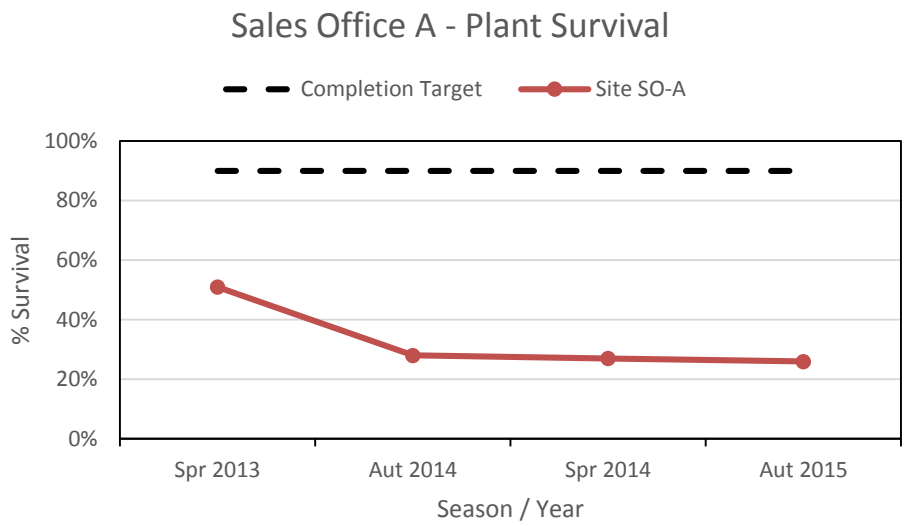



**Figure 15 Sales Office A – Plant Survival Since Site Establishment**

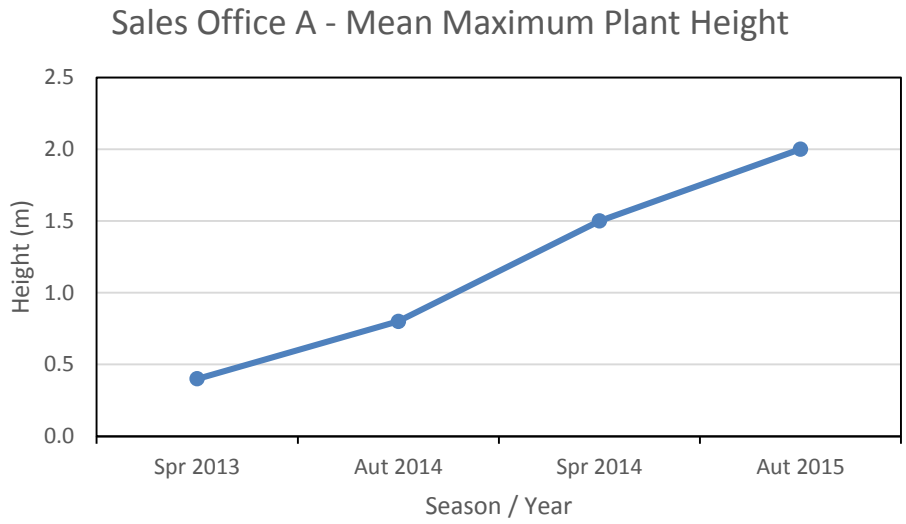



**Figure 16 Sales Office A – Plant Heights Since Site Establishment**

### 5.4.4 Weeds

Average weed cover was 16.7% (± 16.3%).

Sales Office A has the potential to be very weedy given the large population of Narrow-leaf Cotton Bush that was previously established on the road verge immediately up-hill of the site (physically removed by Tranen following planting), as well as the latent soil seed bank of the ex-pasture land. However, the above-ground biomass and the root systems of these weeds can reduce the potential for erosion on steep slopes; hence the need for weed control must be considered against potential for soil erosion.

### 5.4.5 Species Richness

Eleven species were originally planted into Sales Office A in 2013. Four of these species were observed during the survey (36% of the total; Figure 17). The shrubs were severely grazed upon, while *E. wandoo* and *C. calophylla* were healthy and largely untouched by vertebrate herbivores.

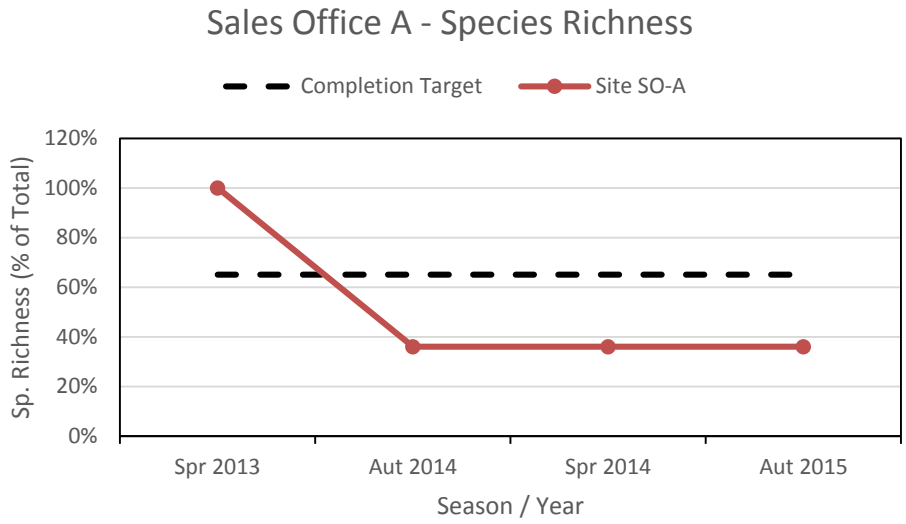



**Figure 17 Sales Office A – Species Richness Since Site Establishment**

### 5.4.6 Fauna

The site appears to have been significantly affected by vertebrate herbivores, with kangaroo presence at the site noted through the presence of dung. There was no evidence that rabbits had been on the site, but it is possible. Seedlings of *E. wandoo* and *C. calophylla* appear to have reached a stage where they are no longer being grazed.

### 5.4.7 Surface Stability and Erosion

There was some evidence of erosion occurring on this site. The site occurs on a relatively steep hillside, and when ripped, some rip-lines were installed perpendicular to the contours rather than parallel (by contractors not organised by Tranen), which channels and increases the speed and volume of surface flows, leading to erosion.

## 5.5 Sales Office B (Established in 2013)

### 5.5.1 Survival and Condition of Revegetation

Mean survival of seedlings installed at Sales Office B was 61% (± 20%) across the five quadrats and ten transects (Table 3). Survival ranged from

61% to 103% across the plots, a slight decrease compared with spring and below the target survival rate of 90% to be met after three years (Figure 18).

The condition of surviving plants was generally very good, with strong growth and few signs of stress.

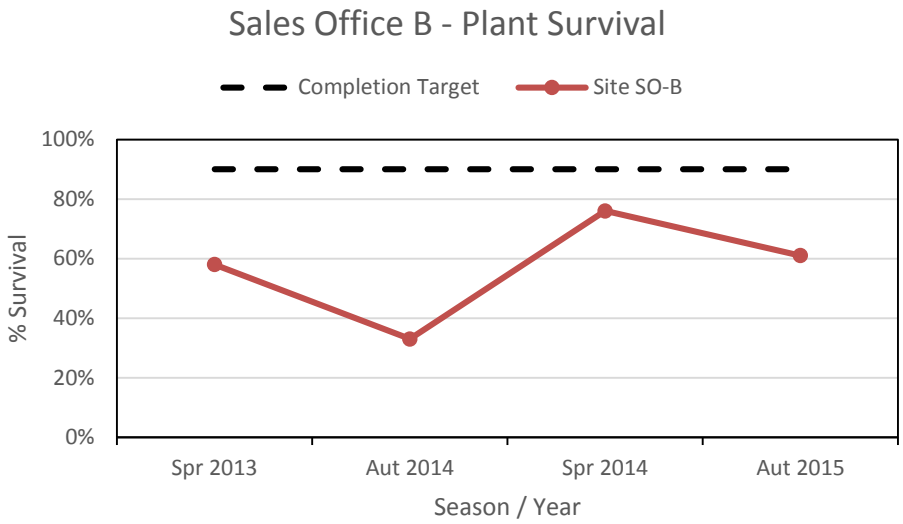



**Figure 18 Sales Office B – Plant Survival Since Site Establishment**

### 5.5.2 Plant Heights

Maximum plant heights at Sales Office B ranged between 0.6 m and 3.2 m, with a mean height of 2.4 m. This represents an increase of 1.2 m since the previous assessment in spring 2014 (Figure 19).

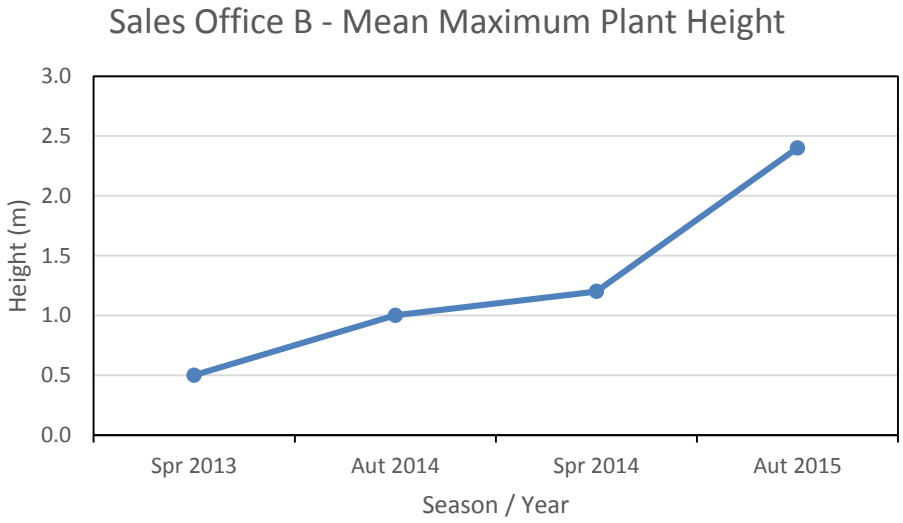



**Figure 19 Sales Office B – Plant Heights Since Site Establishment**

### 5.5.3 Remnant Vegetation

Sales Office B contains patches of remnant vegetation which consist almost entirely of mature *E. wandoo* trees. These are scattered throughout the site, but mainly occur on rocky breakaways. All trees appear to be healthy.

No natural germination was observed on transects or quadrats in autumn 2015.

### 5.5.4 Weeds

Weed cover ranged between 2% and 80% cover, with an average weed cover of 12.7% (± 19.4%). Most weeds were small annuals which were just germinating in the rip lines following the first autumn rains.

### 5.5.5 Species Richness

A total of twenty-six species was planted in Sales Office B over 2013 and 2014. Twenty of these were observed during the survey (77% of the total installed; Table 3), which is above the 65% required to meet the completion criterion (Figure 20).

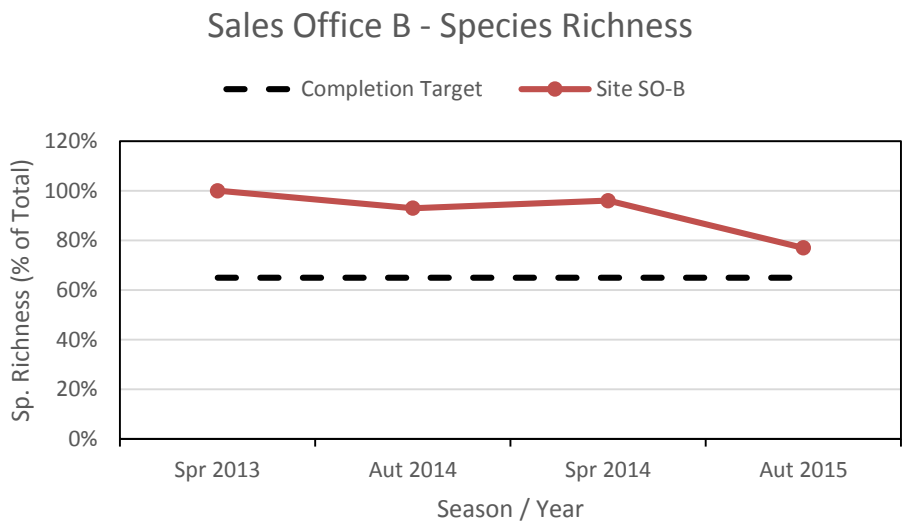



**Figure 20 Sales Office B – Species Richness Since Site Establishment**

### 5.5.6 Fauna

It appeared that there was some grazing of plants at Sales Office B, with evidence of kangaroo and rabbit scats. It appears kangaroos may gain access to the site beneath the gates.

### 5.5.7 Surface Stability and Erosion

There was minor erosion evident in some of the rip-lines that were installed with a slight downhill orientation, and this erosion may have led to some plant deaths. It is not a great concern across this site.

# 6 DISCUSSION

A total of 144,675 seedlings have been planted for the Avon Ridge project out of a total of 214,000 stipulated in the offset package prepared by Peet. Of these, 88,255 seedlings represent initial plantings into the sites, and 56,420 have been planted to account for losses or to increase plant numbers above the 90% survival target. These have been planted across six separate revegetation sites over a three year time frame beginning in 2011. Survivorship of plants installed into the revegetation sites must be 90% or greater after three years to meet Condition 3 of the EPBC approval, and the *Revegetation and Fire Management Plan* (Cardno 2012) presents further completion criteria that must be met, as discussed below.

## 6.1 Assessment Against Completion Criteria

During the autumn 2015 survey, survival of planted tubestock relative to the number initially planted in each site was:

- 125% at Site 2 (2.5 years after initial planting);
- 120% at Site 3 (1.5 years after initial planting);
- 120% at Site 4 (1.5 years after initial planting);
- 26% at Sales Office A (1.5 years after initial planting); and
- 61% at Sales Office B (1.5 years after initial planting).

Plant survival in some sites was greater than 100% owing to extra numbers being installed in winter 2014 to account for future attrition.

Monitoring for Site 1A was completed in spring 2014, and this site met all the completion criteria at that time. It was therefore not assessed during the autumn 2015 monitoring event.

Site 2 monitoring results shown in this report represent the final data against which the completion criteria are to be assessed. At the time of monitoring, revegetation at the site was just over 2.5 years old, with only 4 months to achieve three years since revegetation works were first undertaken. It is concluded that the data provided in this report are evidence that the site has met the completion criteria given the monitoring occurred just prior to winter rains and no further declines in plant numbers or health are likely. Currently, all parameters meet the completion criteria (Table 1), and therefore revegetation at this site is considered complete.

Sites 3 and 4 have approximately 1.5 years to run on revegetation activities before they can be finally assessed against the completion criteria. Both sites currently meet all the criteria (Table 1).

Sales Office A has approximately 1.5 years to run on revegetation activities before it can be finally assessed against the completion criteria. It currently does not meet all the criteria (Table 1). In particular, plant survival measures are below the levels required. However, this site has not been considered for further tubestock planting because kangaroo grazing will substantially affect survival rates. Installation of a fence is not considered an option because the site is in a highly visible area to residents and sits directly below a lookout to the Avon River which is popular with tourists. Therefore, construction of a fence would impact the aesthetic qualities of the area. Instead, plants that would have been installed at this site to account for deaths were installed into sites 2, 3 and 4 in winter 2014. Analysis of surviving plant

numbers across all sites (except 1A) demonstrates that an additional 4,179 plants are alive after accounting for the requirement to meet 90% survivorship of initial plantings (Table 4). Thus, total seedling numbers across all sites currently accounts for losses at both Sales Office sites.

**Table 4 Total Seedling Numbers at Each Site**

| Site | Initial No. installed | Survival (Autumn 2015) | No. seedlings survived (Autumn 2015) | No. seedlings on site to meet 90% survival | No. seedlings in excess of 90% target |
|---|---|---|---|---|---|
| 2 | 24,000 | 125% | 30,000 | 21,600 | 8,400 |
| 3 | 2,610 | 120% | 3,132 | 2,349 | 783 |
| 4 | 10,340 | 120% | 12,408 | 9,306 | 3,102 |
| SO-A | 6,150 | 26% | 1,599 | 5,535 | -3,936 |
| SO-B | 14,380 | 61% | 8,772 | 12,942 | -4,170 |
| **TOTAL** | **57,480** | | **55,911** | **51,732** | **4,179** |

Sales Office B has approximately 1.5 years to run on revegetation activities before it can be assessed against the completion criteria. It currently meets all the criteria except for plant survival (61%) which is below the 90% required (Table 1). It appears that survival has been affected by the ability of kangaroos and rabbits to enter the site, even with fences and gates in place.

## 6.2 Plant Health, Species Richness and Growth of Revegetation

The condition and growth of revegetation works is good across all sites, with the exception of Sales Office A where kangaroo grazing has killed virtually all shrub species (except *Callistemon phoeniceus*). The eucalypt species have survived and are growing well at Sales Office A.

Plant heights have increased at all sites since the previous assessment. This indicates that the fence installed at Site 3, and the improvements to fencing at Site 4 have had a positive result by preventing kangaroos from impacting the seedlings.

Species richness, measured as ≥ 65% of species installed still being present on site, currently meets the completion criteria for all sites except Sales Office A. Infill planting at Sites 3 and 4 replaced many species that were significantly impacted by kangaroo grazing. Some new species were also added to all sites except Sales Office A in 2014, which increased species richness across the project.

## 6.3 Weeds

Weed cover was relatively low across most of the sites at the time of survey apart from the sales office A and B. The timing of monitoring probably influenced these results with sites 2, 3 and 4 surveyed earlier than the Sales Office sites, by which

time rainfall and cooler weather had triggered more weed germination. Most weeds occurred outside the rip-lines, and hence were unlikely to be competing with native seedlings.

## 6.4 Remnant Vegetation and Natural Recruitment

Site 2 has shown improvement in condition through natural recruitment. Species that have been observed germinating at Site 2 over the course of the revegetation activities include *Corymbia calophylla, Eucalyptus rudis*, *Hibbertia commutata* and *Hypocalymma* sp., some of which are Black Cockatoo foraging species (Valentine and Stock, 2008; Groom, 2011). A large population of the native grass *Austrostipa flavescens* has also established in the centre of Site 2, and in less dense populations in other areas throughout the site. It is likely that the natural recruitment of these species has benefitted significantly from the exclusion of kangaroos, particularly the native grass and shrub species.

The younger sites (Sites 3, 4 and Sales Office A and B) have shown little natural recruitment to date. However, this may change as the exclusion of kangaroos and continuing weed control improve conditions for germination and establishment, but is dependent on seed availability in the soil or canopy.

## 6.5 Fauna

Installation of a fence at Site 3 and improvements to the fence at Site 4 have prevented kangaroos from impacting seedlings at these sites. Kangaroos do seem to be able to access Sales Office B, which may have impacted survival rates. The gates at this site will be improved to prevent kangaroos being able to get underneath them.

## 6.6 Surface Stability and Erosion

Surface erosion was noted at Sales Office A and B, and at Site 4, all of which have relatively steep slopes.

# 7 CONCLUSIONS, RECOMMENDATIONS AND FURTHER WORK

Revegetation works at Avon Ridge are progressing well. Site 1A met all the completion criteria at the conclusion of its third year (reported in the previous monitoring report for spring 2014 (Tranen 2015)), and most other sites are on track to do the same.

Site 2 has also met the completion criteria and can be considered complete given it will be three years since initial planting in August 2015. However, all of the excess seedlings installed into Site 2 in 2014 were to account for the reduction in numbers at Sales Office A. Therefore, Site 2 will continue to need surveying until the project is complete to ensure these extra seedlings have survived and that survival is ≥ 90% across the project.

Sales Office A will not meet completion criteria after three years of revegetation works are completed in 2016, as it has not been considered for infill planting or other remedial works. Fencing is the only feasible option to protect seedlings from kangaroos, which would detract from the aesthetics of the area. Further, installing understorey shrubs would increase the fire hazard posed by this vegetation to residents. It is recommended that no further revegetation works be undertaken at this Site (other than weed control, if required). Though survival is less than the required 90% of initial planting numbers, planting works in 2014 allowed for extra plants to be installed in Sites 2, 3 and 4 to account for these losses. Hence, these extra plants should be counted towards the completion criteria for the project as a whole.

Of the remaining sites, currently only Sales Office B is below the required 90% survival target. This site could be planted with more plants in 2015 to bring survival up to >90%. Alternatively, the extra plants that have survived in the other sites could be counted towards the survival target by looking at the project as a whole, as with the recommendation for Sales Office A. By taking this approach, the 90% survival target is met, plus there are an additional 4,179 seedlings alive on site.

# 8 REFERENCES

Cardno (2012) *Avon Ridge Estate, Brigadoon: Revegetation and Fire Management Plan* (Revised 2012). Report prepared for Peet Pty Ltd, June 2012.

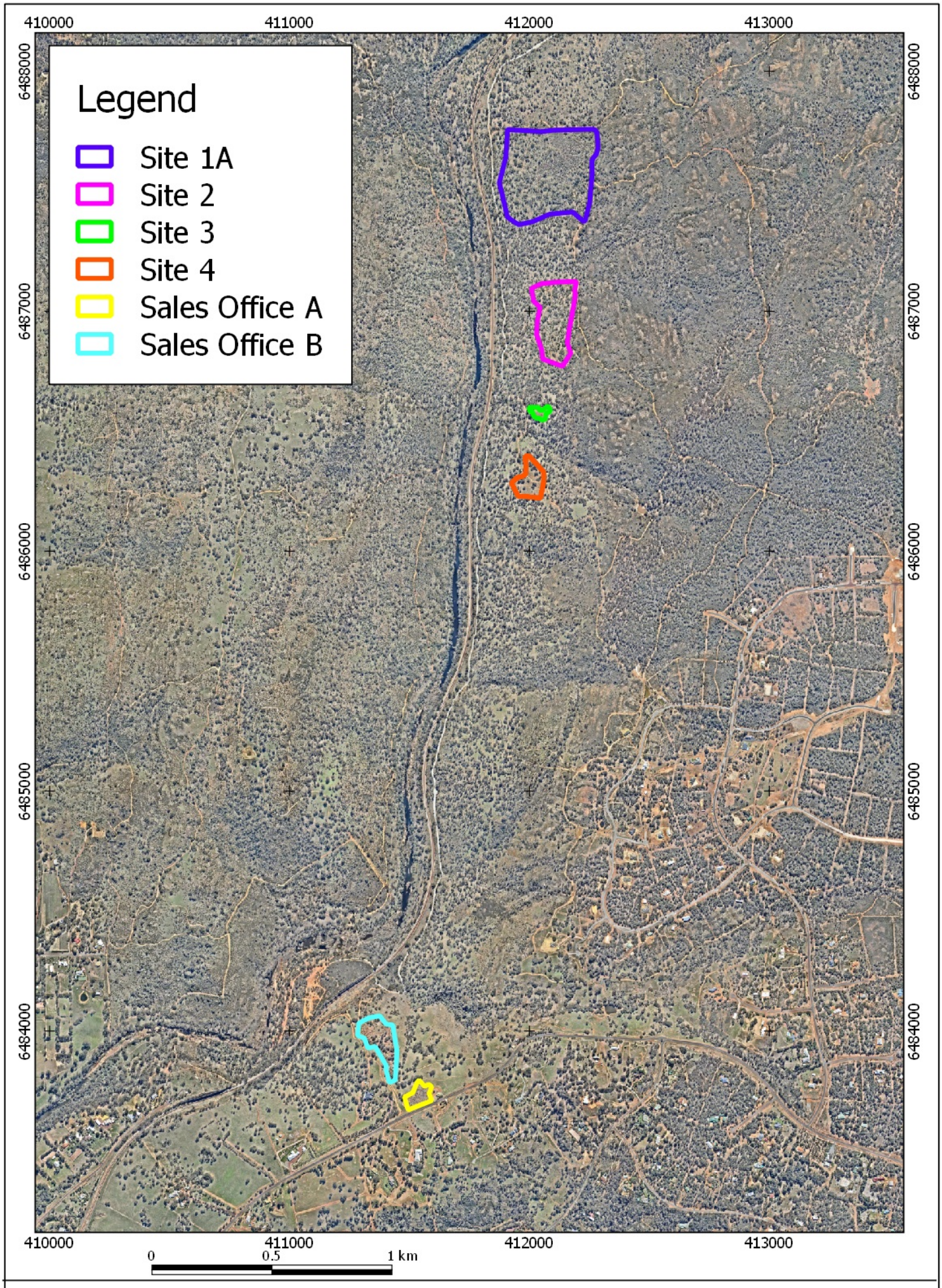
Groom, C. (2011) *Plants Used by Carnaby's Black Cockatoo*. List prepared by Christine Groom, Department of Environment and Conservation, 15 April 2011.

Tranen (2013) *Avon Ridge Estate Bi-annual Monitoring Report – Autumn 2013*. Report prepared for Emerge Associates, August 2013.

Tranen (2015) *Avon Ridge Estate Bi-annual Monitoring Report – Spring 2014*. Report prepared for Emerge Associates, February 2015.

Valentine, L.E. and Stock, W. (2008) *Food Resources of Carnaby's Black Cockatoo (*Calyptorhynchus latirostris*) in the Gnangara Sustainability Strategy Study Area*. http://ro.ecu.edu/ecuworks/6147

# Appendix 1 Revegetation Site Locations




tranen revegetation systems

Project: Avon Ridge Revegetation
Project Number: P496
Client: Emerge Associates

Drawing: Revegetation Sites
Drawing Number: P496A-03
Revision: 0

Date: 30/06/2015
Drawn By: RSW

# Appendix 2 Raw Data

## Avon Ridge Site 2

| Transect No | Est. Total no. planted in 2012 | No. alive Aut 2015 | % Survival Aut 2015 | Tallest sp. observed | Height (m) | Weed cover (%) | Comments |
|---|---|---|---|---|---|---|---|
| 1 | 68 | 52 | **76%** | *Acacia saligna* | 5.5 | 0 | |
| 2 | 9 | 26 | **289%** | *Acacia saligna* | 3.0 | 1 | stinkwort |
| 3 | 8 | 14 | **175%** | *Acacia saligna* | 4.5 | 1 | stinkwort |
| 4 | 36 | 24 | **67%** | *Eucalyptus rudis* | 5.0 | 1 | |
| 5 | 36 | 39 | **108%** | *Eucalyptus rudis* | 5.0 | 1 | *Eucaluptus rudis* recruits up to 4m tall along edge of transect |
| 6 | 18 | 10 | **56%** | *Acacia saligna* | 3.5 | 1 | Ground area of transect has poor survial |
| 7 | 23 | 22 | **96%** | *Acacia saligna* | 3.0 | 1 | Poor growth area, herbivores evident |
| 8 | 15 | 4 | **27%** | *Eucalyptus rudis* | 2.2 | 0 | Dead *Acacia* and *Eucalupt* |
| 9 | 86 | 56 | **65%** | *Acacia saligna* | 5.5 | 1 | Dead *Acacia* and *Hakea varia* |
| 10 | 42 | 45 | **107%** | *Acacia saligna* | 5.5 | 1 | |
| 11 | 144 | 74 | **51%** | *Acacia saligna* | 5.5 | 1 | Deaths were mainly of *Hakea prostrata* |
| 12 | 123 | 110 | **89%** | *Acacia saligna* | 4.5 | 1 | |
| 13 | 71 | 103 | **145%** | *Acacia saligna* | 5.5 | 1 | |
| 14 | 36 | 37 | **103%** | *Eucalyptus rudis* | 1.5 | 1 | No *Acacia saligna* observed |
| 15 | 12 | 16 | **133%** | *Acacia saligna* | 5.5 | 1 | |
| 16 | 9 | 60 | **667%** | *Acacia saligna* | 1.8 | 1 | |
| 17 | 41 | 39 | **95%** | *Eucalyptus rudis* | 2.2 | 1 | |
| 18 | 197 | 83 | **42%** | *Corymbia calophylla* | 1.8 | 1 | |
| 19 | 117 | 54 | **46%** | *Acacia saligna* | 6.0 | 1 | 5 *Corymbia* |
| 20 | 58 | 31 | **53%** | *Acacia saligna* | 6.0 | 1 | Dead *Banskia menzeisii* |
| | | **Mean** | **125%** | | **4.2** | **0.9** | |
| | | **st dev** | **140%** | | **1.6** | **0.3** | |
| | | **min** | **27%** | | **1.5** | **0.0** | |
| | | **max** | **667%** | | **6.0** | **1.0** | |

Note: estimated total number planted is based on average survival from autumn 2013 of 66%

## Avon Ridge Site 2

**2012 planting**

| Species | Observed? |
|---|---|
| *Acacia pulchella* | Y |
| *Acacia saligna* | Y |
| *Allocasuarina fraseriana* | Y |
| *Allocasuarina humilis* | Y |
| *Banksia grandis* | Y |
| *Banksia menzeisii* | Y |
| *Banksia nivea* | N |
| *Banksia prionotes* | Y |
| *Banksia sessilis* | Y |
| *Callistemon phoeniceus* | Y |
| *Calothamnus hirsutus* | N |
| *Calothamnus quadrifidus* | N |
| *Corymbia calophylla* | Y |
| *Eucalyptus marginata* | Y |
| *Eucalyptus rudis* | Y |
| *Eucalyptus wandoo* | Y |
| *Hakea cyclocarpa* | N |
| *Hakea incrassata* | N |
| *Hakea lissocarpha* | Y |
| *Hakea prostrata* | Y |
| *Hakea ruscifolia* | Y |
| *Hakea trifurcata* | Y |
| *Hakea undulata* | Y |
| *Hakea varia* | Y |
| *Hibbertia subvaginata* | Y |
| *Hypocalymma robustum* | Y |
| *Kennedia prostrata* | Y |

Total no. spp planted: 27

No. spp observed: 22

% spp observed: 81%

## Avon Ridge Site 3

Planted in 2013

| Transect No. | Total No. planted 2013 (Baseline) | No. alive Aut 2015 | % Survival Aut 2015 | Tallest spp observed Aut 2014 | Height (m) | Weed cover (%) | Comments |
|---|---|---|---|---|---|---|---|
| 1 | 23 | 28 | **122%** | *Corymbia calophylla* | 0.5 | 0 | |
| 2 | 50 | 47 | **94%** | *Acacia pulchella* | 0.5 | 0 | |
| 3 | 56 | 66 | **118%** | *Eucalyptus wandoo* | 1.2 | 0 | some *Eucalyptus wandoo* recruits |
| 4 | 55 | 65 | **118%** | *Corymbia calophylla* | 0.6 | 0 | |
| 5 | 49 | 55 | **112%** | *Acacia pulchella* | 0.8 | 0 | lots of planting off ripline |
| 6 | 55 | 99 | **180%** | *Eucalyptus wandoo* | 0.5 | 0 | |
| 7 | 66 | 77 | **117%** | *Eucalyptus wandoo* | 0.5 | 0 | lots of *Astrostipa* |
| 8 | 40 | 47 | **118%** | *Corymbia calophylla* | 0.6 | 0 | |
| 9 | 42 | 44 | **105%** | *Banksia sessilis* | 0.5 | 0 | |
| | | **Mean** | **120%** | | **0.6** | **0.0** | |
| | | **Min** | **94%** | | **0.5** | **0.0** | |
| | | **Max** | **180%** | | **1.2** | **0.0** | |
| | | **St. dev.** | **24%** | | **0.2** | **0.0** | |

## Avon Ridge Site 3

| Species | Observed? |
|---|---|
| *Acacia lasiocarpa* | N |
| *Acacia pulchella* | Y |
| *Acacia saligna* | Y |
| *Allocasuarina humilis* | Y |
| *Banksia lindleyana* | Y |
| *Banksia nivea* | Y |
| *Banksia sessilis* | Y |
| *Callistemon phoeniceus* | Y |
| *Calothamnus hirsutus* | Y |
| *Calothamnus quadrifidus* | Y |
| *Corymbia calophylla* | Y |
| *Eucalyptus rudis* | Y |
| *Eucalyptus wandoo* | Y |
| *Gompholobium tomentosum* | Y |
| *Grevillea bipinnatifida* | Y |
| *Hakea lissocarpha* | Y |
| *Hakea prostrata* | Y |
| *Hakea ruscifolia* | N |
| *Hakea trifurcata* | N |
| *Hakea undulata* | Y |
| *Hibbertia subvaginata* | Y |
| *Hypocalymma robustum* | Y |
| *Kennedia coccinea* | Y |
| *Kennedia prostrata* | Y |

Total no. spp planted: 24

No. spp observed: 21

% spp observed: 88%

Note: *Eucalyptus wandoo* seems to be the only species that has survived since 2013

## Avon Ridge Site 4

Planted in 2013

| Transect No. | Total No. planted 2013 (Baseline) | No. Alive Aut 2015 | % Survival Aut 2015 | Tallest spp observed | Height (m) | Weed cover (%) | Comments |
|---|---|---|---|---|---|---|---|
| 1 | 69 | 69 | 100% | *Corymbia calophylla* | 0.6 | 1 | Stinkwort, some erosion |
| 2 | 125 | 190 | 156% | *Eucalyptus rudis* | 2.0 | 1 | |
| 3 | 50 | 75 | 180% | *Eucalyptus wandoo* | 0.7 | 0 | |
| 4 | 62 | 75 | 127% | *Acacia pulchella* | 1.0 | 1 | |
| 5 | 50 | 29 | 64% | *Eucalyptus rudis* | 1.2 | 0 | |
| 6 | 98 | 69 | 71% | *Eucalyptus rudis* | 2.5 | 0 | |
| 7 | 50 | 26 | 60% | *Eucalyptus wandoo* | 1.0 | 0 | |
| 8 | 46 | 0 | 9% | *n/a* | n/a | n/a | was not infilled in 2014- not representive of the site |
| 9 | 32 | 28 | 97% | *Acacia puchella* | 0.5 | 0 | |
| 10 | 44 | 43 | 105% | *Corymbia calophylla* | 0.5 | 0 | |
| 11 | 34 | 37 | 132% | *Eucalyptus rudis* | 2.2 | 0 | |
| 12 | 42 | 56 | 157% | *Corymbia calophylla* | 0.6 | 0 | |
| 13 | 102 | 165 | 194% | *Corymbia calophylla* | 0.7 | 0 | lots of Austrostipa |
| 14 | 22 | 31 | 159% | *Corymbia calophylla* | 0.6 | 0 | |
| 15 | 44 | 73 | 195% | *Corymbia calophylla* | 0.6 | 0 | |
| | | **Mean** | **120%** | | **1.1** | **0.2** | |
| | | **Min** | **9%** | | **0.5** | **0.0** | |
| | | **Max** | **195%** | | **2.5** | **1.0** | |
| | | **St. dev.** | **55%** | | **0.7** | **0.4** | |

## Avon Ridge Site 4

| Species | Observed? |
|---|---|
| *Acacia lasiocarpa* | Y |
| *Acacia pulchella* | Y |
| *Acacia saligna* | Y |
| *Allocasuarina humilis* | Y |
| *Banksia grandis* | N |
| *Banksia lindleyana* | Y |
| *Banksia nivea* | Y |
| *Banksia sessilis* | Y |
| *Callistemon phoeniceus* | Y |
| *Calothamnus hirsutus* | Y |
| *Calothamnus quadrifidus* | Y |
| *Corymbia calophylla* | Y |
| *Eucalyptus marginata* | Y |
| *Eucalyptus rudis* | Y |
| *Eucalyptus wandoo* | Y |
| *Gompholobium tomentosum* | Y |
| *Grevillea bipinnatifida* | Y |
| *Hakea lissocarpha* | Y |
| *Hakea prostrata* | Y |
| *Hakea ruscifolia* | N |
| *Hakea trifurcata* | N |
| *Hakea undulata* | Y |
| *Hakea varia* | N |
| *Hibbertia subvaginata* | Y |
| *Hypocalymma robustum* | Y |
| *Kennedia coccinea* | Y |
| *Kennedia prostrata* | Y |

Total no. spp planted: 27

No. spp observed: 23

% spp observed: 85%

**Avon Ridge Site Sales Office A**

Planted in 2013

| Quadrat # | Alive from 2013 initial works | Expected density (plants/m2) (Baseline) | No. Alive Aut 2015 | Density Aut 2015 (plants / m2) | % Survival Aut 15 | Tallest spp observed | Height (m) | Weed cover (%) | Comments |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 19 | 0.77 | 4 | 0.04 | 5% | *Corymbia calophylla* | 0.7 | 50 | Marri x 2, wandoo x 1, *Callistemon phoeneceus* x1 (not found last year) |
| 2 | 36 | 0.77 | 24 | 0.24 | 31% | *Eucalyptus wandoo* | 2.0 | 10 | marri x 9, wandoo x 15 |
| 3 | 45 | 0.77 | 24 | 0.24 | 31% | *Eucalyptus wandoo* | 2.5 | 10 | Marri x 2, wandoo x 19, *Calllistemon phoeneceus* x 2. Cotton Bush, *Acacia pulchella* |
| 4 | 32 | 0.77 | 14 | 0.14 | 18% | *Eucalyptus wandoo* | 2.2 | 10 | Marri x 4, wandoo x 9, *Callistemon phoeneceus* x 1 |
| 5 | 58 | 0.77 | 35 | 0.35 | 46% | *Eucalyptus wandoo* | 2.5 | 10 | Marri x 10, wandoo x 23, *Callistemon phoeneceus* x 2 |
| 6 | 43 | 0.77 | 19 | 0.19 | 25% | *Eucalyptus wandoo* | 1.8 | 10 | Marri x 1, wandoo x 17, *Callistemon phoeneceus* x 1 |
| | | | | **Mean** | **26%** | | **2.0** | **16.7** | |
| | | | | **Min** | **5%** | | **0.7** | **10.0** | |
| | | | | **Max** | **46%** | | **2.5** | **50.0** | |
| | | | | **St. dev.** | **14%** | | **0.7** | **16.3** | |

## Avon Ridge Sales Office A

**2013 planting**

| Species | Observed? |
|---|---|
| *Acacia saligna* | N |
| *Banksia grandis* | N |
| *Callistemon phoeniceus* | Y |
| *Corymbia calophylla* | Y |
| *Eucalyptus wandoo* | Y |
| *Hakea lissocarpha* | Y |
| *Hakea prostrata* | N |
| *Hakea ruscifolia* | N |
| *Hakea trifurcata* | N |
| *Hakea undulata* | N |
| *Hakea varia* | N |

| | |
|---|---|
| Total no. spp planted: | 11 |
| No. spp observed: | 4 |
| % spp observed: | 36% |

**Avon Ridge Site Sales Office B** Transects and quadrats

Planted in 2013

| Transect / Quadrat # | Total No. planted 2013 (Baseline) | No. Alive Aut 2015 | % Survival Aut 2015 | Tallest spp observed | Height (m) | Weed cover (%) | Comments |
|---|---|---|---|---|---|---|---|
| SOBQ1 | 112 | 78 | **70%** | *Acacia saligna* | 2.2 | 8 | |
| SOBQ2 | 116 | 106 | **91%** | *Acacia saligna* | 3.2 | 3 | |
| SOBQ3 | 168 | 104 | **62%** | *Acacia saligna* | 3.0 | 3 | |
| SOBQ4 | 114 | 96 | **84%** | *Acacia saligna* | 2.2 | 5 | no Kennedia prostrata observed |
| SOBQ5 | 123 | 76 | **62%** | *Acacia saligna* | 3.0 | 2 | |
| SOBT6 | 65 | 31 | **48%** | *Acacia saligna* | 2.5 | 10 | weeds germinating in riplines |
| SOBT7 | 71 | 46 | **65%** | *Acacia saligna* | 2.5 | 5 | weeds germinating in riplines |
| SOBT8 | 66 | 31 | **47%** | *Acacia saligna* | 2.2 | 20 | weeds germinating in riplines |
| SOBT9 | 63 | 30 | **48%** | *Acacia saligna* | 2.8 | 20 | weeds germinating in riplines |
| SOBT10 | 22 | 10 | **45%** | *Eucalyptus rudis* | 0.6 | 80 | weeds germinating in riplines small annual weeds, herbs |
| SOBT11 | 40 | 15 | **38%** | *Eucalyptus rudis* | 2.0 | 10 | weeds germinating in riplines |
| SOBT12 | 66 | 22 | **33%** | *Eucalyptus rudis* | 2.2 | 10 | weeds germinating in riplines |
| SOBT13 | 39 | 27 | **69%** | *Acacia saligna* | 2.5 | 5 | weeds germinating in riplines less herbs noted |
| SOBT14 | 36 | 37 | **103%** | *Acacia saligna* | 2.5 | 5 | |
| SOBT15 | 90 | 44 | **49%** | *Acacia saligna* | 2.0 | 5 | |
| | | | | | | | |
| | | **Mean** | **61%** | | **2.4** | **12.7** | |
| | | **Min** | **33%** | | **0.6** | **2.0** | |
| | | **Max** | **103%** | | **3.2** | **80.0** | |
| | | **St. dev.** | **20%** | | **0.6** | **19.4** | |

**General comments**

Kennedia prostrata doesn't appear to have survived well

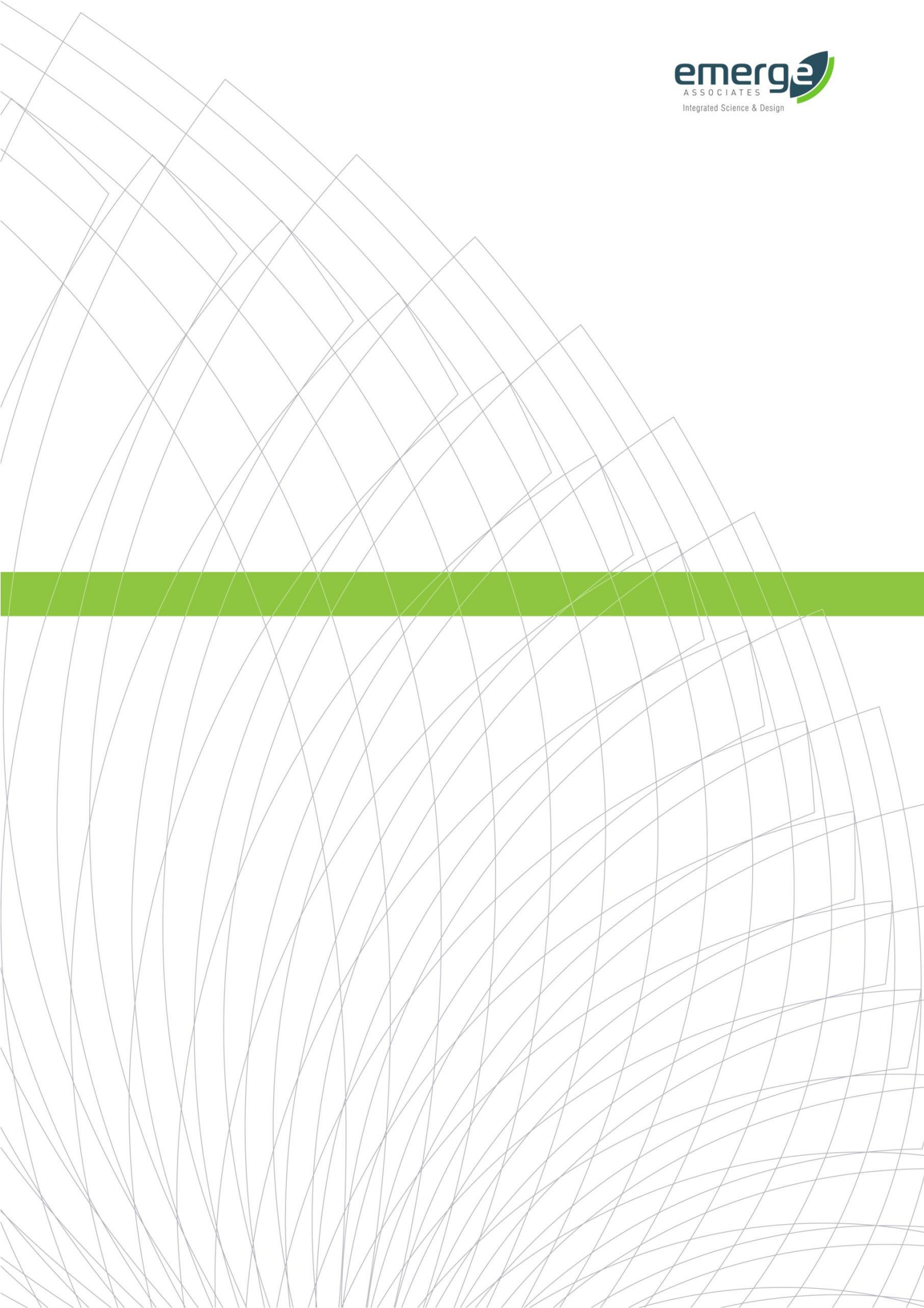
Rabbit and kangaroo activity observed/ scats grazing

## Avon Ridge Site Sales Office B

**2013 planting**

| Species | Observed? |
|---|---|
| *Acacia lasiocarpa* | N |
| *Acacia pulchella* | Y |
| *Acacia saligna* | Y |
| *Allocasuarina humilis* | Y |
| *Banksia grandis* | N |
| *Banksia lindleyana* | Y |
| *Banksia nivea* | Y |
| *Banksia sessilis* | Y |
| *Callistemon phoeniceus* | Y |
| *Calothamnus hirsutus* | Y |
| *Calothamnus quadrifidus* | Y |
| *Corymbia calophylla* | Y |
| *Eucalyptus marginata* | Y |
| *Eucalyptus rudis* | Y |
| *Eucalyptus wandoo* | Y |
| *Gompholobium tomentosum* | N |
| *Grevillea bipinnatifida* | Y |
| *Hakea lissocarpha* | Y |
| *Hakea prostrata* | Y |
| *Hakea ruscifolia* | Y |
| *Hakea trifurcata* | N |
| *Hakea undulata* | Y |
| *Hibbertia subvaginata* | Y |
| *Hypocalymma robustum* | N |
| *Kennedia coccinea* | N |
| *Kennedia prostrata* | Y |

| | |
|---|---|
| Total no. spp planted: | 26 |
| No. spp observed: | 20 |
| % spp observed: | 77% |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