



Barwon Downs Vegetation Monitoring

Barwon Water

Vegetation Monitoring Report

RP_IS019000 | C

7 July 2015



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Project no: IS019000
Document title: Vegetation Monitoring Report
Document No.: RP_IS019000_C
Revision: C
Date: 7 July 2015
Client name: Barwon Water
Client no: Client Reference
Project manager: Drew King
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File name: I:\WCMS\110\Terrestrial Ecology\Barwon Downs\IS019100\RP_IS019100C_Barwon Downs Vegetation Monitoring Report.docx

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Document history and status

Revision	Date	Description	By	Review	Approved
A	27-5-2015	Draft for client review	D King	J Lee	D King
B	19-6-2015	Final	D King	S Parsons S Waller	D King
C	07-7-2015	Final – additional comments addressed	D King	J Lee S Reddington	D King

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Executive Summary

This report outlines results of the flora survey undertaken by Jacobs in 2014-15 on behalf of Barwon Water to fulfil the requirements of groundwater licence no. 893889.

Previous flora surveys were inconclusive due to difficulties in separating the influences of surface water, groundwater, land use change and the provision of environmental flows. In 2012, it was recommended that a comprehensive flora monitoring regime be established to better understand the relationship between groundwater extraction and potential impacts to groundwater dependent vegetation. In 2014, a revised monitoring regime was agreed to between Barwon Water and Southern Rural Water (the regulatory body).

Vegetation assessments were undertaken at 14 sites between November 2014 and March 2015 within the Barongarook and Barwon Downs localities. These sites were identified as being hydrologically sensitive and likely to support Groundwater Dependent Ecosystems (GDEs). Recently constructed groundwater monitoring bores at each site confirmed the hydrogeological nature of the aquifer, such as:

- whether groundwater was in a confined or unconfined part of the aquifer,
- whether sites would be impacted by groundwater extraction:
 - Impact sites were located within areas of the aquifer where the watertable was either known to have been affected from past pumping (in the unconfined areas) or potentially affected (in the confined areas) by the Barwon Downs borefield.
 - Reference sites were located where no impact on water levels in the aquifer caused by the Barwon Downs borefield was observed (or is expected to be observed under future pumping scenarios).

Three of the 14 sites were in the vicinity of previously assessed flora sites, with the remaining eleven sites being new that have not been previously assessed.

Transects were established at each site and eight quadrats assessed at each. All flora species present were recorded and the vegetative cover was assessed. Vegetative cover was used as a surrogate measure for plant performance at each site. Each species was assigned to one of seven functional groups based on its reliance on water availability. It has been conservatively assumed that the water available at each site is at least somewhat derived from groundwater, and therefore the functional groups categorise the reliance of each plant species on groundwater availability. The contribution of groundwater to the water available to plants at each site is not yet fully understood but is being examined further by studies being undertaken concurrently with this survey. Species reliant on groundwater, as conservatively defined for this assessment, were present at all sites and therefore the vegetation present constitutes a GDE, though further work is required to understand the relative reliance on groundwater (as opposed to other water sources) across all sites.

The design of the revised vegetation monitoring program enables statistically robust comparisons to be made. This will enable detection and quantification of changes in the performance of groundwater dependent species over time, as well as between reference and impact sites based on the hydrogeology underlying the vegetation. Importantly, when comparing the impact and reference sites, no difference in the performance of species defined as groundwater dependent was detected, regardless of the underlying hydrogeology.

Given the monitoring regime has significantly changed from previous surveys, and the majority of sites have been established at locations not previously assessed, either for flora or groundwater levels, no comparison with past surveys is possible for this assessment. Therefore, the effect of past water extraction on the vegetation condition is not able to be quantitatively determined at this stage. Based on observations as well as comparing vegetation descriptions in past reports, the current condition of the vegetation assessed does not suggest that a change in ecosystem function is related to recent groundwater usage (with the possible exception of site T1 at Big Swamp which is recovering from fire and potential low soil pH from acid sulphate soils).

In summary, this report outlines the baseline conditions for a flora monitoring program that will be able to correlate vegetation condition of likely GDEs, particularly the presence and performance of groundwater dependent plants, to the hydrological conditions at each site. Differences in vegetation conditions will be measured over time and sites compared based on their underlying hydrogeology and capacity to be influenced by any ground water extraction from the Barwon Downs borefield. The monitoring program as defined is adaptable to changes in knowledge and statistically robust to detect changes over time. No difference between the impacted and reference sites was detected at this time.

Further work is being undertaken to help define the degree to which vegetation at each site is dependent on groundwater. Once completed, it will need to be considered in conjunction with this report.

Important note about your report

The sole purpose of this report and the associated services performed by Jacobs was to conduct a flora survey at 14 sites in the vicinity of Barwon Downs and Barongarook in accordance with the scope of services set out in the contract between Jacobs and Barwon Water ('the Client'). That scope of services, as described in this report, was developed with the Client.

Any survey of flora will be unavoidably constrained in a number of respects. In an effort to mitigate those constraints, we applied the precautionary principle described in the methodology section of this report to develop our conclusions. Our conclusions are not therefore based solely upon conditions encountered at the site at the time of the survey.

As may be expected from a monitoring report conducted with the expectation of that further monitoring will be conducted, the passage of time, manifestation of latent conditions or impacts of future events will be examined in future monitoring, if required. Jacobs has prepared this report in accordance with the usual care and thoroughness of the consulting profession, for the sole purpose described above and by reference to applicable standards, guidelines, procedures and practices at the date of issue of this report. For the reasons outlined above, however, no other warranty or guarantee, whether expressed or implied, is made as to the data, observations and findings expressed in this report, to the extent permitted by law.

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1. Introduction

1.1 Purpose

This report outlines results of the five-yearly flora surveys undertaken in 2014-15 as set out in licence number 893889 for the Barwon Downs borefield.

A total of 14 sites were assessed based on sites identified in the Monitoring Program prepared by SKM and Ecology Australia (2013) and will serve as the baseline study against future monitoring. All sites are shown in the map contained in Appendix B.

1.2 Background

Barwon Water manages and operates the Barwon Downs borefield in accordance with licence number 893889. This licence was granted in 2004 and is due for renewal in June, 2019.

The Barwon Downs borefield has historically been relied upon as an important drought reserve for the greater Geelong region. At the height of the worst drought on record (2006-10), Geelong's water storages dropped to 14 per cent when catchment inflows were severely reduced. During this time, the borefield provided up to 70 per cent of Geelong's drinking water.

Barwon Water undertakes a monitoring program as set out in the licence conditions. While this program was good practice at the time of the last licence renewal, and continues to comply with licence conditions, the community has raised concerns about potential environmental impacts linked to groundwater extraction. A key area of community interest identified through the Barwon Downs Groundwater Community Reference Group was the protection of terrestrial vegetation that was of ecological value. Previous flora studies that have been undertaken in the area are summarised below:

1994 study

An initial vegetation study was undertaken in 1993-94 (Carr & Muir, 1994) and involved surveying of 82 quadrat sites across the Barwon Downs aquifer outcrops areas and associated streams. Although the study was general in nature, it was noted that the areas surveyed placed emphasis upon aquatic (in-stream, riparian, wetland) environments and concentrated on more hydrologically sensitive areas, such as drainage lines and swamps.

2002 study

An ensuing study to review potential impacts linked to groundwater extraction was conducted in 2002 (Carr, 2002). Vegetation was resampled at 24 of the 82 original quadrats. These quadrats were selected because they were deemed hydrologically sensitive and concentrated around Boundary Creek and areas of high botanical significance. The study found that vegetation composition had changed due to decreased moisture availability but could not indicate whether this was due to drought, groundwater extraction, or supplementary watering (Boundary Creek environmental flow release as stipulated in Clause 6.1 of the licence) or a combination of all three (Carr 2002).

2008-09 study

The 2008-09 (EA & SKM, 2009) study documents the first vegetation survey conducted under the current licence and involved classifying changes to the vegetation since the 2002 study. Available hydrogeological data was also reviewed in conjunction with the flora survey to assess if there were any significant changes during the same period.

The study concluded that drought, groundwater extraction and provision of supplementary watering had a significant effect on riparian vegetation. However, given the complex interaction of many factors on vegetation condition, the study was unable to untangle the impact of groundwater extraction on the drying of the vegetation from other environmental processes, such as drought, climate change and other catchment and hydrological factors. This was due to the presence of factors which may have disguised the impact of groundwater extraction (e.g. supplementary watering of Boundary Creek, possibility of highly localised perched water tables, and the masking influence of outflow from adjoining stream and river systems).

The study recommended that a long term vegetation and hydrological monitoring program be designed and implemented to ensure the protection of riparian zones within the study area.

1.3 Application to improve terrestrial vegetation monitoring

Clause 7 of the groundwater licence requires Barwon Water to monitor and protect riparian vegetation, especially vegetation that is groundwater dependent.

A review completed in 2012 exposed the limitations of existing vegetation sites. Consideration of more up to date hydrogeological data enabled a more accurate delineation of impact and reference sites.

In 2013, a desktop assessment and subsequent fieldwork was undertaken to recommend new vegetation sites. 14 sites were selected (including retaining three existing sites) to improve understanding of the link between vegetation and groundwater dependence, and if extraction from the borefield contributes to fluctuations in water table depth at these sites.

In 2014, Southern Rural Water approved Barwon Water's request to amend existing vegetation sites (as referenced in Clause 7) to improve terrestrial vegetation monitoring ahead of licence renewal in 2019.

2. Methods

2.1 Site location

The location of the monitoring sites was determined previously by Ecology Australia (see SKM 2013 and Appendix B) based on a binomial design to test potential impact on Groundwater Dependent Ecosystems (GDE) in both confined and un-confined areas of the pumped aquifer potentially impacted by groundwater extraction at Barwon Downs.

The two variables tested were the hydrogeological nature of the aquifer – i.e. whether the aquifer was confined or unconfined, and whether sites would be impacted by the removal of water at Barwon Downs – i.e. impact sites were located in areas of the aquifer where the watertable was either known to have been affected from past pumping (in the unconfined areas) or potentially affected (in the confined areas) by the Barwon Downs borefield. Reference sites were located in parts of the aquifers where no impact on water levels from the Barwon Downs borefield has been observed (or is expected to be observed under future pumping).

Groundwater monitoring bores were constructed at each site to assess depth to watertable at each site.

2.2 Vegetation assessment including monitoring design rationale

2.2.1 Transect Selection

Transects of 40 m were assessed at each location with the exception of site T1 (70m). Site T1, as described below was subject to a fire in the recent past. The transect began in relatively unburnt vegetation and a total of 70 m was assessed to account for a change between unburnt and burnt vegetation.

Transects were located at the edges of the GDEs and extended 40 m into the GDE. The location at the edge of the ecosystem is to maximise the potential for the monitoring to detect change over time – any detectable change is more likely to be detected in the zone where changes in groundwater level or inundation frequency are most likely to impact dependent vegetation and wetlands generally dry out from the edges. Other concerns were locating transects close to sites used for associated studies of groundwater use including the groundwater monitoring bores installed either at or close to each site (see SKM 2013 for bore descriptions), and the sampling sites for the analysis of groundwater use (work currently in progress).

Transects were marked with short yellow topped posts in areas outside the Great Otway National Park (T1-8) and were not marked at sites within the Great Otway National Park (T9-14) as this was not permitted under the permit conditions.

The start and end of each transect was recorded with GPS (see results for each transect location).

Sites T1-6, T8 and T10 were assessed between 25 November and 2 December 2014. Sites T9 and T11-14 were assessed between 6 February and 5 March 2015. The delay between survey periods was a result of applying for a permit to work in the Great Otway National Park. Site T8 was assessed on 2 December and 5 March to assess potential changes over the intervening period – no assessable difference was noted over the period. This suggests that the spread of the timing of the surveys at different sites has not impacted the reliability of the results.

2.2.2 Analysis of vegetation transects

Each vegetation transect was assessed using eight 5 x 5 m quadrats located along the transect. This differs from the previously proposed method of 20 1 x 1 m quadrats (Ecology Australia & SKM 2013). The change in

method was prompted by the difficulty in assessing the cover of tree and shrub life forms in small 1 x 1 m quadrats knowing that they form major parts of GDEs in the Otway region.

The quadrats were located alternatively on the right then left of the transect. In each quadrat the cover of each species located within the quadrat was estimated to the nearest 5 per cent, including any dead material still attached to plants. Although cover estimates are known to introduce observer error, the analysis of absolute cover estimates as, opposed to categorical measures (such as Braun-Blanquet measures), is more statistically robust and adaptable to data analysis such as functional groups where sums of cover are used, and therefore preferred for this monitoring regime. Where a species represented less than 2.5 per cent of the total cover (i.e. did not round to 5 per cent) a nominal 1 per cent cover was assigned. Cover of litter, bare ground, moss, and water was also recorded. Due to many strata overhanging each other (i.e. trees over shrubs over ferns etc.), totals generally added up to more than 100 per cent. This is common in ecological surveys and has been accounted for when comparing sites by considering the proportion of vegetation cover (i.e. excluding litter and bare ground) that is attributable to any species or functional group.

The eight quadrats allow for sufficient replication to account for variation in the vegetation characteristics within each site, thus providing a representative average cover for each species across the transect (i.e. a site-based value), as well as sufficient replication to allow for statistical analysis for changes over time at each site.

2.2.3 Functional Group selection

As the reliance on ground water differs between species and species differed between sites, each species was assigned a functional group depending on its assumed reliance on groundwater availability. Although various functional groups have been defined for groundwater dependent species, (refer to Cassanova, 2011 and Daly et al. 2012) these generally focus on wetland ecosystems rather than forest and scrub ecosystems encountered in this project. A hybrid system based on previous analyses and Orrelana et al. (2012) has been used in this assessment to focus on terrestrial species that rely on groundwater as outlined in Table 2.1 below.

Table 2.1 : Functional Group descriptions.

Category	Description	Groundwater Dependency
0	Not connected to ground and therefore not linked to groundwater e.g. epiphytes and certain saprophytic and parasitic plants.	None
1	Obligate terrestrial species requiring well aerated soils and not tolerant of saturating conditions in root zone. Can include shallow rooted and annual weed species making opportunistic use of seasonal water availability.	Opportunistic
2	Terrestrial species sometimes found in GDEs as an opportunistic user of available water. Common in ecosystems outside the GDEs assessed where availability of groundwater is low or non-existent. Includes ferns such as Bracken, shrubs such as Prickly Moses and trees such as Messmate.	
3	Terrestrial species only found in riparian ecosystems or GDEs. Species require readily available water but are not tolerant of regular inundation.	Groundwater Dependent
4	Species requiring at least periodic inundation of root zone for continuing survival	
5	Species requiring regular inundation of root zone for continuing survival.	

Category	Description	Groundwater Dependency
6	Obligate aquatic species reliant on inundation for continuing survival.	

Assigning plant species to functional groups was based on descriptions of habitat in literature, primarily in the Flora of Victoria (Walsh and Entwistle, 1994-1999), observer knowledge, past flora reports (Carr and Muir 1994, Carr 2002, SKM and Ecology Australia 2008), and observations taken during the survey described in this report.

The distinction between categories of Opportunistic and Groundwater Dependent species is of limited use for this study as there is natural variation between sites and the range of species they support. However, it is envisaged that the categories within each classification will be of greater utility in future monitoring rounds in examining changes in the vegetation categories

The distinction between groundwater and surface water dependency is difficult to discern as plants do not make a distinction as to the source of water available unless other variables such as pH or salinity are limiting factors. For the purposes of this assessment, a species reliant on water availability in the surface or upper soil strata is defined as groundwater dependent. Whether the species is reliant on groundwater or surface water is dependent on the hydrology at each site and the degree to which the water available at the site is derived from groundwater or surface water sources. Work is currently underway to contribute to the understanding of the hydrology at each site and the sources of water-use currently accessed by the trees at each site.

Moss was not assigned to a category with the exception of sphagnum encountered in great amounts (i.e. >5 per cent on average) at site T1 where the moss category (being almost entirely sphagnum) was assigned to Category three.

For analysis of sites, all species within each category were grouped at each site. The cover recorded in the eight quadrats assessed and then averaged to provide a site estimate of cover. To account for differences in total cover recorded between sites (which could add to >100 per cent as outlined above) this was also expressed as a proportion of total vegetation cover.

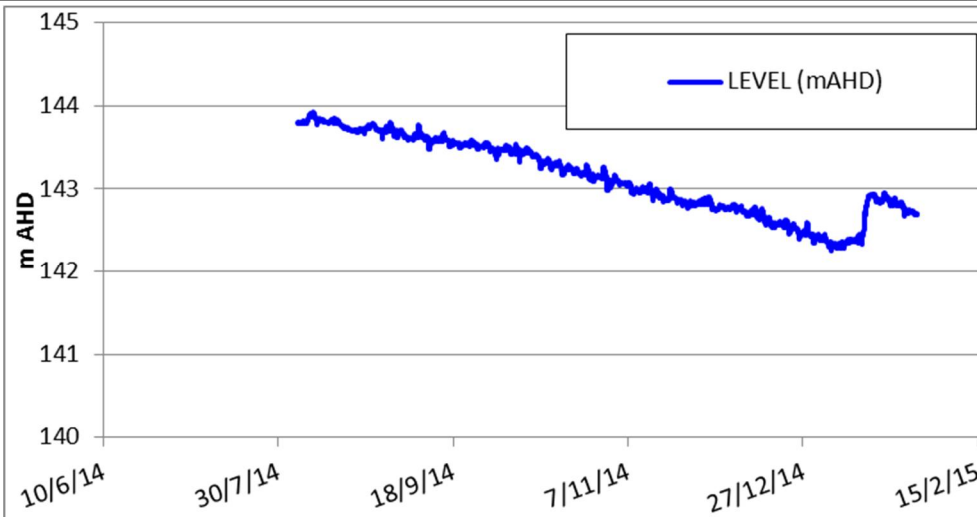
2.3 Statistical Analysis

Statistical analyses were undertaken using the data analysis pack of Microsoft Excel. One way and Two-way ANOVA tests were undertaken with variables being geology (confined versus unconfined aquifer) and impact (reference/control versus impact sites). These tests examine whether any difference between the average cover of groundwater dependent species is detected between groups. A standard alpha value of 0.05 was used for all tests – that is, a positive result states there is a 95 per cent probability that there is a difference between the averages of the groups tested. For a difference to be detected, a p-value of less than 0.05 would be required from the tests performed. For these tests, average cover values for each site were used, therefore accounting for variation in the cover of individual species along each transect.

To maintain equal sample sizes between groups, and therefore the assumptions of the test, sites T3 and T14 were excluded from Two-way ANOVA tests. These specific sites were excluded as Site T3 was found to be unconnected to groundwater sources used by the Barwon Downs borefield (i.e. is a perched aquifer) and Site T14 is a “spare site” to be included should any one site not be available. One-way ANOVA tests were conducted both including and excluding sites T3 and T14.

3. Results

3.1 Site Summary Tables

Site T1 (new)		Peat Swamp	IMPACT, UNCONFINED
Location Description	<p>Located within the Peat Swamp (aka Big Swamp) into which Boundary Creek flows and dissipates before reverting to a channel west of Colac-Forrest Road. The majority of Peat Swamp was burnt intermittently between 1998 and 2010, primarily as a subterranean peat fire, and is now recovering. A large (2m wide x 2m deep) trench runs along the southern edge of Peat Swamp to prevent fire escaping to surrounding areas.</p> <p>The transect is located 5 m north of the trench and extends for 70m at 0 (due north) into the swamp. The transect comprised 14 quadrats encompassing 6 in an unburnt state at the beginning and 8 having been burnt following. Only the latter eight in the burnt areas have been included in the vegetation analysis. The vegetation of the burnt and unburnt sections are described separately below.</p> <p>The transect is located ~ 550 m west of the associated ground water monitoring bore (TB1) whilst trees included in the tree groundwater use study are located within 20 m of the start point of the transect in unburnt areas.</p>		
Location Co-ordinates	START: E735298, N5743774; END: E735248, N5743822		
Depth of Groundwater at TB1			
Vegetation Description	Diversity: 9 species (4 native, 5 introduced)		
<p>Recently burnt section</p> <p>The burnt areas of T1, toward the middle of the swamp, are characterised by reddish humus and ash at ground level. The above-ground front of the fire is located ~30m north of the transect start. The regenerating vegetation is of low diversity and is dominated by Sphagnum moss at ground level throughout the transect whilst the remaining vegetation is simple, dominated by either Bracken (<i>Pteridium esculentum</i>) although this appears stunted, growing to only 50 cm compared to 1 m in unburnt areas, and with many dead and dried plants and with dried leaves on most living plants, or dense Prickly Tea-tree (<i>Leptospermum continentale</i>). Species diversity is low with annual weed species such as Sheep Sorrel, Cat's Ear and Sweet Vernal Grass detected in low abundance. Some regenerating Swamp Gum (<i>Eucalyptus ovata</i>) is present throughout the affected areas.</p> <p>Historically burnt section (not included in analyses)</p> <p>This section, although not included in analyses, was dominated by Bracken with some Swamp Gum and other weedy species present. As per the burnt section, the Bracken showed signs of “burning off” at leaf tips of live plants - some plants had entirely dried.</p> <p>Vegetation Condition: Poor to moderate – evidence of burnt leaf tips particularly on Bracken could be related to changes in water quality as a result of the fire. Weed invasion has also occurred though may be restricted as the site recovers</p> <p>Evidence of Change: Fire has occurred in the recent past.</p> <p>Notes for future monitoring rounds: Particularly note the performance of Sphagnum at this site and the regrowth of Prickly Tea-tree as these dominant species recover from the fire. Also note the changes in the occurrence and performance of weed species.</p>			

Site T1 (new)

Peat Swamp

IMPACT, CONFINED

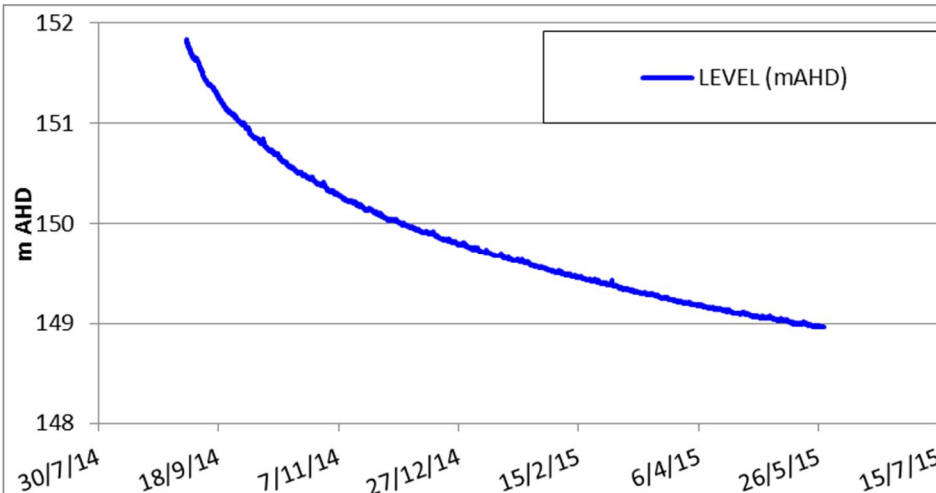
Photos



Recently burnt areas of Pear Swamp looking from the start of the burnt area toward the end of the transect.



Historically burnt Areas of Peat Swamp

Site T2 (existing)		Boundary Creek	IMPACT, UNCONFINED
Location Description	Located at Boundary Creek. west of the crossing of an un-named private road. Access was achieved from the south side of the creek along an unmarked but well made access track to the east of the bore location located ~ 100 m south of the transect. The transect covers 40 m from the edge of the track due north and crosses Boundary Creek which has multiple meandering channels at the site. The transect is marked with a yellow-capped post within 3 m of the edge of the access track.		
Location Co-ordinates	START: E734632, N5744000; END: E734654, N5744034		
Depth of Groundwater at TB2	<div></div> <p>Note – a new bore has been established closer to the transect location to better understand the groundwater dynamics at this site but data is not available for this report.</p>		
Vegetation Description	Diversity: 27 species (26 native, 1 introduced)		
<p>The transect traverses Boundary Creek which has multiple channels at this location. The first and last quadrat are located outside the wider channel at the margins whilst quadrats 2, 3,4 have water present and incorporate at least some aquatic species and quadrat 6 encompasses the main channel at this location.</p> <p>The overstorey comprises Swamp Gum (<i>Eucalyptus ovata</i>) although most trees are rooted at the margins of the creek and overhanging the quadrats. A dense shrub layer dominated by Scented Paperbark (<i>Melaleuca squarrosa</i>) is present throughout over a variable groundlayer. At the margins of the swamp, the ferns Pouched Coral-fern (<i>Gleichenia dicarpa</i>) or Mother Shield-fern (<i>Polystichum proliferum</i>) dominate whilst sedges such as Tall Sedge (<i>Carex appressa</i>), Red-fruit Saw-sedge (<i>Gahnia sieberiana</i>) and Tall Sword-sedge (<i>Lepidosperma elatius</i>) are dominant. Obligate wetland species requiring at least semi-permanent surface water that are present include Club-sedges (<i>Isolepis cernua</i> and <i>I. innundata</i>), Water Ribbons (<i>Cycnogeton procerum</i>) and Austral Brooklime (<i>Gratiola peruviana</i>).</p> <p>Holes for burrowing crayfish, likely the Otway Burrowing Cray were evident throughout the alignment particularly in quadrats 4-6.</p> <p>Vegetation Condition: In good condition – no evidence of dieback and recruitment evident</p> <p>Evidence of Change: None observed</p> <p>Notes for future monitoring rounds: As managed flows are released into Boundary Creek, any monitoring of this site should consider any changes in flow regime and monitor changes in category 5 plants on the margins of the waterway and pools. Significant recruitment was also noted in quadrats 3-7 and could result in significant changes in those quadrats should conditions remain static (i.e. limited to no groundwater use, consistent water flows and rainfall etc.).</p>			
<p>Comparison to 2008</p> <p>The transect described is in the vicinity of Site 1 described in the 2008 study though not directly comparable. The 2008 study noted a general recovery of water dependent ferns and sedges from 2002 (potentially due to provision of environmental flows down Boundary Creek) and the presence of these is confirmed by this assessment where these species are in good health. The windthrow noted in 2008, attributed to a drying of the upper soil strata, was not noted at the transect assessed.</p>			

Site T2

Boundary Creek

IMPACT, UNCONFINED

Photos



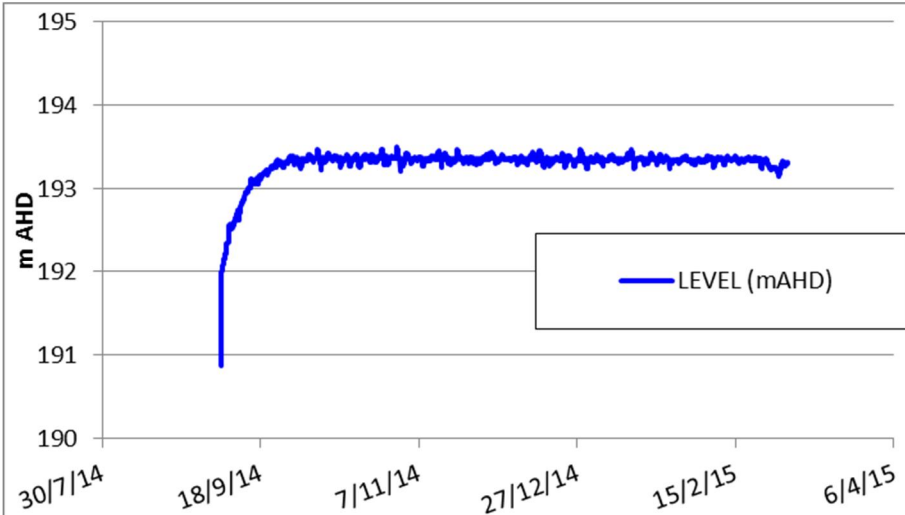
Start of Transect



End of transect



Burrowing Cray holes and emergent vegetation at quadrat 5

Site T3 (new)		Perched Swamp	IMPACT, UNCONFINED
Location Description	<p>Located at an unnamed swamp with standing water across a 1.2 ha area east of an un-named maintenance track running north off Westwood Track and west of crossing of an un-named private road.</p> <p>Access was achieved from the south side of the creek along unmarked but well-made access track to the east of the bore location located 20 m uphill from the transect. The transect covers 40 m from the edge of the track and crosses Boundary Creek which has multiple meandering channels at the site.</p> <p>The transect was located at the western end of the swamp as it appeared to drain to the north east and any potential changes are more likely to be detectable at the upper end and at the edge of the swamp.</p>		
Location Co-ordinates	START: E734632, N5744000; END: E734654, N5744034		
Depth of Groundwater at TB3	<div></div> <p>Note – bore still stabilising during beginning of monitoring period.</p>		
Vegetation Description	Diversity: 11 species (11 native)		
<p>A sedge and rush dominated wetland in standing water (to 35cm at transect but likely deeper toward centre of swamp) with Swamp Gum (<i>Eucalyptus ovata</i>) trees occasionally encroaching from the edges. Trees tended to be small and prone to falling potentially due to the waterlogged substrate – logs were common throughout the transect. Twig sedges (<i>Baumea articulate</i> and <i>B. rubiginosa</i>) and Large Rush (<i>Juncus procerus</i>) to 1.5 m dominated the swamp along with aquatic grasses present throughout (<i>Amphibromus neessii</i> and <i>Lachnigrostis filiformis</i>). Species diversity is relatively low but the swamp appears to be in good condition with little evidence of die-back and water present to the swamp margins when assessed in November 2014 and visited in March 20 15.</p> <p>Vegetation Condition: In good condition – some falling Swamp Gums however this is more likely related to persistent water in the swamp rather than any lack of water availability</p> <p>Evidence of Change: None observed</p> <p>Notes for future monitoring rounds: This site is considered most likely to be linked to a perched aquifer and therefore could be an interesting reference site for future monitoring events once the hydrology is better understood.</p>			

Site T3

Perched Swamp

Photos



Sedge and Rushes dominating vegetation in the swamp



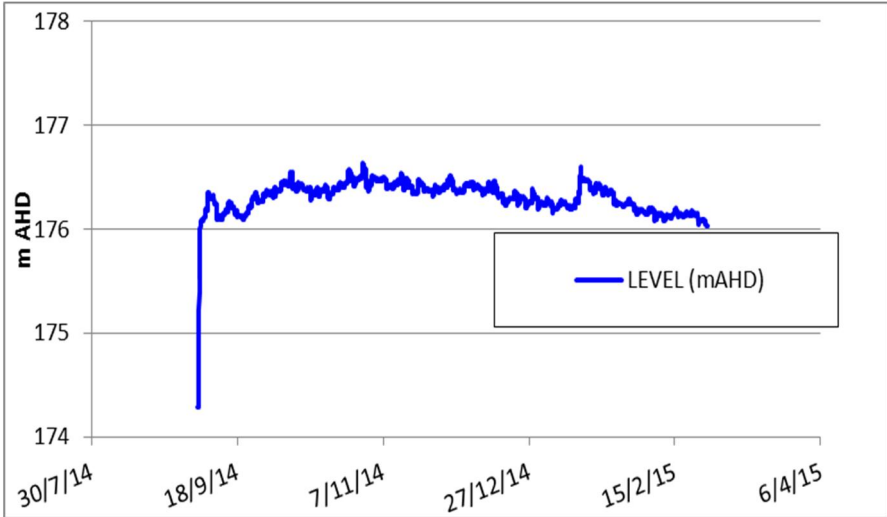
Looking from end of transect to start



End of transect (Q8) with Swamp Gum close by.



Range of lifeforms present within the water throughout the transect

Site T4 (new)		Swampy Riparian Woodland – Quarry Track IMPACT, UNCONFINED	
Location Description	<p>Located at the valley of an un-named tributary of Boundary Creek on the north side of un-named and un-marked access track running east-west along the northern border of the Otway Forest Park. Access can be gained from the west by taking the marked Maintenance track running north from Westwood Road 1 km east of the intersection with Link Track.</p> <p>The transect covers 40 m from the base of the large tree located 5 m north of TB5. As there are multiple bores at this location, TB5 is the yellow bore on the northern side of the road to the west of the un-named waterway.</p>		
Location Co-ordinates	START: E734632, N5744000; END: E734654, N5744034		
Depth of Groundwater at TB4	<div></div> <p>Note – bore still stabilising during beginning of monitoring period.</p>		
Vegetation Description	Diversity: 14 species (14 native)		
<p>An overstorey of Swamp Gum (<i>Eucalyptus ovata</i>) and occasional Messmate (<i>Eucalyptus obliqua</i>) to 20 m over dense cover of Scented Paperbark (<i>Melaleuca squarrosa</i>) and Woolly Tea-tree (<i>Leptospermum lanigerum</i>) at 4-5 m. Lower strata were dominated by large sedges (<i>Lepidosperma elatius</i> and <i>Gahnia sieberii</i>), ferns (<i>Blechnum nudum</i> and <i>Pteridium esculentum</i>) and scrambling grasses (<i>Tetrarrhena juncea</i> and <i>Poa tenera</i>) although at ground-level small herbs were largely absent and a deep litter layer was present throughout the transect, particularly in the ephemeral and meandering waterway.</p>			
Vegetation Condition:		In good condition – no evidence of dieback and recruitment evident	
Evidence of Change:		None observed	
<p>Notes for future monitoring rounds: The ephemeral waterway is open though with a dense shrub layer and thick litter. The potential for colonisation of this area by ground ferns and sedges is high and many recruits were noted. Future monitoring should comment on any changes in quadrats 5-8 that cover the ephemeral waterway.</p>			

Site T4

Swampy Riparian Woodland – Quarry Track
IMPACT, UNCONFINED

Photos



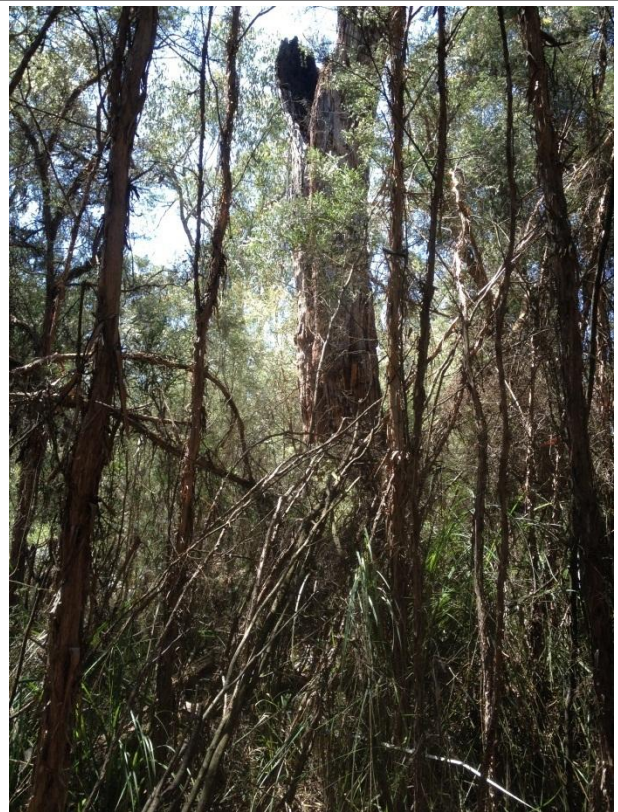
Dense sedgey understorey at 15m mark of transect.



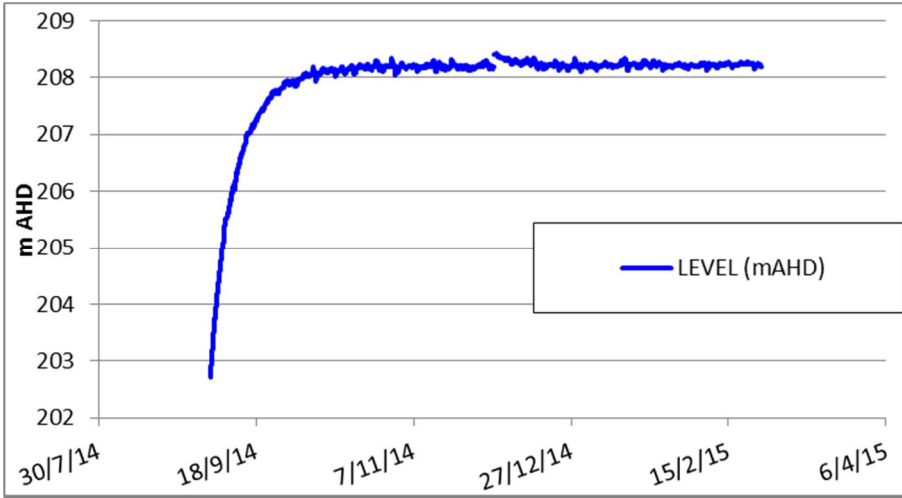
Meandering watercourse with sparse understorey



Start of transect is 5 m north of monitoring borehole.



End of transect at base of large old Messmate tree

Site T5 (new)		Swamp Scrub- Field and Game REFERENCE, UNCONFINED
Location Description	<p>Located at the valley of an un-named tributary of Boundary Creek due west of Field and Game Track where sign is located on the west side of the road.</p> <p>The transect covers 40 m from the base of the large tree located 5 m north of TB5. As there are multiple bores at this location, TB5 is the yellow bore on the northern side of the road to the west of the un-named waterway.</p>	
Location Co-ordinates	START: E73092, N5744000; END: E734654, N5744034	
Depth of Groundwater at TB5	<div></div> <p>Note – bore still stabilising during beginning of monitoring period.</p>	
Vegetation Description	Diversity: 26 species (26 native)	
<p>An overstorey of relatively young Swamp Gum (<i>Eucalyptus ovata</i>) and occasional Narrow-leaf Peppermint (<i>Eucalyptus radiata</i>) trees to 12 m over dense cover of Scented Paperbark (<i>Melaleuca squarrosa</i>) and understorey dominated by large sedges (<i>Lepidosperma elatius</i> and <i>Gahnia sieberii</i>), ferns (<i>Blechnum nudum</i> and <i>Pteridium esculentum</i>) and scrambling grasses (<i>Tetrarrhena juncea</i> and <i>Poa tenera</i>). A number of terrestrial species were present in the understorey that can opportunistically occur in when soil conditions are not too damp were present that are more generally found in nearby (but still damp) terrestrial ecosystems. These included Prickly Moses (<i>Acacia verticillata</i>) and Silver Banksia (<i>Banksia marginata</i>) and may hint at past drying at this site. Future monitoring should assess whether these species persist.</p>		
Vegetation Condition:	In good condition – no evidence of dieback and recruitment evident	
Evidence of Change:	None observed	
Notes for future monitoring rounds:	The presence and performance of Category 1 species in a number of quadrats should be examined as changes in ground water could promote or exclude these species.	

Site T5

Swamp Scrub- Field and Game
REFERENCE, UNCONFINED

Photos



Young Swamp Gums at site T5.



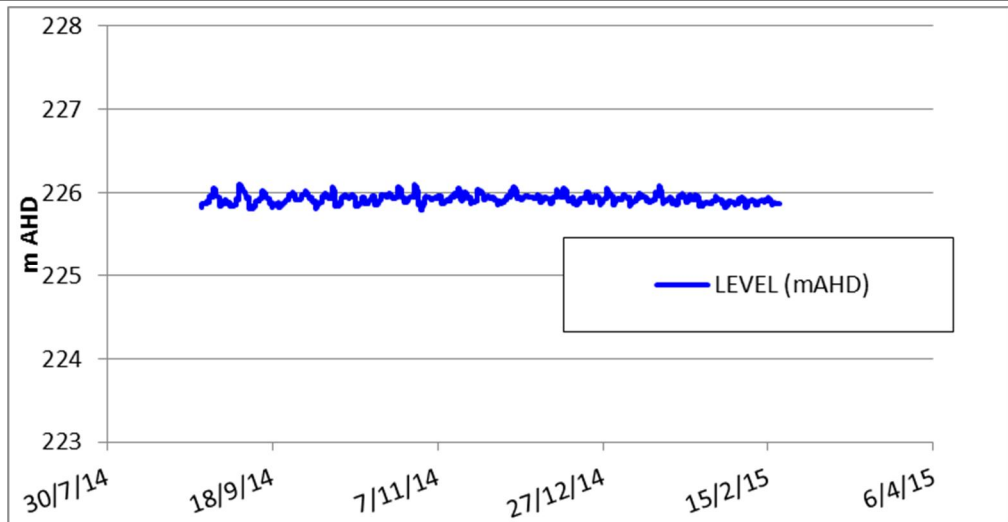
Dense Scented Paperbark and sedge understorey at site T5



Dense Scented Paperbark and sedge understorey at site T5, looking toward end from Q3. Note forked tree.



Marking peg at end of transect

Site T6 (new)		Swamp Scrub – Langdons Road REFERENCE, UNCONFINED	
Location Description	Located at valley of an un-named tributary of Boundary Creek on an un-named access track off Langdons Road. The transect covers 40 m from the base of the large tree located 5 m north of the road on the east side of the tributary. The bore is located ~200 m west of the site at the end of Langdons Road.		
Location Co-ordinates	START: E729402, N5743247; END: E734654, N5744034		
Depth of Groundwater at TB6			
Vegetation Description		Diversity: 21 species (21 native)	
An mixed overstorey of Swamp Gum (<i>Eucalyptus ovata</i>) and occasional Messmate (<i>Eucalyptus obliqua</i>) to 15 m over moderate cover of Scented Paperbark (<i>Melaleuca squarrosa</i>) and understorey dominated by large sedges (<i>Lepidosperma elatius</i> and <i>Gahnia sieberii</i>), and scrambling grasses (<i>Tetrarrhena juncea</i> and <i>Poa tenera</i>). Ferns were only a minor component of the vegetation at this site. There are a number of fallen trees throughout the swampy area, some showing evidence of having fallen recently. The cause of these trees falling was not evident from the field assessment, though the fact many trees had a distinct lean to them could be interpreted as evidence that the soil substrate is relatively unstable.			
Vegetation Condition:		In good condition – no evidence of dieback and recruitment evident	
Evidence of Change:		Fallen trees prevalent – some relatively mature.	
Notes for future monitoring rounds: The presence of fallen trees may open the canopy sufficiently to promote new growth of trees and shrubs – future monitoring should note whether this has occurred.			

Site T6

Swamp Scrub – Langdons Road
REFERENCE, UNCONFINED

Photos



Dense sedge understorey at site T6.



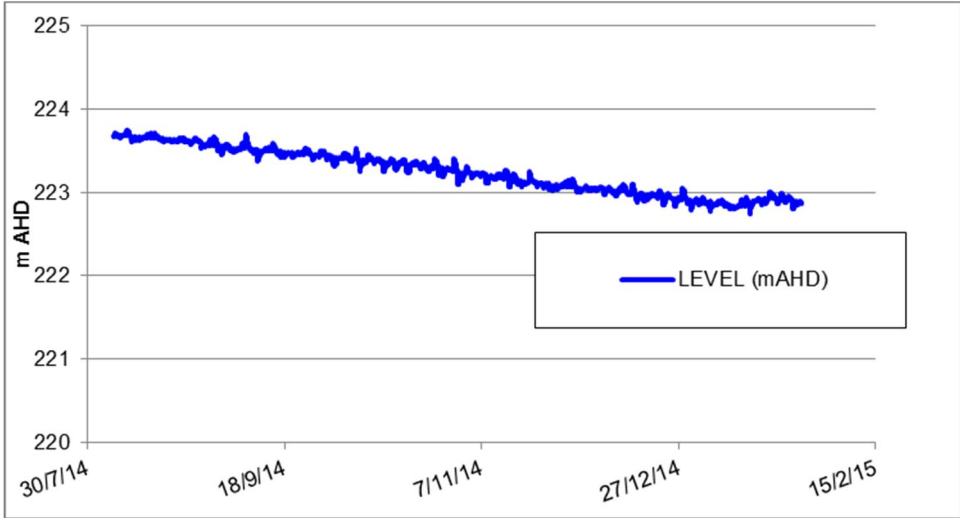
Mixed age of canopy at site.



Transect from start through shrub and sedge understorey



Note lean on Swamp Gums prevalent throughout site – trees may be more prevalent to falling due to unstable soil conditions.

Site T7 (existing)		Swamp Scrub – off Robinson Road REFERENCE, UNCONFINED	
Location Description	Located at valley of an un-named tributary of Ten Mile Creek on an access track running off Robinson Road. The site is located on the western side of the track heading due west from the start location. The start of the transect is located ~ 25 north west of the monitoring bore TB7 and is close to the Old Beechy Trail which is located approximately 50 m to the north.		
Location Co-ordinates	START: E727517, N5742297; END: E727483, N5742294		
Depth of Groundwater at TB7			
Vegetation Description		Diversity: 30 species (28 native, 2 introduced)	
<p>With a largely absent tree layer other than Narrow-leaf Peppermint (<i>Eucalyptus radiata subsp. radiata</i>) to 15 m at the end of the transect and the edge of the GDE, the vegetation was dominated by a dense fern layer over dense cover of Scented Paperbark (<i>Melaleuca squarrosa</i>) and understorey dominated by large sedges (<i>Lepidosperma elatius</i> and <i>Gahnia sieberii</i>), ferns (<i>Blechnum nudum</i> and <i>Pteridium esculentum</i>) and scrambling grasses (<i>Tetrarrhena juncea</i> and <i>Poa tenera</i>). A number of terrestrial species but can opportunistically occur in when soil conditions are not too damp were present that are more generally found in nearby (but still damp) terrestrial ecosystems.</p> <p>Vegetation Condition: In good condition – no evidence of dieback observed and recruitment evident</p> <p>Evidence of Change: None observed</p> <p>Notes for future monitoring rounds: Check the ongoing persistence of the ground ferns in particular as these could be especially vulnerable to changes in groundwater availability at the site.</p>			
<p>Comparison to 2008</p> <p>The site chosen for the transect is some 200m from Site 3 assessed in the 2008 study. The location was changed to better relate the site to the bore location. The species present are similar but the site does not have the surface water noted in the reports. The density of the shrub layer is decreased and the cover of ferns increased at the current transect. The current site is downstream (although there is no defined channel) from Site 3.</p>			

Site T7

Swamp Scrub – off Robinson Road
REFERENCE, UNCONFINED

Photos



Pouched Coral-fern and Scented Paperbark.



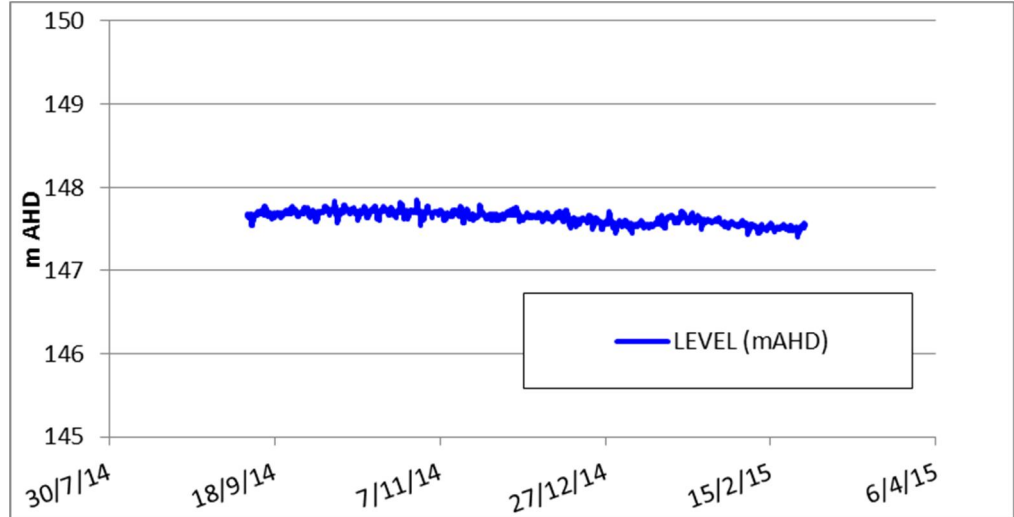
Pouched Coral-fern with emergent Narrow-leaf peppermint



End of Transect



Start of transect

Site T8 (new)		Swamp Scrub – Westwood Track IMPACT, CONFINED	
Location Description	Located at a valley of an un-named tributary of Dividing Creek immediately south of Westwood track ~250 m west of the intersection with Westwood Road. The start of the transect is located ~ 30m west of the monitoring bore TB8 and 5 m south of the road heading at a bearing of 265 ° .		
Location Co-ordinates	START: E734219, N5741628; END: E734181, N5741631		
Depth of Groundwater at TB8			
Vegetation Description		Diversity: 31 species (29 native, 2 introduced)	
With a relatively sparse overstorey of Scented Paperbark (<i>Melaleuca squarrosa</i>) and occasional Swamp Gums and the rare Brooker's Gum (<i>Eucalyptus ovata</i> and <i>E. brookeriana</i>) the vegetation at this location was dominated by Water ferns (<i>Blechnum nudum</i> and <i>B. wattsii</i>) scrambling grasses (<i>Poa tenera</i> and <i>Tetrarhena juncea</i>) and large sedges (<i>Lepidosperma elatius</i> and <i>Gahnia sieberii</i>). The ground layer was diverse with a range of herbs and ferns. A total of 31 species were detected of which only 2 were weed species			
Vegetation Condition:		In good condition – no evidence of dieback and recruitment evident	
Evidence of Change:		None observed	
Notes for future monitoring rounds: Check the ongoing persistence of the ground ferns in particular as these could be especially vulnerable to changes in groundwater availability at the site. A number of herb species were also present though of low cover - comment should be made regarding the persistence of ground water dependent herbs.			

Site T8

Swamp Scrub – Westwood Track
IMPACT, CONFINED

Photos



Start of Transect looking toward end. Note dominance of *Blechnum*



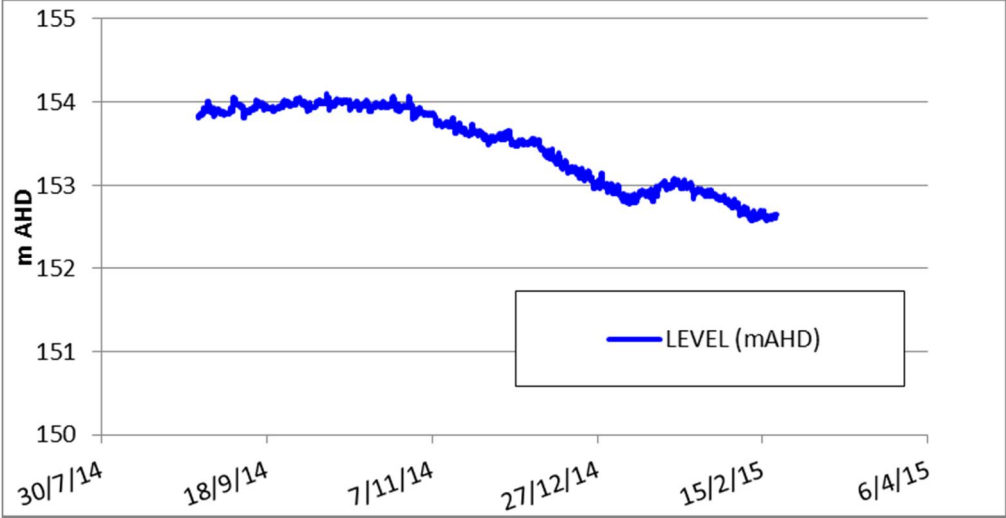
End of transect looking toward start



Fern and sedge dominated understorey.



End of transect at base of fallen tree shown above.

Site T9 (new)		Riparian Forest – Porcupine Creek															
		IMPACT, CONFINED															
Location Description	Located on Porcupine Creek immediately north of Pipeline Road ~ 2km north of the intersection with Colac-Olangolah Pipeline Track. The start of the transect is located ~ 30m north and on the opposite site of the road from the monitoring bore TB9 and 5 m north of the road on the eastern side of Porcupine creek heading at a bearing of 305 °.																
Location Co-ordinates	START: E734219, N5741628; END: E734181, N5741631																
Depth of Groundwater at TB9	 <p>The graph displays the groundwater level (m AHD) at TB9 from 30/7/14 to 6/4/15. The y-axis ranges from 150 to 155 m AHD. The x-axis shows dates: 30/7/14, 18/9/14, 7/11/14, 27/12/14, 15/2/15, and 6/4/15. A legend indicates the blue line represents 'LEVEL (m AHD)'.</p> <table><caption>Approximate data points from the groundwater level graph</caption><thead><tr><th>Date</th><th>Level (m AHD)</th></tr></thead><tbody><tr><td>30/7/14</td><td>154.0</td></tr><tr><td>18/9/14</td><td>154.0</td></tr><tr><td>7/11/14</td><td>154.0</td></tr><tr><td>27/12/14</td><td>152.8</td></tr><tr><td>15/2/15</td><td>153.0</td></tr><tr><td>6/4/15</td><td>152.8</td></tr></tbody></table>			Date	Level (m AHD)	30/7/14	154.0	18/9/14	154.0	7/11/14	154.0	27/12/14	152.8	15/2/15	153.0	6/4/15	152.8
Date	Level (m AHD)																
30/7/14	154.0																
18/9/14	154.0																
7/11/14	154.0																
27/12/14	152.8																
15/2/15	153.0																
6/4/15	152.8																
Vegetation Description	Diversity: 43 species (36 native, 7 introduced)																
<p>This site differs from most other sites in that it supported a more diverse shrub and herb layer with many species detected at only this site; a total of 43 species were detected along the transect although 7 were weed species. Of these, only 17 (39%) were assessed as being dependent on groundwater with the remainder considered opportunistic species taking advantage of but not reliant on the higher water availability along the creek.</p> <p>The forest was dominated by the rare Brooker's Gum (<i>Eucalyptus brookeriana</i>) and occasional Messmate (<i>Eucalyptus obliqua</i>) growing to ~25 m with Blackwood a major sub-canopy tree at this location. A diverse shrub layer of species common in riparian corridors (e.g. Prickly Currant-bush - <i>Coprosma quadrifida</i>, Privet Mock-olive - <i>Notelaea ligustrina</i>, Hazel Pomaderris - <i>Pomaderris aspera</i>) was present over an open (litter comprised almost 50% cover across the site) but diverse ground layer of ferns, grasses and herbs.</p> <p>The transect crosses Porcupine Creek at quadrats 4 and 5.</p> <p>Vegetation Condition: In good condition – no evidence of dieback and recruitment evident</p> <p>Evidence of Change: None observed</p> <p>Notes for future monitoring rounds: A number of ground ferns were observed at this site with room for expansion (i.e. bare ground and litter). Future monitoring rounds should note the performance of ground ferns at the site</p>																	

Site T9

Riparian Forest – Porcupine Creek

IMPACT, CONFINED

Photos



Start of transect – note large Brooker's Gum



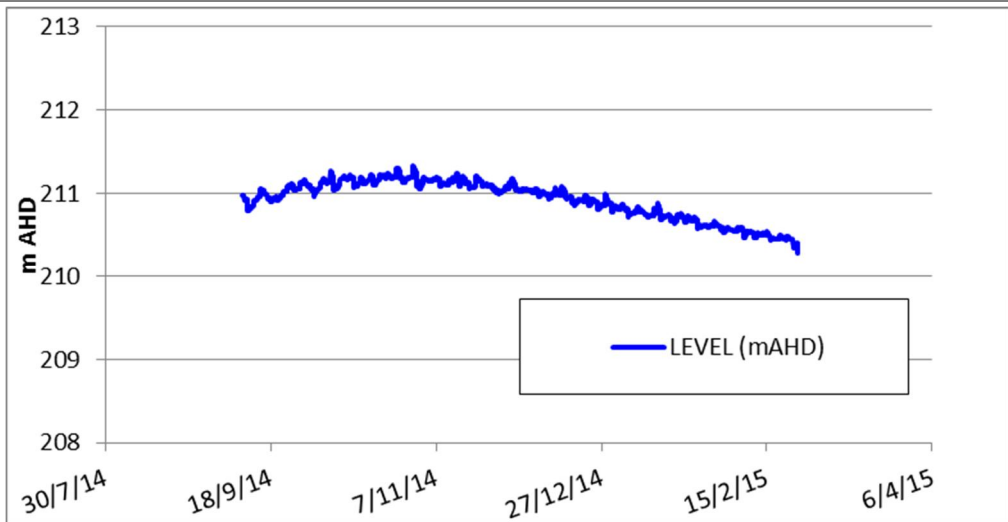
End of transect – Note bifurcated Narrow-leaf peppermint



Fern and tall shrub dominated understorey along banks of Porcupine Creek – looking south from Q6.



Porcupine Creek from Pipeline track.

Site T10 (new)		Swamp Scrub – Wares Road IMPACT, CONFINED	
Location Description	<p>Located immediately south of Wares Road in Great Otway National Park.</p> <p>The start of the transect is located ~ 5 m south of Wares road in thick scrub and west of the opposite site of the road from the monitoring bore TB9 and 5 m north of the road on the eastern side of Porcupine creek heading at a bearing of 305 °.</p> <p>Located in thick scrub, this site is located on the opposite side of the road from the location proposed by Ecology Australia, primarily as the proposed location was on private land and therefore potentially subject to change. The location is the headwater of Dividing Creek though at this location there is no defined channel.</p>		
Location Co-ordinates	START: E734219, N5741628; END: E734181, N5741631		
Depth of Groundwater at TB10	 <p>The graph displays the groundwater level at monitoring bore TB10 in meters Above Horizontal Datum (m AHD). The y-axis ranges from 208 to 213 m AHD in increments of 1. The x-axis shows dates from 30/7/14 to 6/4/15. A blue line represents the 'LEVEL (m AHD)', which starts at approximately 211.0 m AHD on 30/7/14, fluctuates between 210.8 and 211.2 m AHD until late 2014, and then shows a steady decline to about 210.4 m AHD by 6/4/15.</p>		
Vegetation Description		Diversity: 21 species (21 native)	
<p>A sparse overstorey of Swamp Gum (<i>Eucalyptus ovata</i>) and occasional Narrow-leaf Peppermint (<i>Eucalyptus radiata subsp. radiata</i>) over the dominant shrub layer of Woolly Tea-tree (<i>Leptospermum lanigerum</i>) with some Scented Paperbark (<i>Melaleuca squarrosa</i>) which together comprised over 50% cover across the site. The ground layer was sparse, dominated by a thick litter layer (average of over 50% across the transect with an assortment of herbs and ferns, none of which comprised more than 5% of any quadrat).</p>			
Vegetation Condition:		In good condition – no evidence of dieback and recruitment evident	
Evidence of Change:		None observed	
Notes for future monitoring rounds:		The lack of ferns at this site is unusual and future monitoring rounds should make note of whether the trend continues.	

Site T10

Swamp Scrub – Wares Road
IMPACT, CONFINED

Photos



Start of transect with dense Woolly Tea-tree and sedgy understorey



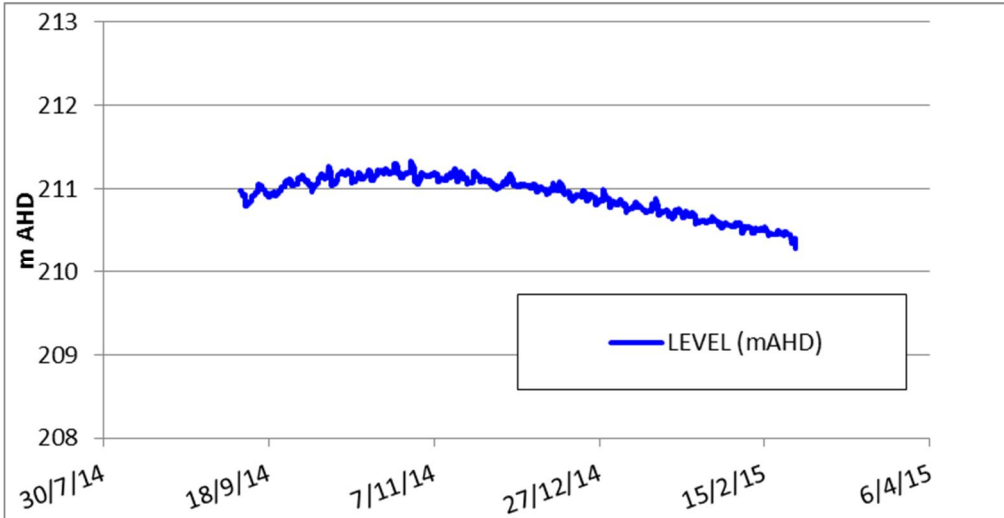
There was a lack of significant variation in vegetation conditions through the transect.



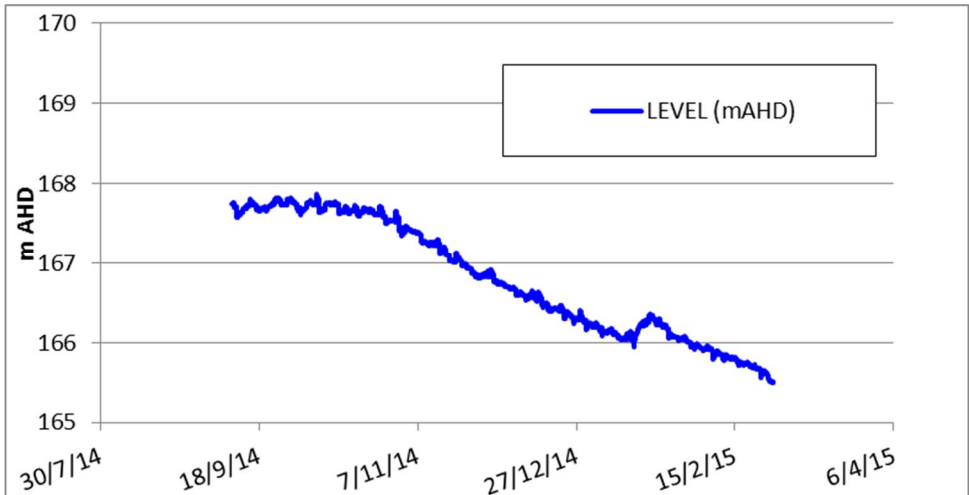
Looking east from Q4, note continued dominance of Woolly Tea-tree and large sedges



End of transect – note open understorey toward end of transect

Site T11 (existing)		Riparian Forest – Pipeline Road REFERENCE, CONFINED	
Location Description	Located on the west side of Colac –Olangolah Pipeline Road north at Porcupine Creek. At this location Porcupine Creek occurs in a wide valley with the transect having been located on the margin of northern margin of the valley. The start of the transect is located ~ 10 m west of Colac –Olangolah Pipeline Road ~200 m north of bore TB11 in thick understorey vegetation, north and slightly uphill from the valley floor and continues at a bearing of 192°.		
Location Co-ordinates	START: E730431, N5737070; END: E728436, N5739895		
Depth of Groundwater at TB11			
Vegetation Description		Diversity: 27 species (27 native)	
<p>This forest ecosystem had a mixed eucalyptus overstorey dominated by Swamp Gum (<i>Eucalyptus ovata</i>) though with Manna Gum (<i>Eucalyptus viminalis</i>), Messmate (<i>Eucalyptus obliqua</i>), and the rare Brooker's Gum (<i>Eucalyptus brookeriana</i>) also present and growing to 25 m. There was a sparse but relatively diverse shrub layer with the ground layer dominated by a mixture of ferns (<i>Pteridium esculentum</i>, <i>Cyathea australis</i>, <i>Blechnum wattsii</i>), scrambling grasses (<i>Poa tenera</i> and <i>Tetrarhena juncea</i>) and large sedges (<i>Lepidosperma elatius</i> and <i>Gahnia sieberii</i>).</p> <p>The ground layer contained a diverse but sparse herb layer with litter dominant at ground level (average of 35%). Overall 28 species were detected along the transect with no weeds present. Koalas were observed and heard at this site during the site assessment.</p> <p>Vegetation Condition: In good condition – no evidence of dieback and recruitment evident</p> <p>Evidence of Change: None observed</p> <p>Notes for future monitoring rounds: Check the ongoing persistence of the herb species as these could be especially vulnerable to changes in groundwater availability at the site.</p>			
<p>Comparison to 2008</p> <p>The site chosen for the transect is some 700 m upstream from Site 5 assessed in the 2008 study. The location was changed to better relate the site to the bore location. The species present are dissimilar to those described and not comparable. The 2008 study described an area dominated by low shrubs (Swamp Scrub) with low diversity, whereas the assessed transect was forested with few shrubs and a diverse fern and sedge understorey.</p>			

Site T11	Riparian Forest – Pipeline Road REFERENCE, CONFINED
Photos	
 <p data-bbox="161 987 365 1014">View from Quadrat 1.</p>	 <p data-bbox="831 987 991 1014">Start of Transect</p>
 <p data-bbox="161 1518 320 1545">End of Transect.</p>	 <p data-bbox="831 1518 1051 1545">Tree ferns at quadrat 4</p>

Site T12 (new)		Swamp Scrub – Gold Hole Road REFERENCE, CONFINED															
Location Description	<p>Located on the north-east side of Gold Hole Road north on an unnamed tributary of Dividing Creek in Great Otway National Park. This site is located downstream from site T13.</p> <p>The start of the transect is located ~ 5m north of Gold Hole Road in thick scrub at the base of a Swamp Gum located south of the waterway and continues at a bearing of due north across the tributary. The start location is on the same side of the waterway and opposite side of the road of bore TB12, which is approximately 25 m from the start location.</p>																
Location Co-ordinates	START: E729592, N5738949; END: E729603, N38989																
Depth of Groundwater at TB12	 <table border="1"><caption>Approximate data points from the groundwater level graph</caption><thead><tr><th>Date</th><th>Level (m AHD)</th></tr></thead><tbody><tr><td>30/7/14</td><td>167.8</td></tr><tr><td>18/9/14</td><td>167.8</td></tr><tr><td>7/11/14</td><td>167.8</td></tr><tr><td>27/12/14</td><td>166.5</td></tr><tr><td>15/2/15</td><td>166.0</td></tr><tr><td>6/4/15</td><td>165.5</td></tr></tbody></table>			Date	Level (m AHD)	30/7/14	167.8	18/9/14	167.8	7/11/14	167.8	27/12/14	166.5	15/2/15	166.0	6/4/15	165.5
Date	Level (m AHD)																
30/7/14	167.8																
18/9/14	167.8																
7/11/14	167.8																
27/12/14	166.5																
15/2/15	166.0																
6/4/15	165.5																
Vegetation Description		Diversity: 42 species (40 native, 2 introduced)															
<p>Located within a wide valley, this site has an open overstorey of Swamp Gum to a height of ~20 m over a shrub layer dominated by Prickly Moses (<i>Acacia verticillata</i>) although relatively diverse with a further 10 species detected. The ground layer was dominated by scrambling grasses with a sparse but diverse ground layer comprising a number of ferns (5 species) and herb species (12). Interestingly, although many ground water dependent species were detected, more than 50% of the vegetation cover is due to plants classified as opportunistic species (Category 2), i.e. opportunistic terrestrial species dominate at this location.</p> <p>Overall 42 species were detected along the transect though Spear Thistle and Blackberry were included in this number</p> <p>Vegetation Condition: In good condition – no evidence of dieback and recruitment evident</p> <p>Evidence of Change: None observed</p> <p>Notes for future monitoring rounds: Check the ongoing persistence of the ground ferns in particular as these could be especially vulnerable to changes in groundwater availability at the site.</p>																	

Site T12

Swamp Scrub – Gold Hole Road

Photos



View from Quadrat 5 toward end of transect.



End of Transect looking toward start.



View from Quadrat 5 toward start of transect.



End of transect downstream

Site T13 (new)		Swamp Heath – Parkes-Lodge Road REFERENCE, CONFINED	
Location Description	<p>Located on the west side of Parkes Lodge Road near an unnamed tributary of Dividing Creek in Great Otway National Park. This site is upstream from Site T12.</p> <p>The start of the transect is located ~ 10m east of Parkes Lodge Road in thick heathy scrub at the base of a Swamp Gum and continues at a bearing of 8°. No defined waterway occurs within the transect.</p> <p>The site was originally to be located on the same tributary but downstream where it crosses Pipeline Road. The construction of the monitoring bore was unable to be completed at this location and therefore the site was moved to Parkes Lodge Road. The current transect is located ~ 40 m north of TB13.</p>		
Location Co-ordinates	START: E729592, N5738949;		

Site T13

Swamp Heath - Parkes-Lodge Road
REFERENCE, CONFINED

Photos



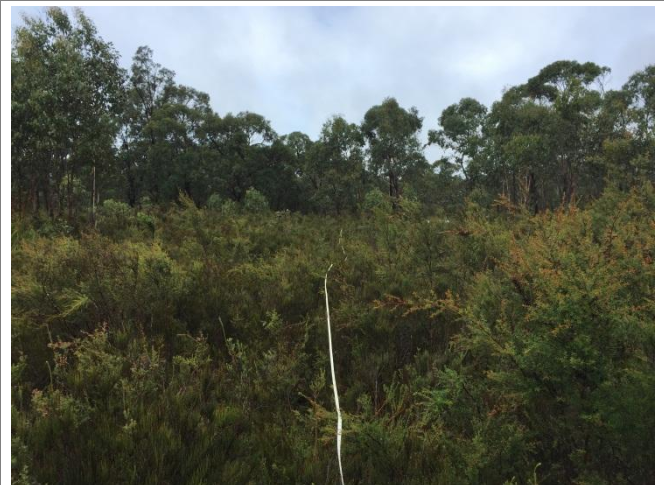
View from Quadrat 1.



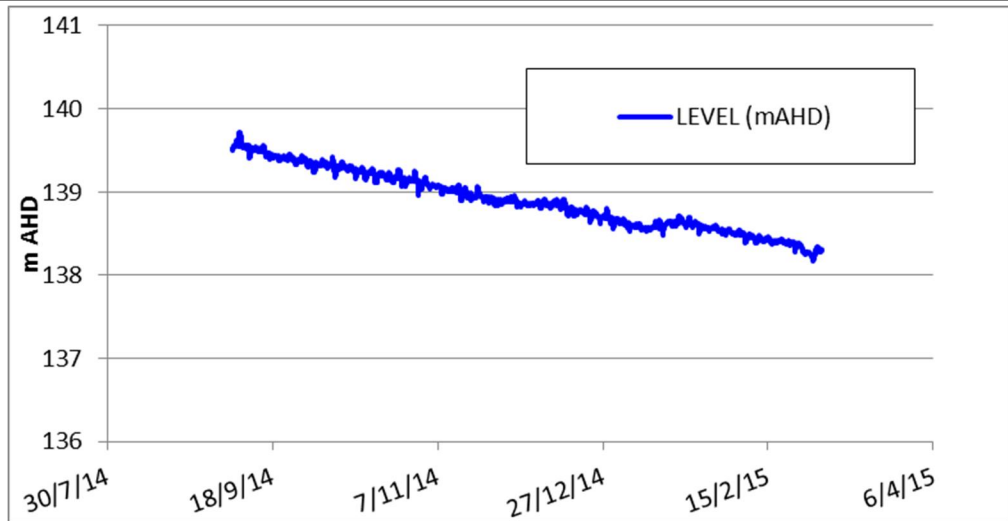
End of Transect looking toward road.



Ground layer with Violets and Spregelia ferns.



End of transect looking to start

Site T14 (new)		Riparian Forest – Robinson Road REFERENCE, CONFINED															
Location Description	<p>Located between Robinson Road and an unnamed access track running east off Robinson Road 30 m north of the intersection with Cashin Road. There is a small parking area and picnic ground where the access track leaves Robinson Road. The transect crosses a small tributary which flows into Ten Mile Creek which runs along Cashin Road. Ten Mile Creek was proposed as the site for vegetation assessment but was altered due to the significant likelihood that Cashins Road and the Old Beechy Train which run along the edge of the Creek would have a compounding influence on the vegetation assemblage at this location.</p> <p>The start of the transect is located ~ 5 m east of the unnamed access track and ~50 m north west of the intersection with Robinson Road at the base of a large tree and continues at a bearing of 319°. A small waterway occurs within the transect and is intersected at quadrats 2 and 3.</p>																
Location Co-ordinates	START: E726670, N5740017; END: E726644, N5740039																
Groundwater Level at TB14	 <table><caption>Approximate Groundwater Level Data (m AHD)</caption><thead><tr><th>Date</th><th>Level (m AHD)</th></tr></thead><tbody><tr><td>30/7/14</td><td>139.6</td></tr><tr><td>18/9/14</td><td>139.5</td></tr><tr><td>7/11/14</td><td>139.3</td></tr><tr><td>27/12/14</td><td>139.0</td></tr><tr><td>15/2/15</td><td>138.6</td></tr><tr><td>6/4/15</td><td>138.3</td></tr></tbody></table>			Date	Level (m AHD)	30/7/14	139.6	18/9/14	139.5	7/11/14	139.3	27/12/14	139.0	15/2/15	138.6	6/4/15	138.3
Date	Level (m AHD)																
30/7/14	139.6																
18/9/14	139.5																
7/11/14	139.3																
27/12/14	139.0																
15/2/15	138.6																
6/4/15	138.3																
Vegetation Description	Diversity: 22 species (22 native)																
<p>This forest community was dominated by a tall overstorey of Messmate and Manna Gum (<i>Eucalyptus obliqua</i> and <i>viminalis</i>) over a dense shrub layer of Scented Paperbark (<i>Melaleuca squarrosa</i>) and rare Currant-wood (<i>Monotoca glauca</i>) with some Tree Ferns (<i>Dicksonia antarctica</i> and <i>Cyathea australis</i>) also present. The ground layer was dominated by ferns which together comprised more than 30% cover. Litter levels were high (average of 52.5% cover) with relatively few herbs and grasses observed. The density of the multiple strata resulted in cover estimates totalling more than 170% across this site.</p> <p>Overall 24 species were detected along the transect with no weeds present</p> <p>Vegetation Condition: In good condition – no evidence of dieback and recruitment evident</p> <p>Evidence of Change: None observed</p> <p>Notes for future monitoring rounds: Check the ongoing persistence of the ground ferns as these could be especially vulnerable to changes in groundwater availability at the site.</p>																	

Site T14	Riparian Forest – Robinson Road REFERENCE, CONFINED
Photos	
	
	
View from start of transect.	Tributary at quadrats 2 and 3
Ground layer with high cover of ground and tree ferns	Scented Paperbark over large sedge and fern dominated ground-layer

3.2 Summary statistics

A total of 133 species were detected across all sites (123 native, 10 weeds) with a full species list presented in Appendix A. All sites had a significant proportion of “ground water dependent” species (as defined in Table 2.1 on page 7) although the number of species and cover of groundwater dependent species varied from site to site. The average cover of ground water dependent species varied from 36 per cent (Site T12) to 100 (Site T3) per cent of the total vegetation cover at a site, whilst the number of groundwater dependent species varied from three (site T1) to 19 (sites T2, T12). There was no significant relationship between the number of groundwater dependent species at a site and the proportion of cover due to groundwater dependent species ($r^2=0.07$, $p=0.37$). As the number of groundwater species at a site is not related to the relative performance of groundwater dependent life forms at the sites, the cover, both total and proportional has been used for subsequent tests.

When testing for differences in the performance of groundwater dependent life forms between impact and reference sites, no difference was detected for either confined or unconfined aquifers, regardless of whether the cover was expressed as a total or proportion of total vegetation cover (One way ANOVA tests, output shown in Appendix D and summarised in Table 3.1).

Table 3.1 : Average performance of Groundwater Dependent Vegetation by site categorisation, including results of one way ANOVA tests

Groundwater Dependent Vegetation	Geology	Impact	Reference	P-value
Total Cover (%)	Unconfined	85	89	0.82
	Confined	72	64	0.68
Proportional Cover	Unconfined	0.89	0.83	0.45
	Confined	0.76	0.75	0.99

When testing for differences in the performance of groundwater dependent life forms between Impact and Reference sites across the project as whole, no difference was detected, regardless of whether the cover was expressed as a total or proportion of total vegetation cover, nor was any significant interaction detected which could confound the results (Two way ANOVA test, output shown in Appendix D and summarised in **Error! Not a valid bookmark self-reference.**). A P-value of 0.054 for Geology was recorded in the two way ANOVA test conducted using Total Cover as a measure of the performance of Groundwater Dependent Vegetation, close to the specified alpha value of 0.05. A P-value of less than 0.05 would have indicated that a significant difference in the total cover of Groundwater Dependent Vegetation was detected between the Unconfined and Confined Aquifers, regardless of whether the sites were considered reference or impact sites. This would have indicated that comparisons between the two geology types would not be comparable at this time as the performance of groundwater dependent vegetation is different based on the underlying geology. The test using Total Cover did not indicate a significant difference at this time, and importantly, when using Proportional Cover as the measure of performance (i.e. the amount of the vegetation at each site dependent on the availability of water) the P-value measured was not close to being significant (P=0.309, **Error! Not a valid bookmark self-reference.**). The fact that Proportional Cover accounts for differences in the overall cover measured at each site makes it a better measure for comparison given the differences encountered in vegetation type across the 14 sites as described in the summary tables.

Table 3.2 : Results of two way ANOVA tests

Category	Total Cover (P-value)	Proportional Cover (P-value)
Reference/Impact	0.547	0.700
Geology (Unconfined/Confined)	0.054	0.309
Interaction	0.896	0.815

No tests were conducted between individual sites as this was not considered to be informative, given no sites are paired within the experimental design. It is envisaged that future monitoring reports will test for differences at each individual site between monitoring events to detect change over time.

Table 3.3 : Summary results of functional groups by site. Cover estimates are in % cover averaged across all 8 quadrats at each site, # of species is a record of the number of species in each category recorded at each site and proportion is the proportion of vegetation cover represented by each category at each site.

Groundwater Dependency		T1	T2	T3	T4	T5	T6	T7	T8	T9	T10	T11	T12	T13	T14
		Unconfined	Unconfined	Unconfined	Unconfined	Unconfined	Unconfined	Unconfined	Confined	Confined	Confined	Confined	Confined	Confined	Confined
		Impact	Impact	Impact	Impact	Reference	Reference	Reference	Impact	Impact	Impact	Reference	Reference	Reference	Reference
0	Cover							0.1				0.5	0.4	1.0	
	# of species							1				1	1	1	
	Proportion							0.0				0.0	0.0	0.0	
1	Cover	3.0	0.1			0.4	0.3	0.3		1.1			0.3		
	# of species	3	1			1	1	1		5			2		
	Proportion	0.0	0.0			0.0	0.0	0.0		0.0			0.0		
2	Cover	21.3	7.0	0.0	18.8	11.8	34.5	11.4	19.1	41.8	5.6	28.5	76.0	2.0	5.5
	# of species	4	7	0	5	12	8	10	18	21	9	12	19	7	8
	Proportion	0.2	0.1		0.2	0.1	0.2	0.1	0.2	0.4	0.1	0.3	0.6	0.0	0.0
Opportunistic	Cover	24.3	7.1	0.0	18.8	12.1	34.8	11.8	19.1	42.9	5.6	29.0	76.6	3.0	5.5
	# of species	7	8	0	5	13	9	12	18	26	9	13	22	8	8
	Proportion	0.2	0.1	0.0	0.2	0.1	0.2	0.1	0.2	0.5	0.1	0.3	0.6	0.0	0.0
3	Cover	78.9	43.9	0.1	57.0	32.6	80.9	65.1	51.1	24.0	87.1	49.8	19.1	65.3	71.5
	# of species	2	10	1	6	9	10	15	9	15	9	11	15	14	11
	Proportion	0.7	0.4	0.0	0.5	0.4	0.6	0.7	0.6	0.3	0.8	0.5	0.2	0.9	0.6
4	Cover	6.4	57.1	7.3	33.4	44.1	23.8	18.6	14.9	27.6	10.9	31.8	24.6	1.9	35.0
	# of species	1	6	3	3	3	2	3	4	2	2	4	4	2	3
	Proportion	0.1	0.5	0.1	0.3	0.5	0.2	0.2	0.2	0.3	0.1	0.3	0.2	0.0	0.3

Groundwater Dependency		T1	T2	T3	T4	T5	T6	T7	T8	T9	T10	T11	T12	T13	T14
		Unconfined	Unconfined	Unconfined	Unconfined	Unconfined	Unconfined	Unconfined	Confined	Confined	Confined	Confined	Confined	Confined	Confined
		Impact	Impact	Impact	Impact	Reference	Reference	Reference	Impact	Impact	Impact	Reference	Reference	Reference	Reference
5	Cover		3.5	52.1											
	# of species		3	6											
	Proportion		0.0	0.9											
6	Cover			1.3											
	# of species			1											
	Proportion			0.0											
Groundwater Dependent	Cover	85.3	104.5	60.8	90.4	76.8	104.6	83.8	66.0	51.6	98.0	81.5	43.8	67.1	106.5
	# of species	3	19	11	9	12	12	18	13	17	11	15	19	16	14
	Proportion	0.8	0.9	1.0	0.8	0.9	0.8	0.9	0.8	0.5	0.9	0.7	0.4	1.0	1.0
Bare Ground	Cover	18.1	16.3	1.3	2.0	1.0	8.8	2.5	1.5	5.6	1.0	1.5	3.5	12.5	4.1
Litter	Cover	27.5	24.4	11.3	40.6	49.4	38.1	42.5	39.4	47.5	51.3	35.6	31.3	18.1	52.5
Moss	Cover	45.6	8.9		1.5	8.1	1.0	13.4	2.5	3.6	4.3	1.5	4.8	1.0	3.0
Water	Cover		8.1	38.8											
Total	Cover	155.1	169.3	112.0	153.3	147.4	187.3	153.9	128.5	151.3	160.1	149.1	159.9	101.8	171.6

4. Discussion

4.1 Vegetation condition

“Groundwater Dependent”¹ vegetation was detected at all sites, supporting the identification of the sites as Ground Water Dependent Ecosystems. The relative importance or performance of Groundwater Dependent species differed between sites, i.e. the cover of groundwater dependent species. It is considered most likely that the variation in the relative importance of groundwater dependent species represents variation in natural conditions between sites. Future rounds of monitoring will help identify any changes over time are related to groundwater levels and environmental conditions.

All vegetation assessed was considered to be in good condition with the exception of site T1 which is recovering from recent burning and acidic soil and groundwater conditions. No sign of decline in vegetation condition that could be related to past extraction from the borefield was observed, however, the ability to detect such change given this is the first monitoring event at these sites is limited. Specifically no dead shrubs, trees and/or large sedges were observed that could be related to a decline in the ground water levels. The possibility, however, that some groundwater dependent species have disappeared from the sites cannot at this stage be determined. Even sites that are in the same vicinity of those that were assessed previously in 2008 (T7 is close to 2008 Site 3, site T2 is close to 2008 site 1 and T11 is close to 2008 site 5) are not comparable as the location has shifted more than 200 m to be closer to the newly established bores and tree water use sampling sites. These locations will enable the analysis of the relationship between any detected vegetation changes and measured changes in groundwater levels, as well as the understanding of water use by trees at the sites.

The current condition of the GDEs assessed does not suggest that a change in ecosystem function related to groundwater usage has occurred recently. No findings, however, can be derived at this time from the findings at Site T1 – Peat Swamp. The peat swamp at this location was burnt recently, has actual acid sulphate soils present and appears to be slowly recovering. The interaction between the borefield aquifer and the local watertable at the swamp is currently being monitored via newly installed nested monitoring bores at the swamp.

No significant difference was detected between reference and impact sites regardless of the underlying geology of the sites. This provides a baseline result upon which future monitoring reports can build on. Relevant questions to be probed in future monitoring events include:

- Are differences detected between monitoring events in the performance of groundwater dependent species at any site? This will provide a basis for determining if any changes in groundwater over the monitoring period can be related to changes in vegetation performance.
- Are differences detected between reference and impact sites in either confined or unconfined aquifers and if yes, can this be related to groundwater levels and extraction?

The above questions can be assessed using statistical techniques, primarily one-way anova tests, and the monitoring design has the capability to detect significant differences in the condition at individual sites and across the various aquifers and project area. Questions specific to each site have been listed in the results section which may be tested in future and are related to detecting change in the composition of groundwater dependent species.

4.2 Groundwater Levels

Groundwater levels at the bores corresponding to each vegetation monitoring site have been measured since installation in 2014. Data is provided for each bore from September 2014 to February 2015. For some bores, a charging period is seen where the bore equilibrates to the surrounding water table. The majority of bores show

¹ As stated in section 2.2.3, the degree to which the water source on which plants defined as groundwater dependent at any site is provided by ground water or surface water is sufficiently well understood at this time. For the purposes of this assessment, a species reliant on water availability at the surface or in upper soil strata is defined as groundwater dependent

a gradual decline (between 1 and 3 m) in the groundwater level over the monitoring period with the exception of sites T3, T4, T5, T6, and T8 which have remained largely static over this period. T2 and T5 show groundwater levels which are stabilising post-drilling and bore development, likely due to the low permeability of soils at the site.

No extraction of groundwater from Barwon Downs has occurred over this time and therefore this represents an environmental response. This is likely a result of evapotranspiration (i.e. water use by plants) over the summer period when water requirements are at their highest, representing seasonal variation in the groundwater levels.

Given the limited period of time over which data has been collected at the groundwater monitoring bores, and the fact that no discernible changes in vegetation condition were observed at any site other than T1, it is not possible at this time to relate the groundwater level to vegetation condition at any site. Future monitoring rounds should be able to relate observations of vegetation condition to groundwater levels by examining the following questions:

- Are any detected changes in vegetation condition at either the site or catchment scale related to changes in groundwater levels? This can be further examined by the following questions:
 - If a change in vegetation condition is measured (i.e. change in cover of groundwater species or species composition), has there been a corresponding change in groundwater that could account for the change? For instance, an increase in the number or cover of Category 4-6 species could be related to an increase in groundwater at a site.
 - Correspondingly, if a significant change in groundwater depth is detected at either the site or catchment level (i.e. a change that is evident after accounting for seasonal variation), has any change in vegetation condition (either cover or presence of groundwater dependent species) been measure? This relates to the potential resilience of the GDEs and ability to withstand and respond to changes in groundwater.
- Has groundwater declined/risen in both reference and impact sites? If so, is the change equivalent in reference and impact sites? These questions aim to separate potential environmental effects (e.g. drought) from any groundwater extraction from the Barwon Downs borefield.

4.3 Link between vegetation and groundwater

With hydrologically sensitive species, defined as groundwater dependent for the purposes of this study, present at all sites, there is a possibility that the GDEs present are dependent on groundwater aquifers; however, it is difficult to separate the importance of surface water versus groundwater at the monitoring sites with current data. Further work is underway to identify the hydrology at each vegetation monitoring site to enable linkages to be drawn between vegetation and their dependency on groundwater availability at each site. This assessment should also consider whether further fauna investigations are required as per the recommendations defined in Figure 5 of the Monitoring Program (SKM 2013)

5. Conclusions

This report outlines the results of the flora survey at the 14 monitoring sites as required under section 7.2 of the amended licence conditions for the Barwon Downs Borefield. These sites have not previously been assessed and this report outlines baseline conditions for future monitoring as recommended in previous flora surveys.

All sites support “Groundwater Dependent”² flora species and therefore the condition of the vegetation could be potentially sensitive to changes in groundwater levels, however, the duration and magnitude of changes in groundwater levels that will induce change in vegetation condition or composition is not known at this time. Past flora surveys have detected changes in vegetation condition and composition that were related to changes in groundwater levels, however, the ability to separate the effects of groundwater extraction, drought, environmental watering, and landuse changes was limited and therefore a more robust vegetation monitoring regime was recommended (SKM & Ecology Australia, 2008).

The monitoring program implemented for this report is able to use statistical tests to analyse whether changes in vegetation condition can be related to groundwater usage. Presently, the statistical tests were limited in scope because the majority of vegetation sites are newly established and existing sites were relocated to be in closer proximity to groundwater monitoring bores to improve understanding between vegetation and groundwater dependency. No statistically significant difference in the performance of groundwater dependent species was detected between impact (i.e. within the influence of the Barwon Downs borefield) and reference sites (i.e. outside the influence of the Barwon Downs borefield).

It is envisaged that future monitoring rounds will be able to use the data captured in this report as a baseline against which changes can be measured – key questions to be analysed have been identified for each site and in the Discussion section of this report. The monitoring program as outlined in this report has specifically been designed so that the data captured is adaptable to any changes in approach that may be required.

The height of each transect, and therefore the depth of groundwater at each site, has not been accurately calculated for this report and therefore not shown in the summary tables in section 3.1. Survey to establish the height at quadrat 1 of each transect is to be organised and will be included in subsequent reports.

² As stated in section 2.2.3, the degree to which the water source on which plants defined as groundwater dependent at any site is provided by ground water or surface water is sufficiently well understood at this time. For the purposes of this assessment, a species reliant on water availability at the surface or in upper soil strata is defined as groundwater dependent as a precautionary measure.

6. References

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Appendix A. Species lists and Functional groupings

Scientific Name	Common Name	Status	Groundwater dependency	T1	T2	T3	T4	T5	T6	T7	T8	T9	T10	T11	T12	T13	T14	Total sites
<i>Acacia dealbata</i>	Silver Wattle		2														X	1
<i>Acacia melanoxylon</i>	Blackwood		2		X					X		X		X			X	5
<i>Acacia mucronata subsp. longifolia</i>	Narrow-leaf Wattle		3												X			1
<i>Acacia verticillata</i>	Prickly Moses		2				X	X	X		X	X	X	X	X			8
<i>Acaena novae-zelandiae</i>	Bidgee-widgee		2							X	X	X		X	X			5
<i>Acetosella vulgaris</i>	Sheep Sorrel	*	1	X														1
<i>Acrotriche prostrata</i>	Trailing Ground-berry		2													X		1
<i>Adiantum aethiopicum</i>	Common Maidenhair		3						X	X			X			X	X	5
<i>Allocasuarina misera</i>	Slender Sheoak		2					X										1
<i>Allocasuarina paludosa</i>	Scrub Sheoak		3													X		1
<i>Amperea xiphoclada var. xiphoclada</i>	Broom Spurge		2					X	X		X		X					4
<i>Amphibromus recurvatus</i>	Dark Swamp Wallaby-grass		5			X												1
<i>Amyema pendula</i>	Drooping Mistletoe		0											X				1
<i>Anogramma leptophylla</i>	Annual Fern		3							X						X		2
<i>Anthoxanthum odoratum</i>	Sweet Vernal-grass	*	2	X							X	X						3
<i>Asperula conferta</i>	Common Woodruff		2												X			1
<i>Asperula scoparia subsp. scoparia</i>	Prickly Woodruff		2								X							1
<i>Asperula spp.</i>	Woodruff		2									X						1
<i>Asplenium flabellifolium</i>	Necklace Fern		4					X			X				X			3
<i>Austrocynoglossum latifolium</i>	Forest Hound's-tongue		3									X						1
<i>Banksia marginata</i>	Silver Banksia		2					X		X			X	X				4

Scientific Name	Common Name	Status	Groundwater dependency	T1	T2	T3	T4	T5	T6	T7	T8	T9	T10	T11	T12	T13	T14	Total sites
<i>Baumea articulata</i>	Jointed Twig-sedge		5			X												1
<i>Baumea rubiginosa</i> s.s.	Soft Twig-sedge		5			X												1
<i>Bedfordia arborescens</i>	Blanket Leaf		3												X			1
<i>Billardiera mutabilis</i>	Common Apple-berry		2						X						X	X		3
<i>Blechnum minus</i>	Soft Water-fern		3							X								1
<i>Blechnum nudum</i>	Fishbone Water-fern		3		X		X			X	X			X	X		X	7
<i>Blechnum wattsii</i>	Hard Water-fern		3								X	X		X	X			4
<i>Brachyscome</i> spp.	Daisy		2														X	1
<i>Burchardia umbellata</i>	Milkmaids		2					X										1
<i>Bursaria spinosa</i> subsp. <i>spinosa</i>	Sweet Bursaria		3		X							X						2
<i>Calochlaena dubia</i>	Common Ground-fern		3								X							1
<i>Cardamine</i> spp.	Bitter Cress		4		X													1
<i>Carex appressa</i>	Tall Sedge		4		X													1
<i>Carex fascicularis</i>	Tassel Sedge		4			X												1
<i>Cassinia longifolia</i>	Shiny Cassinia		2												X			1
<i>Cassytha glabella</i>	Slender Dodder-laurel		0							X								1
<i>Cassytha pubescens</i> s.s.	Downy Dodder-laurel		0												X	X		2
<i>Caustis flexuosa</i>	Curly Wig		3							X						X		2
<i>Centaurium</i> spp.	Centaury	*	1									X						1
<i>Cirsium vulgare</i>	Spear Thistle	*	1									X			X			2
<i>Clematis aristata</i>	Mountain Clematis		2								X	X						2
<i>Coprosma quadrifida</i>	Prickly Currant-bush		2		X						X	X						3

Scientific Name	Common Name	Status	Groundwater dependency	T1	T2	T3	T4	T5	T6	T7	T8	T9	T10	T11	T12	T13	T14	Total sites
<i>Corybas spp.</i>	Helmet Orchid		3									X						1
<i>Cyathea australis</i>	Rough Tree-fern		4											X	X		X	3
<i>Cycnogeton alcockiae</i>	Southern Water-ribbons		5			X												1
<i>Cycnogeton procerum s.s.</i>	Common Water-ribbons		5		X													1
<i>Dianella tasmanica</i>	Tasman Flax-lily		3				X	X	X	X	X	X	X	X	X			9
<i>Dichondra repens</i>	Kidney-weed		2									X		X				2
<i>Dicksonia antarctica</i>	Soft Tree-fern		4				X			X	X						X	4
<i>Dillwynia glaberrima</i>	Smooth Parrot-pea		2							X								1
<i>Drosera auriculata</i>	Tall Sundew		2					X	X				X					3
<i>Echinopogon ovatus</i>	Common Hedgehog-grass		2									X						1
<i>Empodisma minus</i>	Spreading Rope-rush		3					X	X	X			X		X	X		6
<i>Epacris impressa var. impressa</i>	Common Heath		2												X	X		2
<i>Epacris lanuginosa</i>	Woolly-style Heath		3													X		1
<i>Eucalyptus brookeriana</i>	Brooker's Gum	r	4								X	X		X				3
<i>Eucalyptus obliqua</i>	Messmate Stringybark		2				X		X		X	X		X			X	6
<i>Eucalyptus ovata</i>	Swamp Gum		4	X	X	X	X	X	X				X	X	X	X		10
<i>Eucalyptus radiata subsp. radiata</i>	Narrow-leaf Peppermint		2							X		X	X		X			4
<i>Eucalyptus viminalis</i>	Manna Gum		3						X					X			X	3
<i>Gahnia clarkei</i>	Tall Saw-sedge		3						X									1
<i>Gahnia radula</i>	Thatch Saw-sedge		3													X	X	2
<i>Gahnia sieberiana</i>	Red-fruit Saw-sedge		3		X		X	X		X	X	X	X	X	X			9

Scientific Name	Common Name	Status	Groundwater dependency	T1	T2	T3	T4	T5	T6	T7	T8	T9	T10	T11	T12	T13	T14	Total sites
<i>Galium spp.</i>	Bedstraw		3												X			1
<i>Geranium potentilloides</i>	Soft Crane's-bill		2												X			1
<i>Geranium sp. 2</i>	Variable Crane's-bill		2								X	X						2
<i>Geranium spp.</i>	Crane's Bill		2											X				1
<i>Gleichenia dicarpa/microphylla</i>	Coral-fern		3		X					X					X		X	4
<i>Gonocarpus micranthus</i>	Creeping Raspwort		3													X		1
<i>Gonocarpus tetragynus</i>	Common Raspwort		2		X			X	X		X	X	X	X	X			8
<i>Goodenia humilis</i>	Swamp Goodenia		3					X	X				X					3
<i>Goodenia lanata</i>	Trailing Goodenia		3									X		X				2
<i>Gratiola peruviana</i>	Austral Brooklime		4		X													1
<i>Gynatrix pulchella s.l.</i>	Hemp Bush		3									X						1
<i>Holcus lanatus</i>	Yorkshire Fog	*	2	X						X		X						3
<i>Hydrocotyle hirta</i>	Hairy Pennywort		3								X							1
<i>Hydrocotyle pterocarpa</i>	Wing Pennywort		4		X													1
<i>Hydrocotyle spp.</i>	Pennywort		3							X				X				2
<i>Hypericum gramineum spp. agg.</i>	Small St John's Wort		2												X			1
<i>Hypochaeris radicata</i>	Flatweed	*	1	X								X						2
<i>Isolepis cernua</i>	Nodding Club-sedge		5		X													1
<i>Isolepis inundata</i>	Swamp Club-sedge		5		X													1
<i>Juncus planifolius</i>	Broad-leaf Rush		4							X								1
<i>Juncus procerus</i>	Tall Rush		5			X												1
<i>Lachnagrostis filiformis s.s.</i>	Common Blown-grass		4			X												1
<i>Lepidosperma elatius</i>	Tall Sword-sedge		3		X		X	X	X		X		X	X	X		X	9

Scientific Name	Common Name	Status	Groundwater dependency	T1	T2	T3	T4	T5	T6	T7	T8	T9	T10	T11	T12	T13	T14	Total sites
<i>Lepidosperma gunnii</i>	Slender Sword-sedge		3													X		1
<i>Lepidosperma laterale</i>	Variable Sword-sedge		3													X		1
<i>Leptospermum continentale</i>	Prickly Tea-tree		3	X						X				X	X	X		5
<i>Leptospermum lanigerum</i>	Woolly Tea-tree		3		X	X	X	X	X	X	X	X	X		X			10
<i>Leucopogon virgatus</i>	Common Beard-heath		3													X		1
<i>Lomandra filiformis</i>	Wattle Mat-rush		1					X	X	X								3
<i>Lomandra longifolia</i>	Spiny-headed Mat-rush		2					X				X	X		X			4
<i>Lotus spp. (naturalised)</i>	Trefoil	*	1		X							X			X			3
<i>Luzula meridionalis var. flaccida</i>	Common Woodrush		3		X													1
<i>Melaleuca squarrosa</i>	Scented Paperbark		4		X		X	X	X	X	X		X	X	X	X	X	11
<i>Mentha australis</i>	River Mint		4									X						1
<i>Mentha laxiflora</i>	Forest Mint		3														X	1
<i>Microlaena stipoides var. stipoides</i>	Weeping Grass		3		X													1
<i>Monotoca glauca</i>	Currant-wood	r	3					X	X	X			X				X	5
<i>Notelaea ligustrina</i>	Privet Mock-olive		3									X						1
<i>Olearia erubescens</i>	Moth Daisy-bush		3					X										1
<i>Olearia lirata</i>	Snowy Daisy-bush		2		X							X		X	X			4
<i>Olearia phlogopappa</i>	Dusty Daisy-bush		3									X						1
<i>Ornduffia reniformis</i>	Running Marsh-flower		6			X												1
<i>Oxalis spp.</i>	Wood Sorrel		2									X			X			2
<i>Persicaria praetermissa</i>	Spotted Knotweed		5			X												1

Scientific Name	Common Name	Status	Groundwater dependency	T1	T2	T3	T4	T5	T6	T7	T8	T9	T10	T11	T12	T13	T14	Total sites
<i>Plantago lanceolata</i>	Ribwort	*	1									X						1
<i>Poa sieberiana</i>	Grey Tussock-grass		3									X						1
<i>Poa tenera</i>	Slender Tussock-grass		3		X		X	X	X		X	X	X	X	X		X	10
<i>Polystichum proliferum</i>	Mother Shield-fern		3		X												X	2
<i>Pomaderris aspera</i>	Hazel Pomaderris		3									X						1
<i>Poranthera microphylla s.l.</i>	Small Poranthera		2								X							1
<i>Pteridium esculentum</i>	Austral Bracken		2	X	X		X	X	X		X	X	X	X	X		X	11
<i>Pterostylis spp.</i>	Greenhood		3							X							X	2
<i>Pultenaea gunnii</i>	Golden Bush-pea		2												X	X		2
<i>Rubus anglocandicans</i>	Common Blackberry	*	2							X	X				X		X	4
<i>Rubus parvifolius</i>	Small-leaf Bramble		2							X	X	X					X	4
<i>Selaginella uliginosa</i>	Swamp Selaginella		3													X		1
<i>Senecio glomeratus</i>	Annual Fireweed		2	X	X		X				X							4
<i>Senecio minimus</i>	Shrubby Fireweed		2								X							1
<i>Senecio tenuiflorus spp. agg.</i>	Slender Fireweed		2												X			1
<i>Senecio velleioides</i>	Forest Groundsel		3							X		X			X			3
<i>Sprengelia incarnata</i>	Pink Swamp-heath		3													X		1
<i>Stellaria pungens</i>	Prickly Starwort		3											X	X			2
<i>Tetrarrhena distichophylla</i>	Hairy Rice-grass		2													X		1
<i>Tetrarrhena juncea</i>	Forest Wire-grass		2		X		X	X	X	X	X	X		X	X		X	10
<i>Tetralochea ciliata</i>	Pink-bells		2							X								1
<i>Viola hederacea sensu Entwisle (1996)</i>	Ivy-leaf Violet		2					X			X	X	X	X	X	X		7
<i>Vulpia bromoides</i>	Squirrel-tail Fescue	*	1	X														1

Scientific Name	Common Name	Status	Groundwater dependancy	T1	T2	T3	T4	T5	T6	T7	T8	T9	T10	T11	T12	T13	T14	Total sites
<i>Wahlenbergia stricta subsp. stricta</i>	Tall Bluebell		2													X		1
<i>Xanthosia dissecta s.s.</i>	Native Parsley		2					X										1

- * Exotic species not native to Australia
- r Species considered rare in Victoria

Appendix B. Map of sites

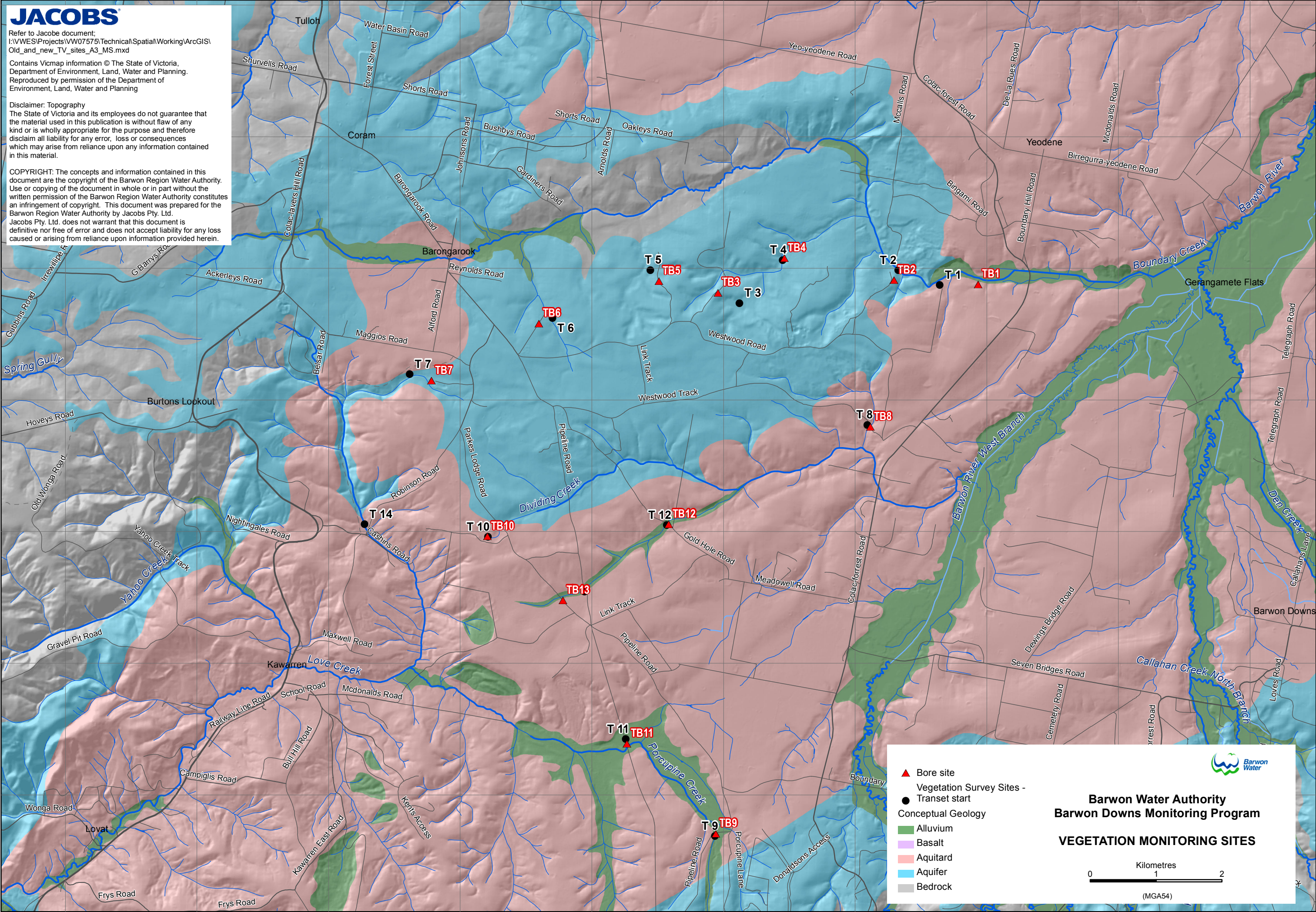
JACOBS

Refer to Jacobs document:
I:\VESI\Projects\W07575\Technical\Spatial\Working\ArcGIS\Old_and_new_TV_sites_A3_MS.mxd

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Appendix C. Data sheets

Vegetation Monitoring Report



Site Name	T1	Site Location	Peat Swamp on Boundary Creek east of Colac-Forrest Road
Latitude GDA94	-38.4233	VBA Survey ID	1084234
Longitude GDA94	143.69535	VBA Site ID	715615
Geology	Unconfined		
Ref/Imp	Impact		

Recorded Information

Summary information

Scientific Name	Common Name	Conservation Status	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Average	Std Dev	Max	Min	No quads
<i>Anthoxanthum odoratum</i>	Sweet Vernal-grass	*	1								0.13		1	1	1
<i>Eucalyptus ovata</i>	Swamp Gum		5	10	25	5	5	1			6.38	8.57	25	1	6
<i>Holcus lanatus</i>	Yorkshire Fog	*	5	1	1	1					1.00	2.00	5	1	4
<i>Hypochaeris radicata</i>	Flatweed	*	1			1	1				0.38	0.00	1	1	3
<i>Leptospermum continentale</i>	Prickly Tea-tree		1	10	5	35	25	60	70	60	33.25	27.34	70	1	8
<i>Pteridium esculentum</i>	Austral Bracken		35	45	35	15	10	10	5	5	20.00	15.81	45	5	8
<i>Acetosella vulgaris</i>	Sheep Sorrel	*	5								0.63		5	5	1
<i>Senecio glomeratus</i>	Annual Fireweed					1					0.13		1	1	2
<i>Vulpia bromoides</i>	Squirrel-tail Fescue	*	10			1	5				2.00	4.51	10	1	3
Bare ground			15	50	20	10	15	20	5	10	18.13	13.87	50	5	8
Litter			20	15	45	25	10	30	30	45	27.50	12.82	45	10	8
Moss			20	35	30	60	60	50	60	50	45.63	15.45	60	20	8

Vegetation Monitoring Report



Site Name	T2	Site Location	On Boundary Creek at unnamed access track~ 650 m upstream of Peat Swamp		
Latitude GDA94	-38.4233	VBA Survey ID	1084235		
Longitude GDA94	143.68766	VBA Site ID	715616		
Geology	Unconfined				
Ref/Imp	Impact				

Recorded Information

Summary Information

Scientific Name	Common Name	Conservation Status	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Average	Std Dev	Max	Min	No quads
<i>Acacia melanoxylon</i>	Blackwood		1								0.125		1	1	1
<i>Blechnum nudum</i>	Fishbone Water-fern			1	5	1	1	5	15	10	4.75	5.349677	15	1	7
<i>Carex appressa</i>	Tall Sedge		1	5	5	20	20	1	25	10	10.875	9.493419	25	1	8
<i>Coprosma quadrifida</i>	Prickly Currant-bush		1	1	1	5	1	1	1		1.375	1.511858	5	1	7
<i>Eucalyptus ovata</i>	Swamp Gum		40	30	20	35	5			5	16.875	15.0831	40	5	6
<i>Gahnia sieberiana</i>	Red-fruit Saw-sedge		10	25	5	20	15	5	5	20	13.125	7.989949	25	5	8
<i>Gleichenia dicarpa/microphylla</i>	Coral-fern		25	20			5		5	15	8.75	8.944272	25	5	5
<i>Gonocarpus tetragynus</i>	Common Raspwort		1								0.125		1	1	1
<i>Gratiola peruviana</i>	Austral Brooklime			1	1	5	1	5	1	5	2.375	2.13809	5	1	7
<i>Hydrocotyle pterocarpa</i>	Wing Pennywort						1	5	5	1	1.5	2.309401	5	1	4
<i>Isolepis inundata</i>	Swamp Club-sedge			1	1		1	15		1	2.375	6.26099	15	1	5
<i>Lepidosperma elatius</i>	Tall Sword-sedge			5	30	15	5				6.875	11.81454	30	5	4
<i>Leptospermum lanigerum</i>	Woolly Tea-tree						5	10	10	20	5.625	6.291529	20	5	4
<i>Luzula meridionalis</i> var. <i>flaccida</i>	Common Woodrush								1		0.125		1	1	1
<i>Melaleuca squarrosa</i>	Scented Paperbark		25	20	20	15	50	50	5	5	23.75	17.67767	50	5	8
<i>Microlaena stipoides</i> var. <i>stipoides</i>	Weeping Grass		5	1							0.75		5	1	2
<i>Olearia lirata</i>	Snowy Daisy-bush		1								0.125		1	1	1
<i>Poa tenera</i>	Slender Tussock-grass					5					0.625		5	5	1
<i>Polystichum proliferum</i>	Mother Shield-fern							1			0.125		1	1	1
<i>Pteridium esculentum</i>	Austral Bracken		5	5							1.25		5	5	2
<i>Senecio glomeratus</i>	Annual Fireweed				1		1	1	1		0.5	0	1	1	4
<i>Tetrarrhena juncea</i>	Forest Wire-grass		5	5	1	10	5	1	1		3.5	3.316625	10	1	7
<i>Cynogeton procerum</i> s.s.	Common Water-ribbons			1				1	1	5	1	2	5	1	4
<i>Bursaria spinosa</i>	Sweet Bursaria				25						3.125		25	25	1
<i>Isolepis cernua</i>	Nodding Club-sedge								1		0.125		1	1	1
<i>Cardamine</i> spp.	Bitter Cress					1	10	1	1	1	1.75	4.024922	10	1	5
<i>Lotus</i> spp. (naturalised)	Trefoil	*				1					0.13		1	1	1
Bare ground			10	15	20	10	15	15	30	15	16.25	6.41	30	10	8
Litter			45	20	25	25	30	25	10	15	24.38	10.50	45	10	8
Moss			10	5	10	10	15	15	5	1	8.88	4.94	15	1	8
Water				15	10	5		35			8.13	13.15	35	5	4

Site Name	T3	Site Location	Unnamed swamp 250 m west of Maintenance Track running north of Westwood Road	
Latitude GDA94	-38.4262	VBA Survey ID	1084236	
Longitude GDA94	143.65868	VBA Site ID	715617	
Geology	Unconfined			
Ref/Imp	Impact			

Recorded Information

Summary information

Scientific Name	Common Name	Conservation Status	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Average	Std Dev	Max	Min	No quads
<i>Amphibromus recurvatus</i>	Dark Swamp Wallaby-grass		40	25	10	35	25	40	20	15	26.25	11.26	40	10	8
<i>Baumea articulata</i>	Jointed Twig-sedge			10	10	5	10	10	20	10	9.38	4.50	20	5	7
<i>Carex fascicularis</i>	Tassel Sedge				1						0.13		1	1	1
<i>Eucalyptus ovata</i>	Swamp Gum			5	1		20	5	20		6.38	9.09	20	1	5
<i>Juncus procerus</i>	Tall Rush		5	5	10	15	10	20	10	20	11.88	5.94	20	5	8
<i>Leptospermum lanigerum</i>	Woolly Tea-tree				1						0.13		1	1	1
<i>Ornduffia reniformis</i>	Running Marsh-flower				1	5	1	1	1	1	1.25	1.63	5	1	6
<i>Persicaria praetermissa</i>	Spotted Knotweed				1	1			1	1	0.50	0.00	1	1	4
<i>Cychnogeton alcockiae</i>	Southern Water-ribbons			1	1						0.25		1	1	2
<i>Lachnagrostis filiformis</i> s.s.	Common Blown-grass		5	1							0.75		5	1	2
<i>Baumea rubiginosa</i> s.s.	Soft Twig-sedge						5	1	10	15	3.88	6.08	15	1	4
Bare ground				5	5						1.25		5	5	2
Litter			10	5	15	10	5	15	15	15	11.25	4.43	15	5	8
Water			40	50	45	25	50	5	35	60	38.75	17.27	60	5	8

Site Name	T4	Site Location	At an unnamed tributary of Boundary Creek immediately north of unmarked access track, ~ 1.2 km west of Maintenance track	
Latitude GDA94	-38.4202	VBA Survey ID	1084237	
Longitude GDA94	143.66735	VBA Site ID	715618	
Geology	Unconfined			
Ref/Imp	Impact			

Recorded Information

Summary information

Scientific Name	Common Name	Conservation Status	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Average	Std Dev	Max	Min	No quads
<i>Acacia verticillata</i>	Prickly Moses					1					0.13		1	1	1
<i>Blechnum nudum</i>	Fishbone Water-fern			1		5	1	1			1.00	2.00	5	1	4
<i>Dianella tasmanica</i>	Tasman Flax-lily			1				1			0.25		1	1	2
<i>Dicksonia antarctica</i>	Soft Tree-fern		5								0.63		5	5	1
<i>Eucalyptus obliqua</i>	Messmate Stringybark							15	10	25	6.25	7.64	25	10	3
<i>Eucalyptus ovata</i>	Swamp Gum		20	30	20	15	35	5	1	5	16.38	12.28	35	1	8
<i>Gahnia sieberiana</i>	Red-fruit Saw-sedge						1		1	5	0.88	2.31	5	1	3
<i>Lepidosperma elatius</i>	Tall Sword-sedge		40	45	50	35	15	50	25	20	35.00	13.63	50	15	8
<i>Leptospermum lanigerum</i>	Woolly Tea-tree		5					5	50	55	14.38	27.50	55	5	4
<i>Melaleuca squarrosa</i>	Scented Paperbark		25	25	20	20	15	20	5	1	16.38	8.91	25	1	8
<i>Poa tenera</i>	Slender Tussock-grass		5	5	1	1	20	10	1	1	5.50	6.68	20	1	8
<i>Pteridium esculentum</i>	Austral Bracken		1		10	10	15	5	1		5.25	5.62	15	1	6
<i>Senecio glomeratus</i>	Annual Fireweed							1			0.13		1	1	1
<i>Tetrarrhena juncea</i>	Forest Wire-grass		10	15	5	10	5	1	5	5	7.00	4.38	15	1	8
Bare ground			1	1	5	1	5	1	1	1	2.00	1.85	5	1	8
Litter			30	35	30	40	30	40	55	65	40.63	12.94	65	30	8
Moss			1	1	1	1	1	1	5	1	1.50	1.41	5	1	8

Site Name	T5	Site Location	~70 m west Field and Game Track in Otway State Forest	
Latitude GDA94	-38.4229	VBA Survey ID	1084238	
Longitude GDA94	143.64523	VBA Site ID	715619	
Geology	Unconfined			
Ref/Imp	Reference			

Recorded Information

Summary information

Scientific Name	Common Name	Conservation Status	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Average	Std Dev	Max	Min	No quads
<i>Acacia verticillata</i>	Prickly Moses			1							0.13		1	1	1
<i>Amperea xiphoclada</i> var. <i>xiphoclada</i>	Broom Spurge		1		1						0.25		1	1	2
<i>Asplenium flabellifolium</i>	Necklace Fern		1	5	1						0.88	2.31	5	1	3
<i>Banksia marginata</i>	Silver Banksia		1		1		1				0.38	0.00	1	1	3
<i>Burchardia umbellata</i>	Milkmaids		1								0.13		1	1	1
<i>Dianella tasmanica</i>	Tasman Flax-lily		1	1	1	1	5				1.13	1.79	5	1	5
<i>Drosera auriculata</i>	Tall Sundew		1	1							0.25		1	1	2
<i>Empodisma minus</i>	Spreading Rope-rush		20	15	1						4.50	9.85	20	1	3
<i>Eucalyptus ovata</i>	Swamp Gum		30	30	20	10	25	35	40	25	26.88	9.23	40	10	8
<i>Eucalyptus radiata</i> subsp. <i>radiata</i>	Narrow-leaf Peppermint						15	5			2.50		15	5	2
<i>Gahnia sieberiana</i>	Red-fruit Saw-sedge		15	5		5	5	1	5	30	8.25	10.03	30	1	7
<i>Gonocarpus tetragynus</i>	Common Raspwort		1			1					0.25		1	1	2
<i>Goodenia humilis</i>	Swamp Goodenia		1		1						0.25		1	1	2
<i>Lepidosperma elatius</i>	Tall Sword-sedge		5	5	5	10	10	40	30	15	15.00	13.09	40	5	8
<i>Leptospermum lanigerum</i>	Woolly Tea-tree		10	1	1		1				1.63	4.50	10	1	4
<i>Lomandra filiformis</i>	Wattle Mat-rush		1	1	1						0.38	0.00	1	1	3
<i>Lomandra longifolia</i>	Spiny-headed Mat-rush			1							0.13		1	1	1
<i>Melaleuca squarrosa</i>	Scented Paperbark		1		15	25	20	15	20	15	13.88	7.54	25	1	7
<i>Olearia erubescens</i>	Moth Daisy-bush							1		1	0.25		1	1	2
<i>Poa tenera</i>	Slender Tussock-grass		1	1	1	1	1	1	1	5	1.50	1.41	5	1	8
<i>Pteridium esculentum</i>	Austral Bracken		5	5	5	5	5	1	5		3.88	1.51	5	1	7
<i>Tetrarrhena juncea</i>	Forest Wire-grass			1	1	10	15	5	5	5	5.25	5.00	15	1	7
<i>Allocasuarina misera</i>	Slender Sheoak			1	1						0.25		1	1	2
<i>Monotoca glauca</i>	Currant-wood	r				1					0.13		1	1	1
<i>Xanthosia dissecta</i> s.s.	Native Parsley		1	1	1						0.38	0.00	1	1	3
<i>Viola hederacea</i> sensu Entwistle (1996)	Ivy-leaf Violet		1	1	1	1					0.50	0.00	1	1	4
Bare ground			1	1	1	1	1	1	1	1	1.00	0.00	1	1	8
Litter			45	40	60	50	55	55	50	40	49.38	7.29	60	40	8
Moss			5	10	5	15	15	5	5	5	8.13	4.58	15	5	8

Site Name	T6	Site Location	Located at unnamed tributary of Boundary Creek on an unnamed access track off Landons Road ~ 400 m from turnoff	
Latitude GDA94	-38.4296	VBA Survey ID	1084232	
Longitude GDA94	143.62805	VBA Site ID	715613	
Geology	Unconfined			
Ref/Imp	Reference			

Recorded Information

Summary information

Scientific Name	Common Name	Conservation Status	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Average	Std Dev	Max	Min	No quads
<i>Acacia verticillata</i>	Prickly Moses					1					0.13		1	1	1
<i>Adiantum aethiopicum</i>	Common Maidenhair						1				0.13		1	1	1
<i>Amperea xiphoclada</i> var. <i>xiphoclada</i>	Broom Spurge		5								0.63		5	5	1
<i>Dianella tasmanica</i>	Tasman Flax-lily		10		5	5	15			1	4.50	5.40	15	1	5
<i>Drosera auriculata</i>	Tall Sundew		1		1		1				0.38	0.00	1	1	3
<i>Empodisma minus</i>	Spreading Rope-rush		10	1	10	10	1			10	5.25	4.65	10	1	6
<i>Eucalyptus obliqua</i>	Messmate Stringybark			20	25	35	45	15			17.50	12.04	45	15	5
<i>Eucalyptus ovata</i>	Swamp Gum		20	25	15			30	20	35	11.88	11.09	35	10	6
<i>Gahnia clarkei</i>	Tall Saw-sedge			10		5	1				2.00	4.51	10	1	3
<i>Gonocarpus tetragynus</i>	Common Raspwort		1				1				0.25		1	1	2
<i>Goodenia humilis</i>	Swamp Goodenia						1				0.13		1	1	1
<i>Lepidosperma elatius</i>	Tall Sword-sedge			35	30	40	40	60	70	70	43.13	16.94	70	30	7
<i>Leptospermum lanigerum</i>	Woolly Tea-tree				10	15	15	1			5.13	6.60	15	1	4
<i>Lomandra filiformis</i>	Wattle Mat-rush		1				1				0.25		1	1	2
<i>Melaleuca squarrosa</i>	Scented Paperbark		30	10	10	10		10	20	5	11.88	8.52	30	5	7
<i>Poa tenera</i>	Slender Tussock-grass			10	10	10	10	20	25	10	11.88	6.27	25	10	7
<i>Pteridium esculentum</i>	Austral Bracken		15	1	5	5	1			1	3.50	5.43	15	1	6
<i>Tetrarrhena juncea</i>	Forest Wire-grass		1	15	20	15	25	15		5	12.00	8.26	25	1	7
<i>Monotoca glauca</i>	Currant-wood	r	10	10							2.50		10	10	2
<i>Billardiera mutabilis</i>	Common Apple-berry		1								0.13		1	1	1
Bare ground			5	15	10	15	5	10	5	5	8.75	4.43	15	5	8
Litter			30	45	40	35	40	40	35	40	38.13	4.58	45	30	8
Moss			1	1	1	1	1	1	1	1	1.00	0.00	1	1	8

Site Name	T7	Site Location			Located at unnamed tributary of Boundary Creek on an unnamed access track off Landons Road ~ 400 m from turnoff											
Latitude GDA94	-38.4386	VBA Survey ID			1084232											
Longitude GDA94	143.60679	VBA Site ID			715613											
Geology	Unconfined															
Ref/Imp	Reference															
Scientific Name	Common Name	Conservation Status	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Average	Std Dev	Max	Min	No quads	
<i>Acacia melanoxylon</i>	Blackwood		1	1	1						0.38	0.00	1	1	3	
<i>Acaena novae-zelandiae</i>	Bidgee-widgee			1							0.13		1	1	1	
<i>Adiantum aethiopicum</i>	Common Maidenhair			1	5	5					1.38	2.31	5	1	3	
<i>Anogramma leptophylla</i>	Annual Fern			1							0.13		1	1	1	
<i>Banksia marginata</i>	Silver Banksia								1		0.13		1	1	1	
<i>Blechnum minus</i>	Soft Water-fern				5						0.63		5	5	1	
<i>Blechnum nudum</i>	Fishbone Water-fern				1	1	1				0.38	0.00	1	1	3	
<i>Cassytha glabella</i>	Slender Dodder-laurel								1		0.13		1	1	1	
<i>Caustis flexuosa</i>	Curly Wig		1	1	1						0.38	0.00	1	1	3	
<i>Dianella tasmanica</i>	Tasman Flax-lily								1		0.13		1	1	1	
<i>Dicksonia antarctica</i>	Soft Tree-fern			5	20	25	1				6.38	11.56	25	1	4	
<i>Dillwynia glaberrima</i>	Smooth Parrot-pea						1		1		0.25		1	1	2	
<i>Empodisma minus</i>	Spreading Rope-rush						1	1	1		0.38	0.00	1	1	3	
<i>Gahnia sieberiana</i>	Red-fruit Saw-sedge			1	1	1					0.38	0.00	1	1	3	
<i>Gleichenia dicarpa/microphylla</i>	Coral-fern		65	30	25	40	75	60	25		40.00	20.70	75	25	7	
<i>Holcus lanatus</i>	Yorkshire Fog	*			1						0.13		1	1	1	
<i>Juncus planifolius</i>	Broad-leaf Rush							1	1		0.25		1	1	2	
<i>Leptospermum continentale</i>	Prickly Tea-tree							1	1		0.25		1	1	2	
<i>Leptospermum lanigerum</i>	Woolly Tea-tree		20	30	5	5	5	1	1		8.38	11.07	30	1	7	
<i>Lomandra filiformis</i>	Wattle Mat-rush							1		1	0.25		1	1	2	
<i>Melaleuca squarrosa</i>	Scented Paperbark		5	5	30	30	25	1			12.00	13.71	30	1	6	
<i>Rubus parvifolius</i>	Small-leaf Bramble					1					0.13		1	1	1	
<i>Rubus anglocandicans</i>	Common Blackberry	*		1							0.13		1	1	1	
<i>Senecio velleioides</i>	Forest Groundsel			1	1	1					0.38	0.00	1	1	3	
<i>Tetrarrhena juncea</i>	Forest Wire-grass						1	1	1	1	0.50	0.00	1	1	4	
<i>Tetralthea ciliata</i>	Pink-bells									1	0.13		1	1	1	
<i>Eucalyptus radiata</i> subsp. <i>radiata</i>	Narrow-leaf Peppermint						10	1	35	30	9.50	16.15	35	1	4	
<i>Monotoca glauca</i>	Currant-wood	r		1		1			45	50	12.13	26.92	50	1	4	
<i>Hydrocotyle</i> spp.	Pennywort				1						0.13		1	1	1	
<i>Pterostylis</i> spp.	Greenhood					1					0.13		1	1	1	
Bare ground			1	1	5	5	5	1	1	1	2.50	2.07	5	1	8	
Litter			40	50	35	30	25	35	45	80	42.50	17.11	80	25	8	
oss			20	30	15	30	1	5	1	5	13.38	12.22	30	1	8	

Site Name	T8	Site Location	Located at unnamed tributary of Dividing Creek immediately south of Westwood Track ~250 m west of intersection with Westwood Road
Latitude GDA94	-38.4429	VBA Survey ID	1084233
Longitude GDA94	143.68372	VBA Site ID	715614
Geology	Confined		
Ref/Imp	Impact		

Recorded Information			Summary information												
Scientific Name	Common Name	Conservation Status	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Average	Std Dev	Max	Min	No quads
<i>Acacia verticillata</i>	Prickly Moses					1	1			1	0.38	0.00	1	1	3
<i>Acaena novae-zelandiae</i>	Bidgee-widgee			1	1	1					0.38	0.00	1	1	3
<i>Amperea xiphoclada</i> var. <i>xiphoclada</i>	Broom Spurge					1					0.13		1	1	1
<i>Anthoxanthum odoratum</i>	Sweet Vernal-grass	*		1							0.13		1	1	1
<i>Asperula scoparia</i> subsp. <i>scoparia</i>	Prickly Woodruff			1							0.13		1	1	1
<i>Asplenium flabellifolium</i>	Necklace Fern			1	1	1	1				0.50	0.00	1	1	4
<i>Blechnum nudum</i>	Fishbone Water-fern		40	35	20	10	25	10	15	5	20.00	12.54	40	5	8
<i>Blechnum waltzii</i>	Hard Water-fern		1	1	1						0.38	0.00	1	1	3
<i>Clematis aristata</i>	Mountain Clematis			1							0.13		1	1	1
<i>Coprosma quadrifida</i>	Prickly Currant-bush		1		1						0.25		1	1	2
<i>Calochlaena dubia</i>	Common Ground-fern		10			1					1.38		10	1	2
<i>Dianella tasmanica</i>	Tasman Flax-lily							5	5		1.25		5	5	2
<i>Dicksonia antarctica</i>	Soft Tree-fern				15	1	15				3.88	8.08	15	1	3
<i>Eucalyptus brookeriana</i>	Brooker's Gum	r		1		1		5			0.88	2.31	5	1	3
<i>Eucalyptus obliqua</i>	Messmate Stringybark								25	5	3.75		25	5	2
<i>Gahnia sieberiana</i>	Red-fruit Saw-sedge		5	1	5	20	10	15	35	5	12.00	11.17	35	1	8
<i>Gonocarpus tetragynus</i>	Common Raspwort				1		1				0.25		1	1	2
<i>Hydrocotyle hirta</i>	Hairy Pennywort		1	1	1	1	1	1			0.75	0.00	1	1	6
<i>Lepidosperma elatius</i>	Tall Sword-sedge				1		1	5	5	25	4.63	10.04	25	1	5
<i>Leptospermum lanigerum</i>	Woolly Tea-tree			5							0.63		5	5	1
<i>Melaleuca squarrosa</i>	Scented Paperbark		20	20	10	10	10	1	1	5	9.63	7.42	20	1	8
<i>Poa tenera</i>	Slender Tussock-grass		1	5	10	10	15	10	10	20	10.13	5.74	20	1	8
<i>Poranthera microphylla</i> s.l.	Small Poranthera					1					0.13		1	1	1
<i>Pteridium esculentum</i>	Austral Bracken					1			10	5	2.00	4.51	10	1	3
<i>Rubus parvifolius</i>	Small-leaf Bramble			1							0.13		1	1	1
<i>Rubus anglocandicans</i>	Common Blackberry	*	1	1							0.25		1	1	2
<i>Senecio glomeratus</i>	Annual Fireweed		1	5	1	1	1				1.13	1.79	5	1	5
<i>Senecio minimus</i>	Shrubby Fireweed			1	1	1	1	1			0.63	0.00	1	1	5
<i>Tetrarrhena juncea</i>	Forest Wire-grass		1	1	10	10	15	5	10	15	8.38	5.55	15	1	8
<i>Viola hederacea</i> sensu Entwisle (1996)	Ivy-leaf Violet		1	1	1	1	1	1			0.75	0.00	1	1	6
<i>Geranium</i> sp. 2	Variable Crane's-bill					1		1			0.25		1	1	2

Vegetation Monitoring Report



<i>Scientific Name</i>	Common Name	Conservation Status	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Average	Std Dev	Max	Min	No quads
Bare ground			1	1	1	1	1	5	1	1	1.50	1.41	5	1	8
Litter			40	45	35	45	40	55	20	35	39.38	10.16	55	20	8
Moss			5	5	5	1	1	1	1	1	2.50	2.07	5	1	8

Site Name	T9	Site Location	located on Porcupine Creek on Pipeline Road ~ 2km north of intersection with Colac-olangolah Pipeline Track
Latitude GDA94	-38.4992	VBA Survey ID	1084231
Longitude GDA94	143.65894	VBA Site ID	715612
Geology	Confined		
Ref/Imp	Impact		

Recorded Information

Summary information

Scientific Name	Common Name	Conservation Status	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Average	Std Dev	Max	Min	No quads
<i>Acacia melanoxylon</i>	Blackwood		15	1	1	1	15	30	15	1	9.88	10.68	30	1	8
<i>Acacia verticillata</i>	Prickly Moses			1							0.13		1	1	1
<i>Acaena novae-zelandiae</i>	Bidgee-widgee			1				1	1		0.38	0.00	1	1	3
<i>Anthoxanthum odoratum</i>	Sweet Vernal-grass	*					1	1	1		0.38	0.00	1	1	3
<i>Blechnum wattsii</i>	Hard Water-fern					15	15		10		5.00	2.89	15	10	3
<i>Bursaria spinosa subsp. spinosa</i>	Sweet Bursaria		5						1	1	0.88	2.31	5	1	3
<i>Cirsium vulgare</i>	Spear Thistle	*					1				0.13		1	1	1
<i>Clematis aristata</i>	Mountain Clematis		5	5	5	1	1	1	1	1	2.50	2.07	5	1	8
<i>Coprosma quadrifida</i>	Prickly Currant-bush		15	10	10	5	5	5	1	5	7.00	4.38	15	1	8
<i>Austrocynoglossum latifolium</i>	Forest Hound's-tongue								1		0.13		1	1	1
<i>Dianella tasmanica</i>	Tasman Flax-lily			1							0.13		1	1	1
<i>Dichondra repens</i>	Kidney-weed			1		1					0.25		1	1	2
<i>Echinopogon ovatus</i>	Common Hedgehog-grass							5	5		1.25		5	5	2
<i>Eucalyptus brookeriana</i>	Brooker's Gum	r	25	40	45	30	30	25	25		27.50	8.02	45	25	7
<i>Eucalyptus obliqua</i>	Messmate Stringybark			5			10	10	10	25	7.50	7.58	25	5	5
<i>Gahnia sieberiana</i>	Red-fruit Saw-sedge		5				1			1	0.88	2.31	5	1	3
<i>Gonocarpus tetragynus</i>	Common Raspwort		1	1	1	1				1	0.63	0.00	1	1	5
<i>Goodenia lanata</i>	Trailing Goodenia									1	0.13		1	1	1
<i>Gynatrix pulchella s.l.</i>	Hemp Bush						1		1		0.25		1	1	2
<i>Holcus lanatus</i>	Yorkshire Fog	*				1	1	1			0.38	0.00	1	1	3
<i>Hypochaeris radicata</i>	Flatweed	*		1			1	1	1		0.50	0.00	1	1	4
<i>Leptospermum lanigerum</i>	Woolly Tea-tree		1								0.13		1	1	1
<i>Lomandra longifolia</i>	Spiny-headed Mat-rush		1	1						1	0.38	0.00	1	1	3
<i>Mentha australis</i>	River Mint								1		0.13		1	1	1
<i>Notelaea ligustrina</i>	Privet Mock-olive		5	5	15	1	1	1	1	1	3.75	4.89	15	1	8
<i>Olearia lirata</i>	Snowy Daisy-bush		5	10	5	1		1	1		2.88	3.60	10	1	6
<i>Olearia phlogopappa</i>	Dusty Daisy-bush								1	5	0.75		5	1	2
<i>Plantago lanceolata</i>	Ribwort	*								1	0.13		1	1	1
<i>Poa sieberiana</i>	Grey Tussock-grass			1	1			1	1		0.50	0.00	1	1	4
<i>Poa tenera</i>	Slender Tussock-grass			1	1	1	1		1	5	1.25	1.63	5	1	6

Scientific Name	Common Name	Conservation Status	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Average	Std Dev	Max	Min	No quads
<i>Pomaderris aspera</i>	Hazel Pomaderris			10	10	15	10	10	5	15	9.38	3.45	15	5	7
<i>Pteridium esculentum</i>	Austral Bracken		1	1	1		1	1	1	15	2.63	5.29	15	1	7
<i>Rubus parvifolius</i>	Small-leaf Bramble				1			1	1		0.38	0.00	1	1	3
<i>Senecio velleioides</i>	Forest Groundsel			1		1		1	1	1	0.63	0.00	1	1	5
<i>Tetrarrhena juncea</i>	Forest Wire-grass		1	1	1	1	1	1	5	5	2.00	1.85	5	1	8
<i>Eucalyptus radiata subsp. radiata</i>	Narrow-leaf Peppermint									5	0.63		5	5	1
<i>Viola hederacea sensu Entwisle (1996)</i>	Ivy-leaf Violet			1		1	1	1	1	1	0.75	0.00	1	1	6
<i>Geranium sp. 2</i>	Variable Crane's-bill		1	1		1	1	1	1		0.75	0.00	1	1	6
<i>Asperula spp.</i>	Woodruff				1			1		1	0.38	0.00	1	1	3
<i>Centaureum spp.</i>	Centaury	*							1		0.13		1	1	1
<i>Corybas spp.</i>	Helmet Orchid		1	1							0.25		1	1	2
<i>Oxalis spp.</i>	Wood Sorrel			1		1	1	1	1	1	0.75	0.00	1	1	6
<i>Lotus spp. (naturalised)</i>	Trefoil	*				1			1		0.25		1	1	2
Bare ground			5	5	5	5	5	5	10	5	5.63	1.77	10	5	8
Litter			50	55	55	50	45	40	35	50	47.50	7.07	55	35	8
Moss			1	1	1	5	10	5	5	1	3.63	3.25	10	1	8

Site Name	T10	Site Location	located on Porcupine Creek on Pipeline Road ~ 2km north of intersection with Colac-olangolah Pipeline Track	
Latitude GDA94	-38.4597	VBA Survey ID	1084239	
Longitude GDA94	143.61789	VBA Site ID	715620	
Geology	Confined			
Ref/Imp	Impact			

Recorded Information

Summary information

Scientific Name	Common Name	Conservation Status	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Average	Std Dev	Max	Min	No quads
<i>Acacia verticillata</i>	Prickly Moses		1								0.13		1	1	1
<i>Adiantum aethiopicum</i>	Common Maidenhair						1	1		5	0.88	2.31	5	1	3
<i>Amperea xiphoclada</i> var. <i>xiphoclada</i>	Broom Spurge									1	0.13		1	1	1
<i>Banksia marginata</i>	Silver Banksia									1	0.13		1	1	1
<i>Dianella tasmanica</i>	Tasman Flax-lily								1		0.13		1	1	1
<i>Drosera auriculata</i>	Tall Sundew								1		0.13		1	1	1
<i>Empodisma minus</i>	Spreading Rope-rush						5	1	1	1	1.00	2.00	5	1	4
<i>Eucalyptus ovata</i>	Swamp Gum		1			30	5	1	10		5.88	12.10	30	1	5
<i>Gahnia sieberiana</i>	Red-fruit Saw-sedge		50	35	10	5	5	10	15	30	20.00	16.48	50	5	8
<i>Gonocarpus tetragynus</i>	Common Raspwort						1	1	1		0.38	0.00	1	1	3
<i>Goodenia humilis</i>	Swamp Goodenia									1	0.13		1	1	1
<i>Lepidosperma elatius</i>	Tall Sword-sedge		5	1	30	35	10	25	10		14.50	13.25	35	1	7
<i>Leptospermum lanigerum</i>	Woolly Tea-tree		50	60	60	45	45	50	35	40	48.13	8.84	60	35	8
<i>Lomandra longifolia</i>	Spiny-headed Mat-rush						10	1		1	1.50	5.20	10	1	3
<i>Melaleuca squarrosa</i>	Scented Paperbark		5	5	5	5	5	5	5	5	5.00	0.00	5	5	8
<i>Poa tenera</i>	Slender Tussock-grass							1	1	1	0.38	0.00	1	1	3
<i>Pteridium esculentum</i>	Austral Bracken		1			1	5	1	1	5	1.75	2.07	5	1	6
<i>Eucalyptus radiata</i> subsp. <i>radiata</i>	Narrow-leaf Peppermint						5			5	1.25		5	5	2
<i>Monotoca glauca</i>	Currant-wood	r					1		10	5	2.00	4.51	10	1	3
<i>Billardiera mutabilis</i>	Common Apple-berry										0.00		0	0	0
<i>Viola hederacea</i> sensu Entwisle (1996)	Ivy-leaf Violet						1	1			0.25		1	1	2
Bare ground			1	1	1	1	1	1	1	1	1.00	0.00	1	1	8
Litter			45	70	65	55	50	45	40	40	51.25	11.26	70	40	8
Moss			1	1	1	1	10	5	5	10	4.25	3.96	10	1	8

Site Name	T11	Site Location	Located at Porcupine Creek immediately east of crossing of Pipeline Road	
Latitude GDA94	-38.4849	VBA Survey ID	1084205	
Longitude GDA94	143.64186	VBA Site ID	715586	
Geology	Confined			
Ref/Imp	Reference			

Recorded Information

Summary information

Scientific Name	Common Name	Conservation Status	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Average	Std Dev	Max	Min	No quads
<i>Acacia melanoxylon</i>	Blackwood									1	0.13		1	1	1
<i>Acacia verticillata</i>	Prickly Moses		1	1				1	5	5	1.63	2.19	5	1	5
<i>Acaena novae-zelandiae</i>	Bidgee-widgee		1								0.13		1	1	1
<i>Amyema pendula</i>	Drooping Mistletoe			1		1			1	1	0.50	0.00	1	1	4
<i>Banksia marginata</i>	Silver Banksia									1	0.13		1	1	1
<i>Blechnum nudum</i>	Fishbone Water-fern					1	5	5		1	1.50	2.31	5	1	4
<i>Blechnum wattsii</i>	Hard Water-fern		5	1	20	10	20	30	55		17.63	18.31	55	1	7
<i>Cyathea australis</i>	Rough Tree-fern			1		15	1	5			2.75	6.61	15	1	4
<i>Dianella tasmanica</i>	Tasman Flax-lily		1	1	1	5	1	1	1	5	2.00	1.85	5	1	8
<i>Dichondra repens</i>	Kidney-weed									1	0.13		1	1	1
<i>Eucalyptus brookeriana</i>	Brooker's Gum	r		10							1.25		10	10	1
<i>Eucalyptus obliqua</i>	Messmate Stringybark		20		5			5		25	6.88	10.31	25	5	4
<i>Eucalyptus ovata</i>	Swamp Gum		20	30	30	30	15	10	10	10	19.38	9.43	30	10	8
<i>Eucalyptus viminalis</i>	Manna Gum						20	25	25	5	9.38	9.46	25	5	4
<i>Gahnia sieberiana</i>	Red-fruit Saw-sedge			20	1	1	20	20	5	10	9.63	8.94	20	1	7
<i>Gonocarpus tetragynus</i>	Common Raspwort				1					1	0.25		1	1	2
<i>Goodenia lanata</i>	Trailing Goodenia									1	0.13		1	1	1
<i>Lepidosperma elatius</i>	Tall Sword-sedge		15	5	15	10	5	5	5	10	8.75	4.43	15	5	8
<i>Leptospermum continentale</i>	Prickly Tea-tree									1	0.13		1	1	1
<i>Melaleuca squarrosa</i>	Scented Paperbark		1	10	15	15	10	5	1	10	8.38	5.55	15	1	8
<i>Olearia lirata</i>	Snowy Daisy-bush			5						1	0.75		5	1	2
<i>Poa tenera</i>	Slender Tussock-grass						1		1	1	0.38	0.00	1	1	3
<i>Pteridium esculentum</i>	Austral Bracken		15	10		1	5	15	10	10	8.25	5.06	15	1	7
<i>Stellaria pungens</i>	Prickly Starwort			1							0.13		1	1	1
<i>Tetrarrhena juncea</i>	Forest Wire-grass		10	10	10	15	15	10	5	5	10.00	3.78	15	5	8
<i>Viola hederacea sensu Entwisle (1996)</i>	Ivy-leaf Violet			1							0.13		1	1	1
<i>Geranium spp.</i>	Crane's Bill							1			0.13		1	1	1
<i>Hydrocotyle spp.</i>	Pennywort					1					0.13		1	1	1
Bare ground			1	1	5	1	1	1	1	1	1.50	1.41	5	1	8
Litter			40	35	35	40	30	30	40	35	35.63	4.17	40	30	8
Moss			1	1	5	1	1	1	1	1	1.50	1.41	5	1	8

Site Name	T12	Site Location	In Otway Forest Park on northern side of Gold Hole Road at un-named tributary of Dividing Creek
Latitude GDA94	-38.457	VBA Survey ID	1083235
Longitude GDA94	143.6493	VBA Site ID	714870
Geology	Confined		
Ref/Imp	Reference		

Recorded Information

Summary information

Scientific Name	Common Name	Conservation Status	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Average	Std Dev	Max	Min	No quads
<i>Acacia mucronata</i> subsp. <i>longifolia</i>	Narrow-leaf Wattle			1			5	1	5		1.50	2.31	5	1	4
<i>Asplenium flabellifolium</i>	Necklace Fern					1	1	1			0.38	0.00	1	1	3
<i>Bedfordia arborescens</i>	Blanket Leaf						1				0.13		1	1	1
<i>Blechnum nudum</i>	Fishbone Water-fern			1	5	1					0.88	2.31	5	1	3
<i>Blechnum wattsii</i>	Hard Water-fern						1				0.13		1	1	1
<i>Cyathea australis</i>	Rough Tree-fern				30	1				1	4.00	16.74	30	1	3
<i>Dianella tasmanica</i>	Tasman Flax-lily		1	1	1	1	1	1	1	1	1.00	0.00	1	1	8
<i>Empodisma minus</i>	Spreading Rope-rush		1								0.13		1	1	1
<i>Eucalyptus ovata</i>	Swamp Gum		25	20	5	25	30	15	10	10	17.50	8.86	30	5	8
<i>Gahnia sieberiana</i>	Red-fruit Saw-sedge		5	1	10	30	5				6.38	11.52	30	1	5
<i>Gleichenia dicarpa/microphylla</i>	Coral-fern			1	5	5					1.38	2.31	5	1	3
<i>Lepidosperma elatius</i>	Tall Sword-sedge		1	10	1						1.50	5.20	10	1	3
<i>Leptospermum continentale</i>	Prickly Tea-tree		1	1	1	1	1	1	1	1	1.00	0.00	1	1	8
<i>Leptospermum lanigerum</i>	Woolly Tea-tree					1					0.13		1	1	1
<i>Melaleuca squarrosa</i>	Scented Paperbark		5	5		10	1	1			2.75	3.71	10	1	5
<i>Poa tenera</i>	Slender Tussock-grass		1	1	20	1	5	1	1	1	3.88	6.66	20	1	8
<i>Senecio velleioides</i>	Forest Groundsel		1		1	1	1				0.50	0.00	1	1	4
<i>Stellaria pungens</i>	Prickly Starwort			1		1					0.25		1	1	2
<i>Galium</i> spp.	Bedstraw							1	1	1	0.38	0.00	1	1	3
<i>Acacia melanoxylon</i>	Blackwood										0.00		0	0	0
<i>Acacia verticillata</i>	Prickly Moses		20	10	10	10	10	50	5	15	16.25	14.33	50	5	8
<i>Acaena novae-zelandiae</i>	Bidgee-widgee		1		1	5	1	1	1	1	1.38	1.51	5	1	7
<i>Asperula conferta</i>	Common Woodruff			1		1	1				0.38	0.00	1	1	3
<i>Cassinia longifolia</i>	Shiny Cassinia			1							0.13		1	1	1
<i>Cassytha pubescens</i> s.s.	Downy Dodder-laurel							1	1	1	0.38	0.00	1	1	3
<i>Cirsium vulgare</i>	Spear Thistle	*		1							0.13		1	1	1
<i>Geranium potentilloides</i>	Soft Crane's-bill		1	1	1	1	1	1	1	1	1.00	0.00	1	1	8
<i>Gonocarpus tetragynus</i>	Common Raspwort		1	1	1	1	5	1	1	1	1.50	1.41	5	1	8
<i>Hypericum gramineum</i> spp. agg.	Small St John's Wort			1	1	1	1	1			0.63	0.00	1	1	5
<i>Lomandra longifolia</i>	Spiny-headed Mat-rush						1	30	50	45	15.75	22.04	50	1	4

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<i>Olearia lirata</i>	Snowy Daisy-bush				1	1	5	1		1	1.13	1.79	5	1	5
<i>Pteridium esculentum</i>	Austral Bracken		30	25	1	1	25	15	15	20	16.50	10.85	30	1	8
<i>Pultenaea gunnii</i>	Golden Bush-pea		1		1	1		1			0.50	0.00	1	1	4
<i>Rubus anglocandicans</i>	Common Blackberry	*				1					0.13		1	1	1
Scientific Name	Common Name	Conservation Status	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Average	Std Dev	Max	Min	No quads
<i>Senecio tenuiflorus</i> spp. agg.	Slender Fireweed			1	1	1	1	1			0.63	0.00	1	1	5
<i>Tetrarrhena juncea</i>	Forest Wire-grass		5	10	10	20	30	10	10	5	12.50	8.45	30	5	8
<i>Eucalyptus radiata</i> subsp. <i>radiata</i>	Narrow-leaf Peppermint							10	20	10	5.00	5.77	20	10	3
<i>Billardiera mutabilis</i>	Common Apple-berry							1	1	1	0.38	0.00	1	1	3
<i>Epacris impressa</i> var. <i>impressa</i>	Common Heath						1		1		0.25		1	1	2
<i>Viola hederacea</i> sensu Entwisle (1996)	Ivy-leaf Violet		1	1	1	1	1	1	1	1	1.00	0.00	1	1	8
<i>Oxalis</i> spp.	Wood Sorrel		1	1	1	1	1	1	1	1	1.00	0.00	1	1	8
<i>Lotus</i> spp. (naturalised)	Trefoil					1					0.13		1	1	1
Bare ground			5	5	5	5	5	1	1	1	3.50	2.07	5	1	8
Litter			45	20	25	25	25	40	40	30	31.25	9.16	45	20	8
Moss			5	10	10	1	5	5	1	1	4.75	3.73	10	1	8

Site Name	T13	Site Location	on North side of Parkes Lodge Rd ~200m north of Mcdonalds Road intersection	
Latitude GDA94	-38.4682	VBA Survey ID	1083896	
Longitude GDA94	143.63163	VBA Site ID	715424	
Geology	Confined			
Ref/Imp	Reference			

Recorded Information

Summary information

Scientific Name	Common Name	Conservation Status	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Average	Std Dev	Max	Min	No quads
<i>Acrotriche prostrata</i>	Trailing Ground-berry									1	0.13		1	1	1
<i>Adiantum aethiopicum</i>	Common Maidenhair		1								0.13		1	1	1
<i>Anogramma leptophylla</i>	Annual Fern			1		1		1	1		0.50	0.00	1	1	4
<i>Cassytha pubescens</i> s.s.	Downy Dodder-laurel		1	1	1	1	1	1	1	1	1.00	0.00	1	1	8
<i>Allocasuarina paludosa</i>	Scrub Sheoak		5	20	35	20	15	15	25	20	19.38	8.63	35	5	8
<i>Caustis flexuosa</i>	Curly Wig		1	5	5	5	1	5	10	10	5.25	3.41	10	1	8
<i>Empodisma minus</i>	Spreading Rope-rush									1	0.13		1	1	1
<i>Epacris lanuginosa</i>	Woolly-style Heath							1	1	5	0.88	2.31	5	1	3
<i>Eucalyptus ovata</i>	Swamp Gum		5	5	1	1			1	1	1.75	2.07	5	1	6
<i>Gahnia radula</i>	Thatch Saw-sedge		1		1			5	1	5	1.63	2.19	5	1	5
<i>Lepidosperma laterale</i>	Variable Sword-sedge		5	10	5	10	20	5	1	1	7.13	6.22	20	1	8
<i>Leptospermum continentale</i>	Prickly Tea-tree		60	40	20	5	20	20	15	15	24.38	17.41	60	5	8
<i>Leucopogon virgatus</i>	Common Beard-heath						1		1	1	0.38	0.00	1	1	3
<i>Melaleuca squarrosa</i>	Scented Paperbark							1			0.13		1	1	1
<i>Pultenaea gunnii</i>	Golden Bush-pea								1	1	0.25		1	1	2
<i>Selaginella uliginosa</i>	Swamp Selaginella		1	1	1	1	1	1	1	1	1.00	0.00	1	1	8
<i>Sprengelia incarnata</i>	Pink Swamp-heath		1	1	1	1	1	1	1	1	1.00	0.00	1	1	8
<i>Tetrarrhena distichophylla</i>	Hairy Rice-grass								1		0.13		1	1	1
<i>Wahlenbergia stricta</i> subsp. <i>stricta</i>	Tall Bluebell						1	1			0.25		1	1	2
<i>Gonocarpus micranthus</i>	Creeping Raspwort		1	1	1	1	1	1	1	1	1.00	0.00	1	1	8
<i>Billardiera mutabilis</i>	Common Apple-berry		1	1							0.25		1	1	2
<i>Epacris impressa</i> var. <i>impressa</i>	Common Heath				1			1	1	1	0.50	0.00	1	1	4
<i>Lepidosperma gunnii</i>	Slender Sword-sedge								5	15	2.50		15	5	2
<i>Viola hederacea</i> sensu Entwisle (1996)	Ivy-leaf Violet						1	1	1	1	0.50	0.00	1	1	4
Bare ground			20	20	20	10	10	10	5	5	12.50	6.55	20	5	8
Litter			15	15	15	25	20	25	15	15	18.13	4.58	25	15	8
Moss			1	1	1	1	1	1	1	1	1.00	0.00	1	1	8

Site Name	T14	Site Location	Located east of Robinson Road approximately 150 m north of intersection with Cashin's Road	
Latitude GDA94	-38.4592	VBA Survey ID	1084204	
Longitude GDA94	143.59752	VBA Site ID	715585	
Geology	Confined			
Ref/Imp	Reference			

Recorded Information

Summary information

Scientific Name	Common Name	Conservation Status	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Average	Std Dev	Max	Min	No quads
<i>Acacia dealbata</i>	Silver Wattle							1			0.13		1	1	1
<i>Acacia melanoxylon</i>	Blackwood								1		0.13		1	1	1
<i>Adiantum aethiopicum</i>	Common Maidenhair									1	0.13		1	1	1
<i>Blechnum nudum</i>	Fishbone Water-fern		20	10	5	5	20	10	10	20	12.50	6.55	20	5	8
<i>Cyathea australis</i>	Rough Tree-fern									10	1.25		10	10	1
<i>Dicksonia antarctica</i>	Soft Tree-fern								5	5	1.25		5	5	2
<i>Eucalyptus obliqua</i>	Messmate Stringybark		25								3.13		25	25	1
<i>Eucalyptus viminalis</i>	Manna Gum		10	30	30	35	30	30	10	5	22.50	11.95	35	5	8
<i>Gahnia radula</i>	Thatch Saw-sedge			5	1	30	15	5	20		9.50	11.08	30	1	6
<i>Gleichenia dicarpa/microphylla</i>	Coral-fern		25	20	25	5	10	30	20	10	18.13	8.84	30	5	8
<i>Lepidosperma elatius</i>	Tall Sword-sedge		5		1		1				0.88	2.31	5	1	3
<i>Melaleuca squarrosa</i>	Scented Paperbark		30	25	40	25	45	20	30	45	32.50	9.64	45	20	8
<i>Mentha laxiflora</i>	Forest Mint									1	0.13		1	1	1
<i>Poa tenera</i>	Slender Tussock-grass				1						0.13		1	1	1
<i>Polystichum proliferum</i>	Mother Shield-fern		5	30	10						5.63	13.23	30	5	3
<i>Pteridium esculentum</i>	Austral Bracken			1						1	0.25		1	1	2
<i>Rubus parvifolius</i>	Small-leaf Bramble							1			0.13		1	1	1
<i>Rubus anglocandicans</i>	Common Blackberry	*							1		0.13		1	1	1
<i>Tetrarrhena juncea</i>	Forest Wire-grass		1	1	1	1	1	5	1	1	1.50	1.41	5	1	8
<i>Monotoca glauca</i>	Currant-wood	r						10	5		1.88		10	5	2
<i>Brachyscome</i> spp.	Daisy			1							0.13		1	1	1
<i>Pterostylis</i> spp.	Greenhood					1					0.13		1	1	1
Bare ground			1	1	5	5		1	10	10	4.13	4.03	10	1	7
Litter			50	50	60	65	60	45	40	50	52.50	8.45	65	40	8
Moss			1	5	1	5	1	5	1	5	3.00	2.14	5	1	8

Appendix D. Statistical outputs

D.1 One Way Anova

Unconfined - total cover		With T3						
Impact	Reference	Anova: Single Factor						
85.25	76.75							
104.5	104.625	SUMMARY						
60.75	83.75	<i>Groups</i>	<i>Count</i>	<i>Sum</i>	<i>Average</i>	<i>Variance</i>		
90.375		Impact	4	340.875	85.21875	332.3581		
		Reference	3	265.125	88.375	210.2969		
		ANOVA						
		<i>Source of Variation</i>	<i>SS</i>	<i>df</i>	<i>MS</i>	<i>F</i>	<i>P-value</i>	<i>F crit</i>
		Between Groups	17.07757	1	17.07757	0.060231	0.815886	6.607891
		Within Groups	1417.668	5	283.5336			
		Total	1434.746	6				

Unconfined - proportion		With T3						
Impact	Reference	Anova: Single Factor						
0.778539	0.863572							
0.93617	0.750673	SUMMARY						
1	0.876963	<i>Groups</i>	<i>Count</i>	<i>Sum</i>	<i>Average</i>	<i>Variance</i>		
0.828179		Impact	4	3.542888	0.885722	0.010135		
		Reference	3	2.491208	0.830403	0.004813		
		ANOVA						
		<i>Source of Variation</i>	<i>SS</i>	<i>df</i>	<i>MS</i>	<i>F</i>	<i>P-value</i>	<i>F crit</i>
		Between Groups	0.005246	1	0.005246	0.655284	0.455011	6.607891
		Within Groups	0.040029	5	0.008006			
		Total	0.045275	6				

Unconfined - total cover		Without T3						
Impact	Reference	Anova: Single Factor						
85.25	76.75							
104.5	104.625	SUMMARY						
90.375	83.75	Groups	Count	Sum	Average	Variance		
		Impact	3	280.125	93.375	99.39063		
		Reference	3	265.125	88.375	210.2969		
		ANOVA						
		Source of Variation	SS	df	MS	F	P-value	F crit
		Between Groups	37.5	1	37.5	0.24218	0.648422	7.708647
		Within Groups	619.375	4	154.8438			
		Total	656.875	5				

Unconfined - proportion		Without T3						
Impact	Reference	Anova: Single Factor						
0.778539	0.863572							
0.93617	0.750673	SUMMARY						
0.828179	0.876963	<i>Groups</i>	<i>Count</i>	<i>Sum</i>	<i>Average</i>	<i>Variance</i>		
		Impact	3	2.542888	0.847629	0.006496		
		Reference	3	2.491208	0.830403	0.004813		
		ANOVA						
		<i>Source of Variation</i>	<i>SS</i>	<i>df</i>	<i>MS</i>	<i>F</i>	<i>P-value</i>	<i>F crit</i>
		Between Groups	0.000445	1	0.000445	0.078726	0.792945	7.708647
		Within Groups	0.022616	4	0.005654			
		Total	0.023061	5				

Confined -total cover		With T14						
Impact	Reference		Anova: Single Factor					
66	81.5							
51.625	43.75		SUMMARY					
98	67.125		<i>Groups</i>	<i>Count</i>	<i>Sum</i>	<i>Average</i>	<i>Variance</i>	
	106.5		Impact	3	215.625	71.875	563.5469	
			Reference	3	192.375	64.125	363.0156	
			ANOVA					
			<i>Source of Variation</i>	<i>SS</i>	<i>df</i>	<i>MS</i>	<i>F</i>	<i>P-value</i>
			Between Groups	90.09375	1	90.09375	0.194469	0.68201
			Within Groups	1853.125	4	463.2813		7.708647
			Total	1943.219	5			

Confined -proportion		With T14						
Impact	Reference		Anova: Single Factor					
0.77533	0.737557							
0.546296	0.363448		SUMMARY					
0.945718	0.957219		<i>Groups</i>	<i>Count</i>	<i>Sum</i>	<i>Average</i>	<i>Variance</i>	
	0.950893		Impact	3	2.267344	0.755781	0.040171	
			Reference	4	3.009116	0.752279	0.077618	
			ANOVA					
			<i>Source of Variation</i>	<i>SS</i>	<i>df</i>	<i>MS</i>	<i>F</i>	<i>P-value</i>
			Between Groups	2.1E-05	1	2.1E-05	0.000336	0.98609
			Within Groups	0.313197	5	0.062639		6.607891
			Total	0.313218	6			

Confined -total cover		Without T14							
Impact	Reference	Anova: Single Factor							
66	81.5								
51.625	43.75	SUMMARY							
98	67.125	Groups	Count	Sum	Average	Variance			
		Impact	3	215.625	71.875	563.5469			
		Reference	3	192.375	64.125	363.0156			
		ANOVA							
		Source of Variation	SS	df	MS	F	P-value	F crit	
		Between Groups	90.09375	1	90.09375	0.194469	0.68201	7.708647	
		Within Groups	1853.125	4	463.2813				
		Total	1943.219	5					

Confined -proportion		Without T14						
Impact	Reference	Anova: Single Factor						
0.77533	0.737557							
0.546296	0.363448	SUMMARY						
0.945718	0.957219	Groups	Count	Sum	Average	Variance		
		Impact	3	2.267344	0.755781	0.040171		
		Reference	3	2.058223	0.686074	0.090129		
		ANOVA						
		Source of Varia	SS	df	MS	F	P-value	F crit
		Between G	0.007289	1	0.007289	0.111874	0.754823	7.708647
		Within Gro	0.2606	4	0.06515			
		Total	0.267889	5				

D.2 Two Way ANOVAs

Total cover GW dependant vegetation- no T3 or T14						
		Geology				
	Ref/Imp	Confined	Unconfined			
	Impact	66	85.25			
		51.625	104.5			
		98	90.375			
	Reference	81.5	76.75			
		43.75	104.625			
		67.125	83.75			
Anova: Two-Factor With Replication						
SUMMARY	Confined	Unconfined	Total			
<i>Impact</i>						
Count	3	3	6			
Sum	215.625	280.125	495.75			
Average	71.875	93.375	82.625			
Variance	563.5469	99.39063	403.85			
<i>Reference</i>						
Count	3	3	6			
Sum	192.375	265.125	457.5			
Average	64.125	88.375	76.25			
Variance	363.0156	210.2969	405.7438			
<i>Total</i>						
Count	6	6				
Sum	408	545.25				
Average	68	90.875				
Variance	388.6438	131.375				
ANOVA						
Source of Variation	SS	df	MS	F	P-value	F crit
Ref/Imp	121.9219	1	121.9219	0.394489	0.547456	5.317655
Geology	1569.797	1	1569.797	5.079221	0.054252	5.317655
Interaction	5.671875	1	5.671875	0.018352	0.895588	5.317655
Within	2472.5	8	309.0625			
Total	4169.891	11				

Gwdependent as a proportion of total vegetation - no T3 or T14						
	Geology					
	Confined	Unconfined				
Impact	0.77533	0.778539				
Impact	0.546296	0.93617				
Impact	0.945718	0.828179				
Reference	0.737557	0.863572				
Reference	0.363448	0.750673				
Reference	0.957219	0.876963				
Anova: Two-Factor With Replication						
SUMMARY	Confined	Unconfined	Total			
<i>Impact</i>						
Count	3	3	6			
Sum	2.267344	2.542888	4.810232			
Average	0.755781	0.847629	0.801705			
Variance	0.040171	0.006496	0.021197			
<i>Reference</i>						
Count	3	3	6			
Sum	2.058223	2.491208	4.549432			
Average	0.686074	0.830403	0.758239			
Variance	0.090129	0.004813	0.044226			
<i>Total</i>						
Count	6	6				
Sum	4.325568	5.034096				
Average	0.720928	0.839016				
Variance	0.053578	0.004612				
ANOVA						
<i>Source of Variation</i>	<i>SS</i>	<i>df</i>	<i>MS</i>	<i>F</i>	<i>P-value</i>	<i>F crit</i>
Ref/Imp	0.005668	1	0.005668	0.160106	0.699531	5.317655
Geology	0.041834	1	0.041834	1.181694	0.308676	5.317655
Interaction	0.002066	1	0.002066	0.058349	0.815202	5.317655
Within	0.283216	8	0.035402			
Total	0.332784	11				