

# **Castlemaine Botanical Gardens Flora and Fauna Reserve**

## **Environmental Management Plan**



**January 2020**



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All photographs by Karl Just except where otherwise credited.

Cover photos: Top: Castlemaine Botanical Gardens Flora and Fauna Reserve. Inset left: Eltham Copper Butterfly (*Paralucia pyrodiscus lucida*). Inset centre: Nodding Greenhood (*Pterostylis nutans*). Inset right: Yam Daisy (*Microseris walteri*).



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## 1.0 INTRODUCTION

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### 1.1 Project Background

The Castlemaine Botanical Gardens Flora and Fauna Reserve (the reserve) is situated in the north-western section of the Castlemaine Botanical Gardens (Figure 1). The reserve is of national significance for supporting a population of the endangered Eltham Copper Butterfly, while it also contains numerous other important ecological features and is a valued community asset.

The aim of this Environmental Management Plan is to identify and describe the values of the Castlemaine Botanical Gardens Flora and Fauna Reserve and to formulate a ten-year action plan to guide future management. The recently prepared Castlemaine Botanical Gardens Conservation Management Plan (CMP) included the flora and fauna reserve and provided several recommendations for this area (JPLA 2019). This document differs from the CMP in that it only includes the flora and fauna reserve and is focused on the preservation and management of ecological values.

This plan:

- Identifies the reserve's natural and recreation values.
- Establishes a vision for the reserve's future use and management.
- Identifies threats to achieving this vision.
- Identifies a series of prioritised management actions aimed at mitigating any threats and achieving the vision for the reserve.
- Establishes a monitoring and evaluation program to assess changes in the reserve's natural environment values and the success of the impact of this management plan.

The Castlemaine Botanical Gardens Flora and Fauna Reserve is crown land managed by Mount Alexander Shire Council (Council). Several community groups have provided valuable input into this plan including the Castlemaine Field Naturalists Club, Friends of the Box Ironbark Forests, Barkers Creek Landcare and Wildlife Group and Castlemaine Bush Kinder.

## 1.2 Vision Statement

The vision for the Castlemaine Botanical Gardens Flora and Fauna Reserve is to ensure the reserve's natural, cultural and recreational values are protected and managed in perpetuity. Council will work with the community to control threatening processes, manage the Eltham Copper Butterfly population and enhance the integrity of native vegetation and habitat. Trails, nature interpretation and visitor facilities will be improved and maintained to encourage passive recreation.

The following management plan outlines how this vision is to be achieved.

## 1.3 Methods for developing this plan

This management plan was prepared following a review of existing literature, community consultation and field survey.

### Background review

Key information sources that were reviewed as part of the plan preparation included:

- *Three-year schedule of works for the Castlemaine Botanic Gardens Flora and Fauna Reserve* (Just 2014) – a management schedule with accompanying maps showing the distribution of introduced (non-native) flora at the reserve.
- *Castlemaine Botanical Gardens Conservation Management Plan* (CMP) (John Patrick Landscape Architects 2019) – the CMP differs from the current plan in that although it emphasised the importance of the flora and fauna reserve and provided some recommendations, it mainly focused on the exotic elements of the gardens.
- *Eltham Copper Butterfly Monitoring Plan for the Castlemaine Botanical Gardens* (Bayes 2011)
- *Management guidelines for the Eltham Copper Butterfly at the Castlemaine Botanical Gardens* (Johnson 2001)
- *Wild plants of the Castlemaine District* (<https://www.castlemaineflora.org.au>) - an online database prepared by the late Ern Perkins that provides detailed information on the distribution and ecology of the regional flora.
- *Victorian Biodiversity Atlas (VBA)* – the flora and fauna database managed by the Department of Environment, Land, Water and Planning (DELWP).
- Mount Alexander Shire Environment Strategy 2015-2025
- Mount Alexander Shire - Council Plan (2017-2021) and Annual Plan (2019/2020)



- Mount Alexander Shire - Investing In Play 2014-2024
- Municipal Emergency Management Plan
- Mount Alexander Shire - Public Open Space Strategy (May 2016)
- Mount Alexander Shire - Walking and Cycling Strategy 2010-2020

### **Community consultation**

Several local environmental groups were invited to provide input into the current plan, including Castlemaine Field Naturalists Club (CFNC), Friends of Box Ironbark Forests (FOBIF), Barkers Creek Landcare and Wildlife Group and Castlemaine Bush Kinder.

A consultation session was run with these groups on the 25<sup>th</sup> of June 2019, where participants were given the opportunity to discuss various management issues and objectives for the reserve. A questionnaire was also provided to participants so that all feedback could be properly evaluated and documented.

### **Field survey**

This plan has been informed by numerous field surveys undertaken since 2014. This included mapping of high threat weeds in autumn 2014 (within all areas of the flora and fauna reserve with the exception of Barkers Creek and the adjacent floodplain area. During 2019, the reserve was visited on numerous occasions to fully document the ecological values of the reserve, which included compiling a list of vascular flora, bryophytes and fauna for the reserve; mapping of key features such as Ecological Vegetation Classes (EVCs), threatened species locations and Eltham Copper Butterfly hotspots and documentation of threatening processes.

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## 2.0 SITE CONTEXT

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### 2.1 Location and description

The Castlemaine Botanical Gardens Flora and Fauna Reserve is located in the north-west section of the Castlemaine Botanical Gardens, approximately 1.5 kilometres to the north-west of the Castlemaine township. The reserve is approximately 14.42 hectares in area and is bounded by Froomes Road to the north, Odgers Road to the west, Barkers Creek to the east, and the Big4 Castlemaine Gardens Holiday Park to the south.

The reserve is situated within the Goldfields Bioregion, a region that encompasses the relatively dry woodland and forest of the inland slopes of the Great Dividing Range. The reserve crown land managed by Council and is within the jurisdiction of the North Central Catchment Management Authority (NCMA).

The Castlemaine Botanical Gardens Flora and Fauna Reserve is shown in Figure 1.

### 2.2 Regional context

Lands surrounding the flora and fauna reserve are utilised for various purposes.

The remainder of the botanical gardens occurs to the east of Barkers Creek. The botanical gardens are of State Significance for containing some of Victoria's earliest horticultural plantings, including many very old trees, as well as several heritage buildings and other features (JPLA 2019). Although most of the gardens are dominated by exotic vegetation, this area still serves an important ecological function as a buffer to the flora and fauna reserve from residential and industrial lands further to the east.

Lands to the north of the flora and fauna reserve are mostly comprised of low-density residential lands, which generally support an almost continuous canopy of eucalypts, while the Barkers Creek corridor extends to the north adjacent to the Midland Highway. These vegetated lands serve as an important faunal corridor leading into the gardens. The Barkers Creek corridor south of the gardens has recently been restored through removal of willows and revegetation with indigenous trees and shrubs. This provides an important link through the urban area of Castlemaine, eventually linking with Forest and Campbells Creek downstream.



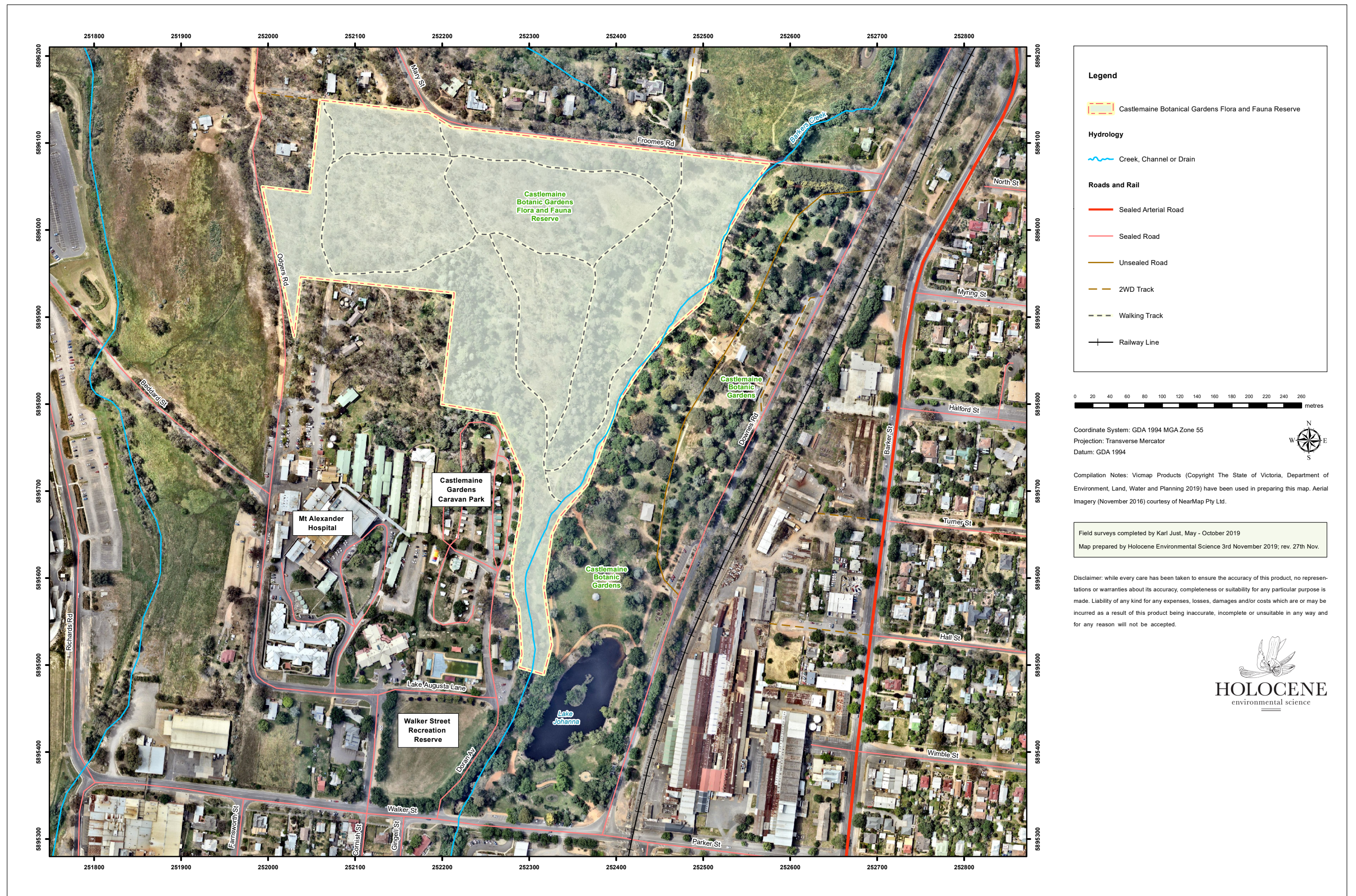


Figure 1: Castlemaine Botanical Gardens Flora and Fauna Reserve



Part of the southern boundary of the flora and fauna reserve occurs adjacent to the Big4 Castlemaine Gardens Holiday Park, a caravan park that includes a combination of cleared and developed land with scattered large planted and remnant trees. Lake Johanna, a small artificial lake that supports indigenous and introduced waterbirds, occurs to the immediate south of the reserve within the botanical gardens.

Lands to the west are mostly cleared beyond the Odgers Roadside, and the large industrial complex and car parks of the Don Factory are located less than 300m to the west.

There are many large areas of core bushland in the local area, including Kalimna Park (to the east of Castlemaine township) and bushland along the low ranges to the west. The presence of extensive bushland in the local area is an important feature for the flora and fauna reserve, particularly for fauna such as birds which move between various patches of bushland throughout the year.

## **2.3 Climate**

The closest weather station with long term data available is situated at Castlemaine, where rainfall records have been collected since 1966. The mean annual rainfall is 588mm, although there has been extreme variation over time: the wettest year on record was 970mm (1973) while the driest was 251mm (1967). Winter and spring have historically been the wettest time of year with the months of July, August and September having averages of 60.6, 66.1, and 60.7 respectively. Late summer and early autumn is the driest time of year with January, February and March having averages of 39.8, 36.3 and 33.9 respectively. However, during La Nina conditions summer can receive well above average rainfall as occurred in 2010-2011. The coolest month of the year is July with an average of 11.8C. The hottest months of the year are January and February with average maximum temperatures of 28.3C and 28.4C.

## **2.4 Policy Context**

There are a number of policy documents, independent reports and legislation that are relevant to the management and protection of the Botanical Gardens Flora and Fauna Reserve. These are discussed separately below.

### **Environment Protection and Biodiversity Conservation (EPBC) Act (1999)**

The EPBC Act is the Australian government's key piece of legislation for protecting and managing Australia's threatened species and ecological communities. As part of the Act, any action that could potentially impact on a listed species or community is deemed a 'Controlled Action' and requires approval from the federal environment minister. The Act also outlines priorities and actions for managing threatened species and communities through the preparation of Listing Advice and/or Recovery Plans. The Castlemaine Botanical Gardens Flora and Fauna Reserve supports at least one species listed as endangered under the EPBC Act – the Eltham Copper Butterfly (*Paralucia pyrodiscus lucida*). As part of its listing, Conservation Advice has been prepared for the Eltham Copper Butterfly that includes priority actions and mitigation measures for key threats.

## Flora and Fauna Guarantee (FFG) Act (1988)

The FFG Act is the Victorian government's key piece of legislation for protecting and managing Victoria's threatened species and ecological communities. As part of the Act, policy documents called 'Action Statements' are prepared for listed species and ecological communities that outline priority actions for protection and conservation.

The Castlemaine Botanical Gardens Flora and Fauna Reserve supports the following FFG values:

- Late-flowering Flax-lily (*Dianella tarda*) and Red-tipped Greenhood (*Pterostylis rubescens*), listed as *critically endangered* and *endangered* respectively.
- Creekline Grassy Woodland (Goldfields) community - (remnants along Barkers Creek)
- habitat for at least two listed fauna– the Eltham Copper Butterfly (*Paralucia pyrodiscus lucida*) and Powerful Owl (*Ninox stenua*), as well as potential habitat for several other species such as the Brush-tailed Phascogale (*Phascogale tapoatafa*).

## Biodiversity 2037

Biodiversity 2037 is a biodiversity strategy launched by the Victorian Government in 2017. The strategy has wide-reaching goals to prevent further species decline and loss of habitat across the state of Victoria. Further information on the strategy can be found at:

[https://www.environment.vic.gov.au/\\_data/assets/pdf\\_file/0018/51255/Biodiversity-2037-Summary.pdf](https://www.environment.vic.gov.au/_data/assets/pdf_file/0018/51255/Biodiversity-2037-Summary.pdf).

## Mount Alexander Environment Strategy 2015-2025

Aims and goals of Council's environment strategy include:

- **'Priority Area 1: Enable the community to take action'** Priority Area 1 recognises the great wealth of community knowledge, commitment and experience regarding natural values and sustainability and makes the commitment to support the community in taking positive action. Key strategic tasks include implementation of the grant and workshop programs and development of memoranda of understanding with key community groups.
- **'Priority Area 7 - Protect and manage priority natural environment assets'**. Priority Area 7 recognises the significant environmental assets occurring within the Shire and makes a commitment to protect and improve their ecological condition. Key strategic tasks that are listed include preparation of an open space strategy and implementation of a number of existing Council documents such as the Roadside Conservation Management Plan and Rural Land Study. It is also suggested that the planning scheme be reviewed and amended and that site management plans are prepared for priority areas.

## Walking and Cycling Strategy 2010-2020

The Walking and Cycling Strategy was developed with the aim of improving and increasing walking and cycling in the Shire over the decade.

The strategy did not assess or acknowledge any of the walking trails within the flora and fauna reserve, with the closest assessed trail being the main botanical gardens circuit to the east (designated as a 'Secondary Trail'). Although the trails within the reserve were not directly assessed, various aspects of the strategy such as the policy context and vision statement provide important guidance. For example, the strategy called for:

- "Footpaths that are developed, accessible and safe.
- Improvements in pedestrian and cycle infrastructure that will create continuous routes.
- The development of green travel plans for workplaces, schools and communities".

### 2.5 Management history

Management of the reserve's ecological values largely began following the discovery of the Eltham Copper Butterfly at the reserve in 1989. The Castlemaine Field Naturalists Club (CFNC) invested significant time and resources to control a variety of woody weeds that were rampant across the reserve, particularly Montpellier Broom (*\*Genista monspessulana*) and Flax-leaf Broom (*\*Genista linifolia*).

If it was not for these concerted efforts, the reserve would likely be in far poorer condition and it is possible the Eltham Copper Butterfly would not have survived due to blocking of flight paths and suppression of the key food plant Sweet Bursaria (*Bursaria spinosa*).

In the last 10 years, there have only been sporadic weed control works within the upper section of the reserve, including two days of woody weed control around the Eltham Copper Butterfly hotspots in 2015 (funded by DELWP) and recent work funded by Council controlling Broom species. In the last several years, Council have undertaken significant control works in the southern section of Barkers Creek and on the slopes above the creek near the pine plantation, where heavy infestations of woody weeds have been removed and the treated areas revegetated with indigenous shrubs.



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## 3.0 NATURAL VALUES

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### 3.1 Geology and landforms

The Castlemaine Botanical Gardens Flora and Fauna Reserve contains two distinct geological formations. The higher sections of the reserve above the flats of Barkers Creek are dominated by sedimentary rocks known as the 'Castlemaine Group', a combination of sandstone, siltstone, shale and chert. These rocks were formed during the Ordovician period (485-443 million years ago), at a time when much of eastern Australia was a basin submerged beneath the ocean. This basin was gradually filled with sediments, eroded off mountain ranges that were located to the west near the present-day Flinders Ranges. The basin was later uplifted out of the ocean and folded and tilted from the Devonian period (419-358 million years ago) onwards, and over time became the bedrock of the Castlemaine Group. These sediments were later intruded in the mid-Devonian by numerous gold-bearing quartz veins, and there is a relatively high concentration of quartz throughout the higher areas of the reserve. Examples of Castlemaine sedimentary rocks can be viewed along the trail above Barkers Creek, as well as within a small disused quarry in the central-eastern section.



**Plate 1** Sedimentary bedrock of the Castlemaine Group in the small disused quarry.

The other dominant geology is Quaternary Alluvium along Barkers Creek, consisting of soils that have been deposited by the creek in the last one million years. However, these soils were heavily mined during the gold rush and so have been heavily turned over and modified since European Settlement.

There is significant topographic variation within the reserve, which has its lowest point along Barkers Creek at 280m above sea level (asl), gradually rising to 330m asl in the western section.

#### **Geology – priorities and actions**

- Preserve all geological features within the Reserve, particularly cuttings that reveal cross-sections of Ordovician sediments.
- Potentially include a description of the reserve's geology in future interpretative signage.

### **3.2 Native Flora**

The Castlemaine Botanical Gardens Flora and Fauna Reserve supports a relatively high diversity of indigenous flora species. During surveys carried out in 2019, a total of 99 indigenous flora species were recorded, whilst an additional 59 indigenous species have previously been recorded within the reserve by the Castlemaine Field Naturalists Club. The total list includes a variety of floral groups including trees, shrubs, lilies, orchids, grasses and forbs.

The reserve supports at least one threatened plant species - Late-flowering Flax-lily (*Dianella tarda*), listed as *critically endangered* under the Flora and Fauna Guarantee Act 1988. This species is scattered across central Victoria and is only known from a small number of sites around Castlemaine. Late-flowering Flax-lily has declined significantly across Victoria due to widespread clearance of its preferred habitat.

The Red-tipped Greenhood (*Pterostylis rubescens*) has also been recorded historically within the reserve by the Castlemaine Field Naturalists Club. This is an autumn-flowering orchid species that is listed as *endangered* under the Flora and Fauna Guarantee Act 1988. Although the species has not been sighted in recent years it could very likely still survive.

The reserve also contains a good diversity and cover of bryophyte species, which play a major role in stabilising the soil, preventing erosion and providing areas for germination of vascular plant species (Read & Slattery 2014). A total of 13 species were recorded during the 2019 survey.





**Plate 2** Parts of the reserve support an impressive cover of wildflowers, including daisies, lilies and orchids.

### **3.3 Ecological Vegetation Classes (EVCs)**

The Castlemaine Botanical Gardens Flora and Fauna Reserve contains two different types of vegetation which are described here using the Ecological Vegetation Class (EVC) system. In Victoria, all remnant vegetation has been divided into EVCs, which are broad groupings of plant communities that are distributed according to dominant landscape features such as geology, soil type and aspect. Each EVC has a 'bioregional status' which provides an indication of how common or threatened that particular type of vegetation has become since European settlement.

#### **Box Ironbark Forest (EVC 61) – listed as *Depleted* in the Goldfields Bioregion**

Box Ironbark Forest is the dominant EVC on the hilly areas above the flats of Barkers Creek and includes the most ecologically intact areas of the reserve. This EVC typically occupies low-nutrient sedimentary soils and covers large areas of the inland slopes of the Great Dividing Range. Box Ironbark Forest is listed as *depleted* in the Goldfields bioregion.



At the Castlemaine Flora and Fauna Reserve, this vegetation is dominated by Yellow Gum (*Eucalyptus leucoxylon* ssp. *pruinosa*) and Grey Box (*Eucalyptus microcarpa*) with scattered Red Stringybark (*Eucalyptus macrorhyncha*), Yellow Box (*Eucalyptus melliodora*) and Red Box (*Eucalyptus polyanthemos* ssp. *vestita*). The understorey is dominated by low to medium heathy shrubs including Cat's Claw Grevillea (*Grevillea alpina*), Bushy Needlewood (*Hakea decurrens*), Gorse Bitter-pea (*Daviesia ulicifolia* subsp. *ruscifolia*) and Narrow-leaf Bitter-pea (*Daviesia leptophylla*), with scattered Cherry Ballart (*Exocarpos cupressiformis*). The groundflora is relatively diverse and includes daisies such as Sticky Everlasting (*Xerochrysum viscosum*), Common Everlasting (*Chrysocephalum apiculatum*) and Clustered Everlasting (*Chrysocephalum semipapposum*); lilies such as Chocolate Lily and Early Nancy (*Wurmbea dioica*); orchids such as Autumn Greenhood (*Pterostylis* sp. aff. *revoluta*), Nodding Greenhood (*Pterostylis nutans*) and Sharp Midge-orchid (*Corunastylis despectans*) and grasses such as Wallaby-grass (*Rytidosperma* spp.), Spear-grass (*Austrostipa* spp.), Kangaroo Grass (*Themeda triandra*).

There is a high cover of bryophytes across the EVC, with dominant species including Tall Beard-moss (*Leptodontium paradoxum*) and Juniper Haircap (*Polytrichum juniperinum*).



**Plate 3 Box Ironbark Forest (EVC 61) at the Castlemaine Botanical Gardens Flora and Fauna Reserve, characterised by a canopy dominated by Grey Box (*Eucalyptus microcarpa*) and Yellow Gum (*Eucalyptus leucoxylon*) with an understorey rich in peas, wattles, daisies, orchids and lilies.**

**Creekline Grassy Woodland (EVC 68) - Alluvial Terraces Herb-rich Woodland Mosaic (EVC 67) – listed as *endangered* in the Goldfields Bioregion**

Prior to the arrival of Europeans, Creekline Grassy Woodland would have occurred along Barkers Creek, whilst the adjacent alluvial flats likely supported areas of Alluvial Terraces Herb-rich Woodland. Both EVCs have been significantly cleared and degraded across Victoria due to a combination of alluvial mining, grazing pressure and weed invasion and are listed as *endangered* in the Goldfields bioregion. Creekline Grassy Woodland is also an FFG-listed community.

With the coming of the goldrush in the 1850's, all of the alluvial flats along Barkers Creek would have been dug over many times, destroying much of the native understorey. The original course of the creek has also been shifted in some areas, notably in the south, where a former bend in the creek that originally meandered to the east was straightened to allow for the construction of Lake Joanna (JPLA 2019). Despite this history of heavy disturbance, the creek and flats still support areas of remnant vegetation, including:

- scattered River Red Gum (*Eucalyptus camaldulensis*) trees along the creek, some which are very old and contain numerous hollows,
- a minor element of remnant groundflora along the creek channel, including scattered rushes (*Juncus* spp.) and small forbs such as Lesser Loose-strife (*Lythrum hyssopifolium*).
- the alluvial flats are predominately comprised of exotic pasture grasses and environmental weeds, however some areas still retain a good diversity of grasses and forbs, including Crested Spear-grass (*Austrostipa blackii*), Fine-head Spear-grass (*A. oligostachya*), Quizzical Spear-grass (*A. stuposa*), Sweet Hound's-tongue (*Cynoglossum suaveolens*), Plume-grass (*Dichelachne* spp.), Common Wheat-grass (*Anthosachne scabra*), Weeping-grass (*Microlaena stipoides*) and Wallaby-grass (*Rytidosperma* spp.).
- Several areas of the creek have been revegetated by Council in the last ten years, including a recent planting on the western bank in the southern section of the reserve. Prominent species in the revegetation include Blackwood (*Acacia melanoxylon*), Silver Wattle (*Acacia dealbata*), Spiny-headed Mat-rush (*Lomandra longifolia*) and Common Tussock-grass (*Poa labillardierei*).





**Plate 4 EVC Creekline Grassy Woodland would originally have occurred along Barkers Creek and adjacent flats but was mostly cleared during the gold rush. The area now supports scattered remnant River Red Gum trees and areas of revegetation.**

#### **Native Flora – priorities and actions**

- Control high threat weeds across the reserve.
- Consider species enrichment plantings in the bushland area.
- Manage the population of the threatened Late-flowering Flax-lily (*Dianella tarda*) including preventing disturbance, controlling weeds and possibly planting additional plants.
- Discourage off-trail walking.



### 3.4 Native fauna

The Castlemaine Botanical Gardens Flora and Fauna Reserve contains valuable habitat for a variety of fauna species, including mammals, birds, amphibians, reptiles and invertebrates. The most significant fauna species occurring at the reserve is the Eltham Copper Butterfly (*Paralucia pyrodiscus lucida*), and because this species is one of the highest management priorities, a specific chapter is provided in Section 4. The current chapter will discuss the remaining faunal values of the reserve.

The reserve would support a number of resident fauna species, as well being an important area for visiting fauna that move around the landscape in response to seasonal conditions, particularly birds. The two dominant eucalypts of the bushland section of the reserve, Yellow Gum (*Eucalyptus leucoxylon*) and Grey Box (*Eucalyptus microcarpa*), are among the highest nectar and pollen producing trees in Victoria. When these tree species are in flower over the autumn and winter months, they attract large numbers of birds, particularly honeyeaters, parrots and lorikeets. Among these is the Swift Parrot (*Lathamus discolor*), a nationally threatened species that is known to visit autumn-flowering eucalypts across the region.

There are very few hollow-bearing trees within the reserve, with the exception of several large River Red Gums along Barkers Creek, which would provide valuable nesting and roosting habitat for birds, micro-bats and possums.

Other fauna that have been known to occur within the reserve include Eastern Grey Kangaroo (*Micropus gigantetus*), Black Wallaby (*Wallabia bicolor*) and several skink and frog species. The Eastern Grey Kangaroo appears to mostly frequent the western edge of the reserve adjacent to Odgers Road, but at times pass through most of the bushland area. Breeding habitat for frogs is largely confined to Barkers Creek, although some species such as the Southern Brown Tree-frog (*Litoria ewingii*), Spotted Marsh Frog (*Limnodynastes tasmaniensis*) and Pobblebonk (*Limnodynastes dumerilii*) would frequent the reserve outside of the breeding season.

The threatened Powerful Owl (*Ninox strenua*) regularly roosts in exotic trees within the gardens to the east and occasionally breeds in a nearby River Red Gum tree. Powerful Owl pellets have been observed within the flora and fauna reserve, indicating that this species occasionally forages within the reserve.

An additional threatened species that may occasionally occur within the reserve is the Brush-tailed Phascogale (*Phascogale tapoatafa*), a hollow dependant mammal species. Although this species is unlikely to be resident due to the paucity of hollows, the males typically cover large areas during the winter breeding season in search of females and so could very likely frequent the reserve occasionally.

Installation of additional nestboxes throughout the reserve should be considered, including various designs targeting different kinds of fauna (e.g. parrot, phascogale and bat boxes).

### Native Fauna – priorities and actions

- Protect, manage and monitor the Eltham Copper Butterfly population (see Section 4).
- Install additional nest boxes throughout the reserve, including various designs targeting different kinds of fauna (e.g. parrot, phascogale and bat boxes).
- Conduct further revegetation along Barkers Creek and adjacent flats to improve fauna habitat and corridor.



**Plate 5** The threatened Powerful Owl (*Ninox strenua*) is resident within the Castlemaine Botanical Gardens (Photo by Frank Pierce).





**Plate 6** The flora and fauna reserve contains habitat for the threatened Brush-tailed Phascogale (*Phascogale tapoatafa*) (Photo by Frank Pierce).

### 3.5 Hydrology

Barkers Creek has a relatively small catchment and originates in the granite hills to the north in Harcourt. The creek flows south, passing through the botanical garden before entering Campbells Creek approximately two kilometres downstream. Notably, a large section of the creek within the gardens (including the southern half of the study area) originally meandered towards the east but this section was straightened in the 19<sup>th</sup> century to allow for the construction of Lake Joanna (JPLA 2019).

In most years, the creek only fills as a series of scattered pool, or flows for short periods over the winter-spring months before drying out over summer and autumn. However, during occasional large rain events, the creek is transformed into a fast-flowing stream and can flood across the adjacent flats. A record-breaking rain event in September 2016 led to the creek flooding across the gardens, while other notable flood events occurred in 2011, 1870 and 1889 (JPLA 2019).

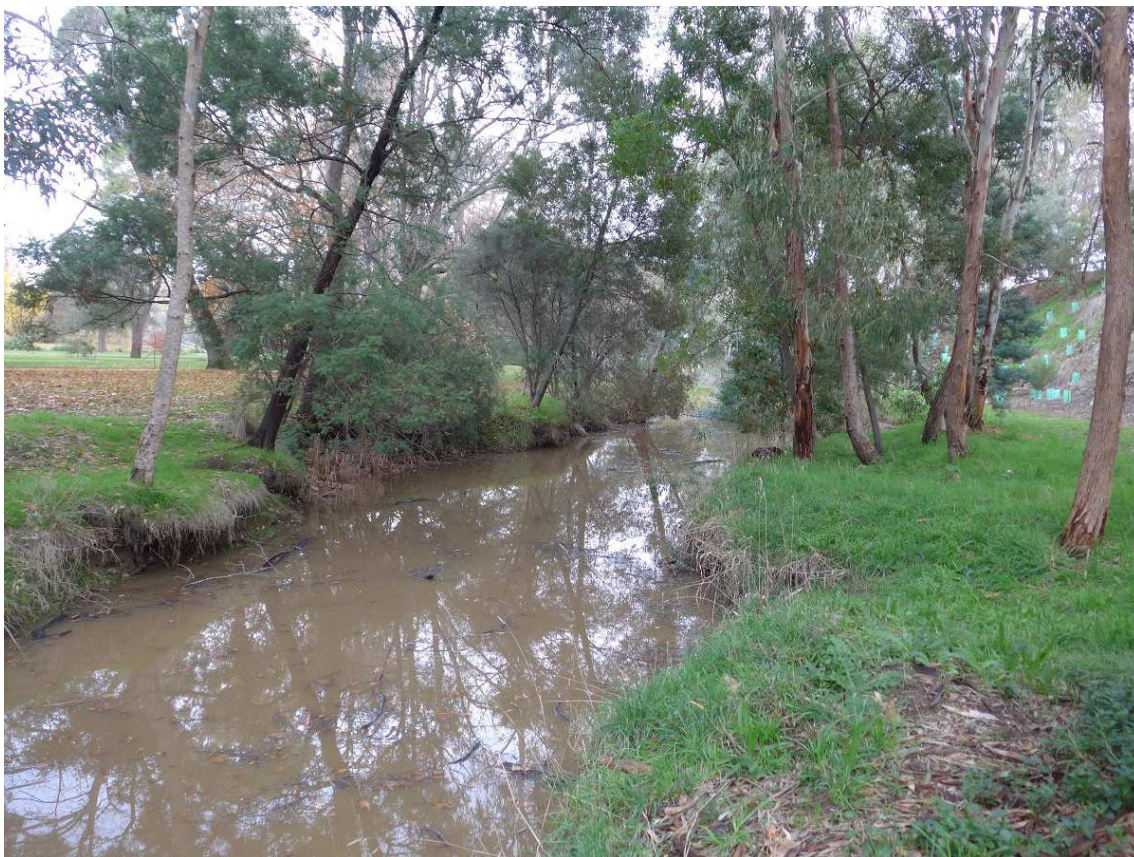
The Waterwatch program has recently begun water quality monitoring at Barkers Creek at a sampling point within the flora and fauna reserve. The results so far have showed that salinity levels, measured in electrical conductivity,

range from 446-1533 EC  $\mu\text{S}/\text{cm}$ . This indicates relatively low to medium levels of salinity (high levels are above 5000 EC  $\mu\text{S}/\text{cm}$ ). PH ranged from 5.9-7.8 and turbidity 9-24, the latter indicating that the water column can become more turbid than desired on occasion.

This is not uncommon in the local creek systems, where soil destabilisation caused by impacts of the gold mining area have led to significant erosion throughout the catchment during rain events. Properly addressing this issue is challenging, and requires catchment-wide strategies such as revegetation and fencing waterways from stock further upstream. Within the reserve, soil stabilisation can be partly addressed through further revegetation along the creek banks. Although the central section of the creek will be kept relatively open to maintain views across the gardens, patches of grasses, sedges and rushes could be established in this area.

#### **Hydrology – priorities and actions**

- Support Waterwatch monitoring.
- Report water contamination issues to the Environment Protection Authority (EPA).
- Conduct further revegetation along Barkers Creek and adjacent flats to reduce erosion of the creek banks.



**Plate 7 Barkers Creek in the central section of the reserve**



### 3.6 Invasive species

#### **Flora**

The Castlemaine Botanical Gardens Flora and Fauna Reserve supports a wide range of introduced plant species, posing one of the most serious risks to the reserve's ecological values. By the 1980's, past disturbance (such as mining and construction of trails) and lack of weed management had led to invasion of a variety of introduced plants. Following the discovery of the Eltham Copper Butterfly at the reserve, the Castlemaine Field Naturalists Club (CFNC) invested significant efforts into reducing weed cover in core areas of habitat. The following statement was provided by the late Ern Perkins of the CFNC for a previous report prepared for site (Johnson 2001):

*"Since 1989, the Castlemaine Field Naturalists Club has organised annual broom pulls. In earlier years, they were 2, 3 or 4 days in duration, and were assisted by Australian Trust for Volunteers. Some of the broom was over head height. The Council provided a tip truck, and we carted away heaped truck loads of broom. Over the past couple of years, the working-bees have been just for a day, or less, and we have had assistance from Bendigo Regional Institute of TAFE and other volunteers, concentrating on Cape Broom.*

*As well as extending the area cleared, we go over, every year, the previously pulled areas. It is an enormous job. 1000 seedlings per square metre are often encountered. Subsequent years are easier, but we are still pulling many seedlings from the areas first pulled over 10 years ago. Many of the areas pulled now have good native cover, including Bursaria. Encouragingly, some of the areas that were covered with dense broom, now have colonies of butterfly."*

By the time a thorough audit of the exotic flora was undertaken in 2014, there was a high diversity of weeds throughout the reserve (Just 2014), but the cover was clearly far lower than in the previous decades thanks to the work led by CFNC.

During the field survey conducted for this plan a total of 124 introduced flora species were recorded, at least 51 of which are considered 'high threat' species requiring control programs. There has been some control works in the last five years and woody weed cover is now relatively low across most of the bushland area, although the lower eastern slopes and the block adjacent to Odgers Road still support some dense infestations. The most persistent woody weeds in future will likely be Montpellier Broom and Flax-leaf Broom (\**Genista* spp.), which produce vast numbers of long-lived seeds that remain viable in the soil for at least ten years. Other prominent high threat woody weeds include non-local wattles (#*Acacia decurrens* and #*A. baileyana*), Italian Buckthorn (\**Rhamnus alaternus*), Mock Privet (\**Phillyrea latifolia*), Laurustinus (\**Viburnum tinus*), Cotoneaster (\**Cotoneaster* spp.), Atlantic Cedar (\**Cedrus atlantica*) and Radiata Pine (\**Pinus radiata*). The presence of some uncommon weeds throughout the reserve is partly due to past plantings of exotic specimens in the gardens, an example being the infestation of Mock Privet (\**Phillyrea latifolia*), the only known occurrence in Victoria. This exotic shrub has potential to be a serious weed throughout the region and beyond and originally spread from larger shrubs in the gardens that have recently been

removed by Council. Others have spread from adjacent private gardens, with an infestation of Angular Pigface (*\*Malephora crocea*) along Froomes Road being the only known infestation in Victoria.

A row of Atlantic Cedar (*\*Cedrus atlantica*) was planted into some relatively high-quality vegetation in the eastern section of the bushland area several decades ago and require removal before they displace large areas of native groundflora.

Several high threat grasses and forbs occur throughout the bushland area, the most concerning being Large Quaking-grass (*\*Briza maxima*) and Annual Veldt-grass (*\*Ehrharta longiflora*). These annual grasses are highly invasive and tend to germinate in greater numbers in years of good autumn-spring rainfall. Their ability to blanket the ground-layer is of particular concern for the life cycle of the Eltham Copper Butterfly due potential disruption to the *Notoncus* ant colonies.

The flats adjacent to Barkers Creek were cleared during the gold rush era and are largely dominated by exotic grasses and forbs with scattered areas of revegetation. In 2015, Margaret Panter of CFNC identified infestations of three very invasive stipoid grasses from this area, including Chilean Needle-grass (*\*Nassella neesiana*), Cane Needle-grass (*\*N. hyalina*) and Texas Needle-grass (*\*N. leucotricha*). Although numerous scattered populations of Chilean Needle-grass are known around Castlemaine, Texas Needle-grass is uncommon and there are very few other records of Cane Needle-grass in central Victoria, which is the dominant of the three within the reserve. Since 2015 CFNC with support of Council have successfully controlled part of these infestations through digging out plants, herbicide application and mulching. Council have also altered their mowing regime to avoid further spread of the seeds.

Management of introduced plant species should occur along two fronts. The first is to follow the 'Bradley Method', where efforts are focused in the best quality areas, expanding outwards. This should include control of weeds around Eltham Copper Butterfly habitat, namely patches of host Sweet Bursaria plants and surrounding areas. The second focus should be to control the most invasive species occurring in less intact vegetation to prevent their spread into bushland, particularly needle-grasses along the creek flats. Removal of any dumped garden waste is also of high priority to prevent introduction of new weeds to the reserve.

## **Fauna**

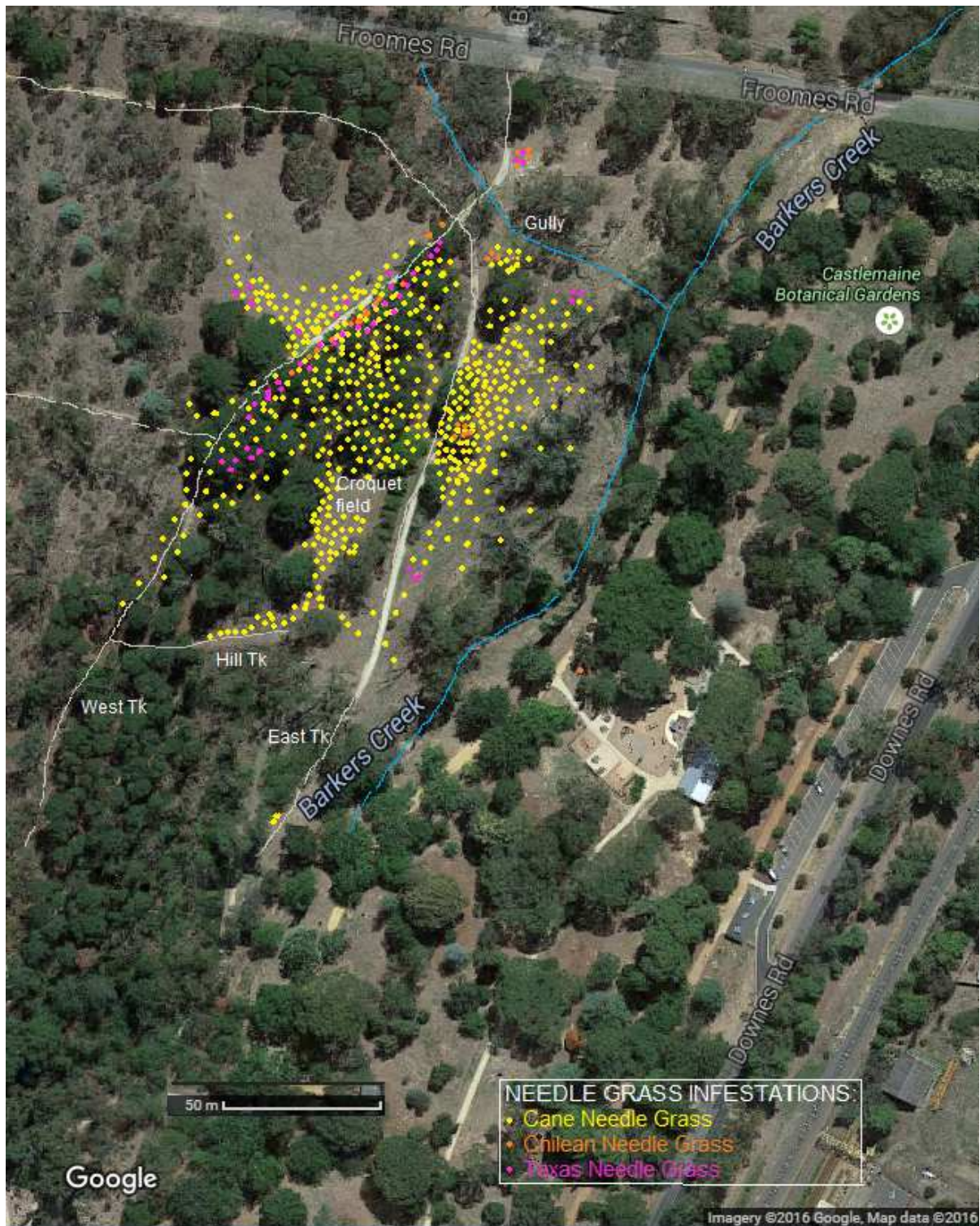
A number of introduced fauna species have been recorded within the reserve, none of which are widespread or abundant. The European Rabbit (*\*Oryctolagus cuniculus*) is only occasionally sighted and there are no established burrows, while the Red Fox (*\*Vulpes vulpes*) is common in the local area. Several introduced bird species may be resident within part of the reserve or occasionally pass through, including the Common Mynah (*\*Acridotheres tristis*), European Goldfinch (*\*Carduelis carduelis*), House Sparrow (*\*Passer domesticus*) and Common Blackbird (*\*Turdus merula*). There are likely to be various introduced invertebrate species, the most troubling being the European Wasp (*\*Vespula germanica*). Several small nests have been recorded within the reserve in the past and



require treatment to prevent negative impacts to native fauna (including the Eltham Copper Butterfly) and possible stings to visitors.

#### **Invasive species – priorities and actions**

- Control high threat weeds throughout the reserve, prioritising Eltham Copper Butterfly habitat and the best quality native vegetation. The north-west section of Management Zone 1 (see Figure 4) is currently a priority due to the higher cover of Broom (*\*Genista* spp.) species.
- Reduce cover of Large Quaking-grass (*\*Briza maxima*) and Annual Veldt-grass (*\*Ehrharta longiflora*) around Eltham Copper Butterfly habitat.
- No herbicide to be used for weed control within 10 meters of Sweet Bursaria plants.
- Only highly skilled bushland practitioners to control weeds around Eltham Copper Butterfly habitat.
- Remove stand of Atlantic Cedar (*\*Cedrus atlantica*) in the eastern section of the bushland area.
- Control needle-grass (*\*Nassella*) species throughout the reserve by hand removal, herbicide application and mulching. Council to continue to improve their mowing regime so as to avoid further spread of seeds.
- Remove any dumped garden waste to prevent introduction of new weeds to the reserve.
- Destroy any rabbit or fox warrens identified.
- Treat any European Wasp nests identified.



**Plate 8 Mapping of Needle-grass species completed by Margaret Panter** The dots aim to show the approximate density of infestations observed during 2015-2018. In some of the areas the infestations have been greatly reduced. However seeds can remain viable in the soil for 12 years, so it is best to assume Needle Grass is still present in these areas even if plants are not visible.



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## 4.0 ELTHAM COPPER BUTTERFLY

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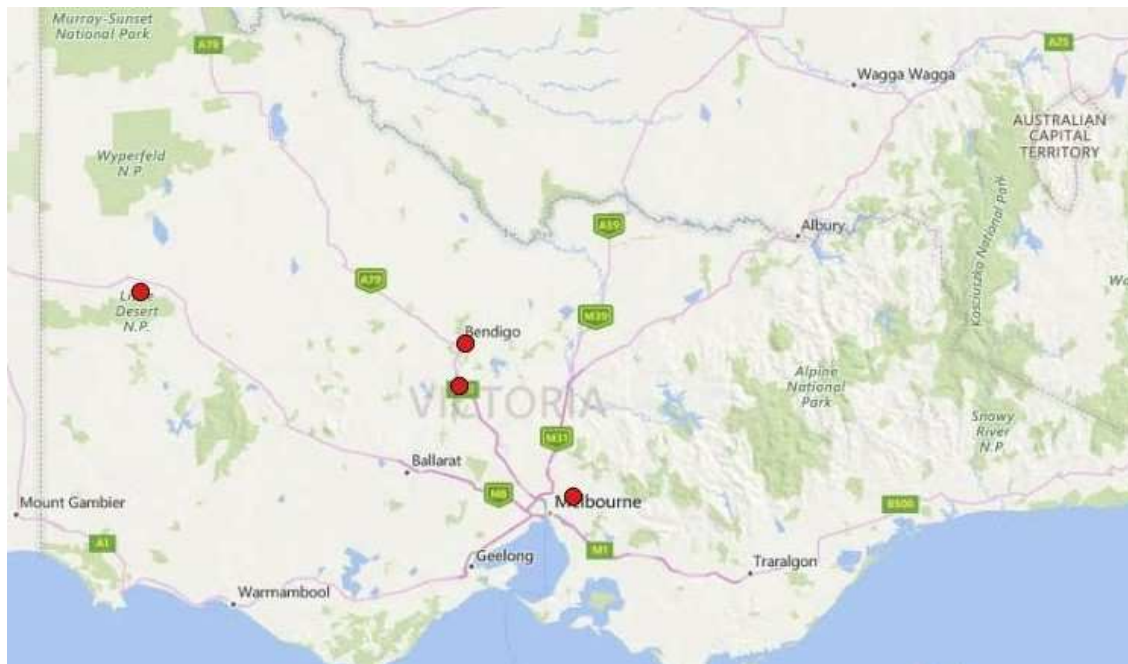
**Plate 9 The Eltham Copper Butterfly (*Paralucia pyrodiscus lucida*)**

### 4.1 Introduction

The Eltham Copper Butterfly (ECB) (*Paralucia pyrodiscus lucida*) was first recorded at Castlemaine in 1895, but following further records in 1907 and 1914, the species was not relocated until the 1980's (Braby et. Al. 1992).

Following records in in the 1950's north-east Melbourne, the species was not sighted again for over thirty years and was believed to be possibly extinct until it was rediscovered at a site in Eltham in 1987. State-wide targeted surveys undertaken that year recorded additional sites at Eltham, Greensborough and Kiata, as well as at the Castlemaine Botanical Gardens Flora and Fauna Reserve (Vaughan 1988). The species was recorded several years later at Kalimna Park on the west side of Castlemaine, while two more populations were located at Chewton and Campbells Creek in 2011 (Bayes 2011). These three sites all occur within the Castlemaine Diggings National Heritage Park managed by the Department of Environment Land Water and Planning (DELWP) and Parks Victoria. The species has also been

recorded at several sites around Bendigo in the last ten years. In 2016, the ECB was listed as *endangered* under the federal Environment Protection and Biodiversity Conservation (EPBC) Act and is also listed as threatened under the Flora and Fauna Guarantee (FFG) Act.



**Plate 10** The Eltham Copper Butterfly is only known from four disjunct localities, shown in red.

## 4.2 Ecology

The ECB has an obligate and intricate three-way relationship with a species of ant in the *Notoncus* genus and the flowering shrub Sweet Bursaria (*Bursaria spinosa*). This relationship makes the ECB a specialist species that is only able to survive in a limited area of habitat and only under very specific and uncommon ecological conditions.

The life cycle begins when the adults lay their eggs at the base of the Sweet Bursaria plant or nearby on leaf litter. The larvae hatch around two weeks later and shortly after enter the nest of the *Notoncus* ant, which is located at the base of the Bursaria plant. Between autumn and spring, the larvae leave the nest to feed on the leaves of the Sweet Bursaria, where they are closely attended and protected by the ants. In return, the larvae excrete a sweet substance which the ants feed upon (Vaughan 1988).

The first generation of adult butterflies usually emerge around November and fly to around mid February. In some years a second generation results from the rapid development of eggs layed in December, in which case adult butterflies may be active into March or even April (Vaughan 1988). The adult butterflies are mainly active on warm, sunny days.



**Plate 11** *Notoncus capitatus* attending the Eltham Copper Butterfly larvae

#### **4.3 Distribution at the Castlemaine Botanical Gardens Flora and Fauna Reserve**

When the Eltham Copper Butterfly was rediscovered at the reserve in 1987, the population was found in two separate areas, including on a north-facing slope (near the old open cut mine site) and at the top of the main ridge in the western section. More recent surveys have only found butterflies and larvae at the top of the main ridge, the adjacent slope to the east, and within the triangular block of land adjacent to Odgers Road (Bayes 2011).

Suitable and potential habitat extends throughout the majority of the bushland area, although some localised patches do not currently support any host *Bursaria* plants, likely due to past disturbance. These areas could potentially be enhanced through planting copses of Sweet *Bursaria* plants.

#### **4.4 Abundance**

Early counts of the ECB population at the Castlemaine Botanical Gardens Flora and Fauna Reserve recorded up to 200 adult butterflies (Vaughan 1988), however anecdotal reports and sporadic surveys since that time indicate that the population has possibly declined.

Monitoring efforts between 1999-2005 focused on counting larvae rather than adults, but it is unclear whether all plants were counted during each event, making comparison on the results difficult. The greatest number of larvae recorded on a single night was 309 in 1999, but only nine were recorded the following year.

In 2011, seven transects of various lengths were set up across the reserve to allow a more rigorous survey method that could be compared across the years. The transects were surveyed at monthly or weekly intervals on four occasions in 2010 and eight occasions in 2011, with significant variation in the results. The highest number of adult ECB recorded in 2010 was 47 on the 27<sup>th</sup> of December, whilst the highest number in 2011 was 32 on the 4<sup>th</sup> of January (Bayes 2012).

The seven transects were re-surveyed during the current project on three occasions:

- On the 10<sup>th</sup> of December 2019, six individuals were recorded at four separate locations in the central bushland area.
- On the 21<sup>st</sup> of December 2019 no individuals were recorded
- On the 1<sup>st</sup> of January 2020, only one individual was recorded in the northern portion of the bushland area.

The above results reveal that numbers for 2019-2020 were very low, particularly in comparison with the original count of close to 200 adult butterflies in 1987-88 and 47 in 2010. This is a cause for concern, however numbers are known to fluctuate across the years, particularly in response to climatic conditions. Monitoring of ECB was also conducted at Kalimna Park in 2019, and although numerous sub-populations were recorded, most of these were also in low numbers (less than 10-20 individuals). This highlights the need for ongoing monitoring of the ECB within the botanical gardens using a consistent method, so that the long-term trajectory of the population can be determined, rather than assessing its status based on sporadic surveys.

#### **4.5 Key threats and management issues**

Maintaining and enhancing the Eltham Copper Butterfly population and its habitat will require ongoing protection and management of the reserve. Potential threats to the population include:

- *Inappropriate fire regimes*, any fire event can potentially have a negative impact on the ECB population, the attendant *Notoncus* ants and *Bursaria* food plants.
- *Weed invasion*. Introduced shrubs and small trees can potentially transform vegetation structure and block flight paths for adult butterflies. Grasses and forbs can potentially alter groundflora habitat for the *Notoncus* ants, particularly if they cover ant nests, however there has been no decline of *Notoncus* ant activity observed due to high grassy weed cover (Cam Beardsell pers. comm.).
- *Physical disturbance to habitat*, including off-trail walking, bike riding or any kind of mechanical or vehicle disturbance.
- *Lack of Bursaria cover or loss of the Notoncus ant* – the ongoing survival of the Eltham Copper Butterfly is totally dependent on maintenance of healthy ant and *Bursaria* populations.
- *Predation by European Wasps* (\**Vespula germanica*).



- *Genetic isolation and inbreeding depression.* The population is considerably isolated from the next known population at Kalimna Park.
- *Climate change* – with drier and hotter conditions likely to adversely affect the ECB population, the attendant *Notoncus* ants and *Bursaria* food plants. The drying trend the region has experienced in the last 20 years may already have impacted the population.



**Plate 12 Eltham Copper Butterfly**

Key management priorities include:

*Weed Control* - a key priority is to manage high threat weeds in core areas of habitat. Scattered plants of Broom (\**Genista* spp.) in the north-western section where butterflies have recently been recorded should be controlled first.

Controlling woody weeds is achievable with regular effort, although reduction of grassy weeds such as Large Quaking-grass (\**Briza maxima*) and Annual Veldt-grass (\**Ehrharta longiflora*) is more challenging. It should be noted that it is unknown whether the high cover of grassy weeds around Sweet *Bursaria* plants affects the ECB larvae or *Notoncus* ants. At Pauline Toner Reserve in Eltham, in some years grassy weed cover has been very high but larvae activity has still been abundant (Cam Beardsell pers. comm.). However, it is possible that when grassy weed cover

smothers habitat, that this can restrict the movement of the ants and larvae and even discourage the ants from residing at the base of Sweet Bursaria plants. For this reason, effort should be taken to control grassy weeds around at least some of the host Sweet Bursaria plants.

Due to potential impacts on the ant and butterfly, no herbicide should be sprayed within 10 meters of Bursaria plants, and grassy weeds instead controlled by hand removal. At Andrew Yandell Habitat Reserve in Greensborough where the Eltham Copper Butterfly also occurs, the Banyule City Council bushland management unit have been hand weeding around *Notoncus* ant colonies for many years and have avoided disturbance by carefully holding the soil layer down with one hand while removing each grassy weed (Megan Lowe and Kylie D'Amico pers. comm.) Another option is to cut off seeds prior to maturation and removing these from the reserve. Because these weeds are annual species with relatively short-lived seed, preventing seed set for 2-3 consecutive years can drastically reduce infestations. All control of grassy and herbaceous weeds at the Castlemaine Botanical Gardens Flora and Fauna Reserve should only be carried out by highly skilled practitioners to ensure that no damage to ECB habitat occurs.

*Planting Sweet Bursaria* – ECB have been recorded colonizing planted Sweet Bursaria within two years of planting at Eltham (Cam Beardsell pers. comm.). There are scattered patches adjacent to current host plants where previous disturbance has removed much of the understorey. This includes the south-west section of the top ridge and within the block adjacent to Odgers Road. These areas could be planted with dense Sweet Bursaria in an effort to increase available habitat. The use of green plastic tree guards should be avoided due to their tendency to blow away, with plants instead marked with one or several wooded stakes or protected with black mesh tree guards.

*Monitoring* – the primary form of monitoring should be counts of adult butterflies, following the seven transects of established by Bayes (2011). Ideally, each transect should be walked twice a month between the months of November and February during suitable weather and all butterflies observed counted and mapped using a GPS. Additionally, it would be of value to monitor the distribution of larvae each season so as to determine where management should be focused. However, this can be very time consuming and would likely require the assistance of a volunteer group. Monitoring the abundance of Sweet Bursaria should also be considered, using the plots established by Bayes (2011) (see locations in Appendix 1).

*Preventing disturbance* – Creation of new walking trails across the bushland area must be discouraged and no major works carried out within the reserve (e.g. trail works) without consultation with an expert on the ECB. Installation of a significant roadside vegetation sign on Froomes Road is recommended to alert contractors to the presence of ECB habitat.

### **Eltham Copper Butterfly – priorities and actions**

- Control high threat weeds in core areas of habitat.
- Implement an annual monitoring program for adult butterflies and possibly larvae and habitat (Bursaria health).
- Plant additional Sweet Bursaria plants in less intact sites adjacent to existing ECB core area.
- No fuel reduction burning to be conducted without strict expert review and consideration.
- No native vegetation clearance or major infrastructure works around potential habitat without due diligence to prevent impacts to the Eltham Copper Butterfly.
- Restrict bike riding to the designated trails.
- Enforce dogs on-lead policy
- Discourage off-trail walking and rehabilitate any disturbance caused by this activity.
- Prevent disturbance to understorey vegetation, including during weed control and other management works.
- Treat any European Wasp nests identified.
- Install significant roadside vegetation sign on Froomes Road to alert contractors to the presence of ECB habitat.



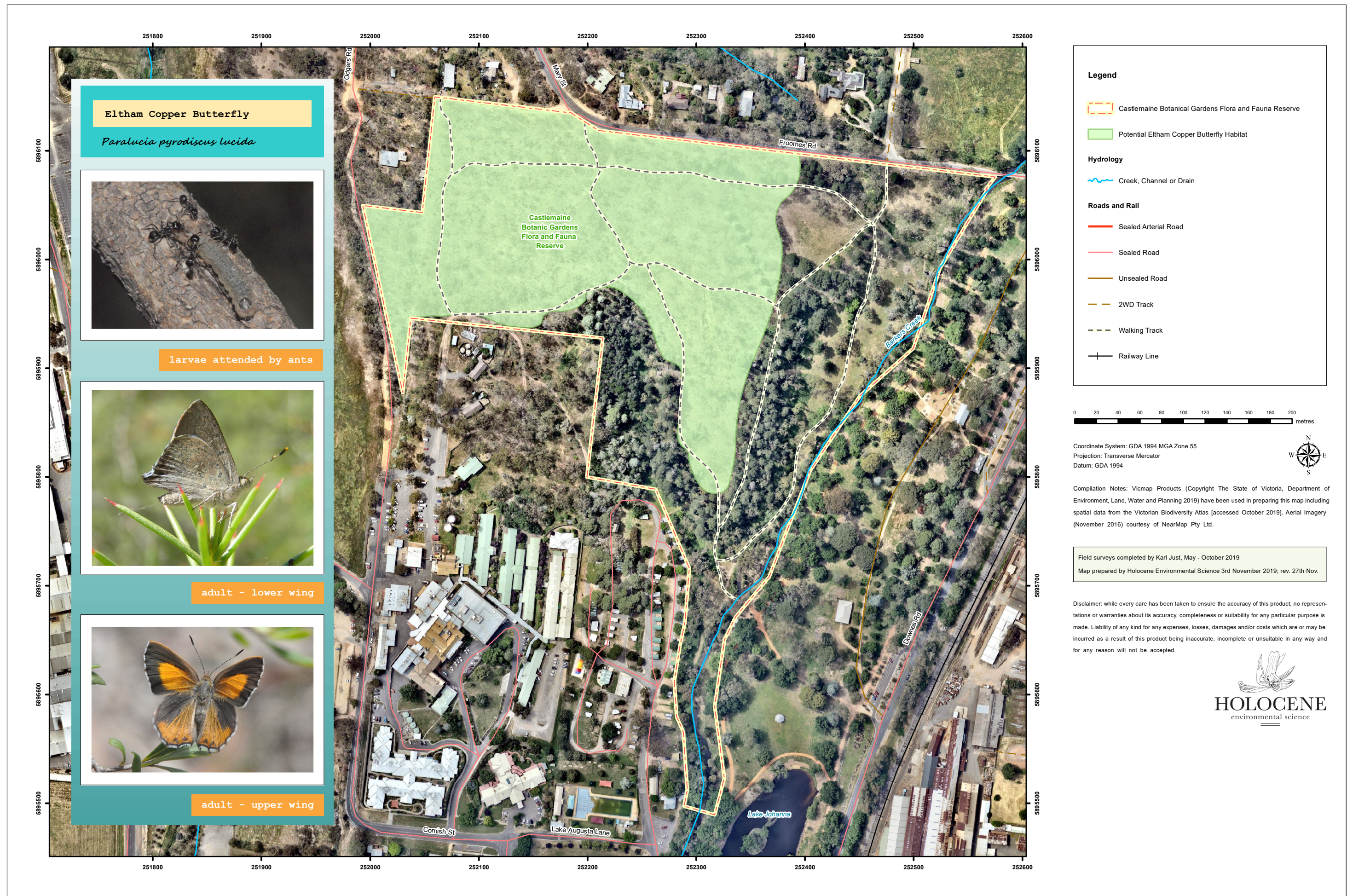


Figure 2: Potential habitat for Eltham Copper Butterfly, Castlemaine Botanical Gardens Flora and Fauna Reserve



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## 5.0 Cultural Heritage

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### 5.1 Aboriginal cultural heritage

The traditional owners of the Castlemaine area are the Dja Dja Wurrung, who have inhabited the region for tens of thousands of years. No sites of cultural significance are known within the reserve and it is probable that any such sites were destroyed during past mining activities. However, it is possible that artefacts such as tool scatter deposits could occur in some areas, and a cultural heritage assessment would be required to investigate the presence of significant or sensitive sites. Any proposed works that involve significant ground disturbance along Barkers Creek are likely to first require a Cultural Heritage Assessment (CHA).

The story of the Dja Dja Wurrung is an integral part of the landscape and it is important to educate the community about their history and traditional and contemporary culture. This could be incorporated into future interpretive signs prepared for the walking trails.

#### Aboriginal cultural heritage – priorities and actions

- Investigate the potential for interpretive signage that describes the history and culture of the Dja Dja Wurrung.
- A Cultural Heritage Assessment is first required for any proposed works that involve significant ground disturbance along Barkers Creek.

### 5.2 Post-settlement cultural heritage

European arrival to the Castlemaine area began in the 1830-40's, when the first squatters arrived and established sheep runs. This initial period of settlement ended in 1851, when gold was discovered at Specimen Gully on Barkers Creek in 1851, three kilometres to the north-east of the gardens. This led to the area being inundated by thousands of prospectors, who turned over the creek flats within the reserve in the search for gold and cleared many of the surrounding trees for use in mine shafts, construction of huts and as firewood. After several years the alluvial gold was largely exhausted, and following several petitions to the government, the reserve of the Castlemaine Botanical Gardens was gazetted and fenced in 1860. A detailed description of the history of the gardens is described in the CMP (JPLA 2019).

The greater Castlemaine Botanical Gardens, including the flora and fauna reserve, is listed under the Victorian Heritage Register (VHR) for its high historical significance. The recently updated heritage assessment prepared by JPLA (2019) provides a detailed evaluation of how the gardens meets at least six of the key criteria for listing under the VHR, including that the site is ‘an outstanding example of the botanical gardens created by communities in regional Victoria during the nineteenth century’. While most of the features described in the VHR listing relate to the remaining area of the gardens, it is important to note that flora and fauna reserve was a key feature of at least one of the criteria. This included under Criteria E of the VHR statement ‘Importance in exhibiting particular aesthetic characteristics’:

*“The narrow and deeply treed nature of the core area of the gardens, set within and taking advantage of the flood plain of Barkers Creek, and its connectivity with a biologically important area of remnant bushland retained within the original reserve, enforces an unusual aesthetic character which sets the Castlemaine Botanical Gardens apart from most other regional botanical gardens in Victoria” (JPLA 2019).*

Seen in this light, the flora and fauna reserve is of high heritage significance and is certainly included within the VHR listing.

Known features of historical interest within the flora and fauna reserve boundary include:

- The north-south pathway on the eastern slope that is lined with Monterey Pine (*\*Pinus radiata*) (located between Barkers Creek and the bushland area) is possibly part of the original trail network as laid out by the first curator of the gardens, Phillip Doran (JLPS 2019).
- Remnants of the original Pine plantation established in the late 19<sup>th</sup> century. Although most Pines within the reserve originate from more recent plantings or natural recruits, the Monterey Pine (*\*Pinus radiata*) along the north-south pathway on the eastern slope were possibly planted during the establishment of the original network of paths. A small stand of Aleppo Pine (*\*Pinus halepensis*) that extends from the caravan park north to near the gully in the south-east section of the reserve is also of significance (JLPS 2019).
- A disused bowling green, now only evident as an area of flat ground cut into the slope, located between Barkers Creek and an area of Monterey Pine (*\*Pinus radiata*). This green was established sometime prior to 1972 near the original site for a bowling green established in the 1880’s (JSPS 2019).
- The lower bridge over Barkers Creek was constructed near the beginning of the 20<sup>th</sup> century and has significance as a structure which survives from the Garden’s key period of development under curator Phillip Doran (JSPS 2019).
- The middle bridge is a relatively recent construction with low heritage significance (JSPS 2019).



- Remnant stone abutments of a bridge that originally crossed Barkers Creek in the northern section of the reserve. These abutments were rated to be of low historical significance with limited interpretative appeal (JSPS 2019).

#### **Post-settlement cultural heritage – priorities and actions**

- The small number of Pines with historical significance should be conserved, however the majority are younger individuals that should be removed when possible.
- Conserve and maintain the current path network, encompassing any original and historic sections of path.
- Any new built features should consider following early designs that are in keeping with the gardens overall historical character.

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## 6.0 Recreational Management

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### 6.1 Low impact and passive recreation

The Castlemaine Botanical Gardens Flora and Fauna Reserve is ideally suited for passive recreation activities and has been appreciated by members of the community for many years. Several walking trails traverse the reserve, offering opportunities for walking, bird watching and a variety of nature studies. Walkers who reach the top of the hill in the northern section of the reserve are greeted by views of Mount Alexander (Leanganook) in the distance to the north-east.

The Castlemaine Bush Kinder group have been meeting within the reserve since 2011. A key focus of the group has been environmental education for young children, particularly in regard to conservation of the endangered Eltham Copper Butterfly. The group regularly assists with the environmental program by picking up litter, conducting monitoring activities and removing weeds from the bushland area. The Bush Kinder group play an important role in educating children how to appreciate and care for the environment and Council should continue to support their activities.

There is ample space and opportunity to install some additional picnic tables and chairs near Barkers Creek in the eastern section of the reserve. These would ideally be placed in a shady location near the walking trail.

#### **Passive recreation - Priorities and Actions:**

- Continue to improve accessibility within the reserve to allow passive recreation.
- Continue to support and work with Castlemaine Bush Kinder
- Install picnic table and chairs near Barkers Creek

## 6.2 Visitor Impacts

Recreation within the reserve must be monitored and managed to prevent negative visitor impacts. Due to the presence of significant flora and fauna values, it is important that visitors stay on the trail network wherever possible, particularly within the bushland area. Development of new unwanted trails often arises when visitors begin to follow pathways through bushland created by previous off-trail walking, increasing the width of the trail and further encouraging other visitors to follow its path. One method to discourage this development is through placement of branches across any developing unsanctioned trails, particularly near branching points near official trails. Future signage should request that all visitors stay on existing trails when walking through the reserve. Walking of dogs and bike riding are to be better managed. Bike riding should be restricted to designated trails only and a program on enforcing dogs on-leads should be implemented as a priority. This should be made clear on future signage. Regular visitors to the reserve have often noted dog droppings along the trails and through the bush and many dogs have been observed off-lead or running through the bush.

### Visitor impacts - Priorities and Actions:

- Restrict bike-riding to designated trails
- Enforce dogs on-lead policy
- Monitor the reserve to identify negative visitor impacts.

## 6.3 Signage and interpretation

Development and installation of welcome and interpretation signage is a high priority for the reserve, and was raised as a key objective by many of the stakeholder community groups met with during the development of this plan. There are currently several old wooden signs within the reserve, but these are in a state of disrepair, are outdated and require replacement.

There are at least two kinds of signage that should be considered for installation in the near future. The first is a welcome sign that clearly shows the name of the reserve, provides an overview of the reserve's values (including the Eltham Copper Butterfly population) and outlines prohibited activities, such as dumping of rubbish. This sign could also potentially include a small map of permitted walking trails. Such a sign should ideally be relatively large (up to one meter wide) and include colour photographs. A welcome sign should at the least be installed at the entrance to the reserve near the carpark near Froomes Road, although a replica could also be positioned at another key location such as where the walking trail from Barkers Creek meets the bushland area in the southern section.



The other option is for numerous interpretation signs that could be set up as part of a set nature trail. These signs could include an overview of numerous topics with colour photographs, although the inclusion of Quick Response (QR) Codes would allow visitors who have installed a QR reader application on their mobile devices to quickly scan the code and be redirected to more detailed material. This method has been used successfully by Friends of Campbells Creek Landcare Group on billboards installed along Campbells Creek.

Points of interest that could be discussed in interpretive signage include:

- The Eltham Copper Butterfly, its distribution, ecology, threatening processes and conservation.
- Signage near Barker Creek, providing an overview of the mining and botanical gardens history and describing efforts to restore creek health.
- Discussion of notable geological features and other flora and fauna species occurring within the reserve.
- Discussion of Box Ironbark Forest, its history, ecology and conservation.

Another option that should be considered for interpretation purposes is development of a podcast on the Eltham Copper Butterfly. In recent times it has become much more achievable to develop a podcast and upload it to one of numerous websites, which visitors can easily download onto their mobile device for listening. The podcast address could be listed on the welcome sign, giving visitors the option to take a walk through the reserve while listening to the fascinating story of the Eltham Copper Butterfly and conservation efforts. It would probably be advisable to make any listing of a podcast address an added rather than permanent feature to a sign (such as a magnet placed beneath the screen) so that it can be updated if changes to the website occurs.

#### **Signage and interpretation - Priorities and Actions:**

- Prepare and install new welcome signs within the reserve, including at Froomes Road entrance and other key entry points.
- Prepare interpretative signage, potentially including QR Codes that link to more detailed information.
- Consider development of a podcast on the Eltham Copper Butterfly, with links included on welcome signs.



**Plate 13** The current welcome sign to the reserve near the carpark on Froomes Road. Replacement of this sign is a high priority.



**Plate 14** A welcome sign installed at Andrew Yandell Habitat Reserve, Greensborough in 2015 by Banyule City Council. Installation of similar large, colourful welcome signs with detailed overview information should be considered for the Castlemaine Botanical Gardens Flora and Fauna Reserve.



## 6.4 Trails

All walking trails within the reserve are unpaved. The established trail network traverses much of the reserve and is situated so that it provides the opportunity to complete a number of loops. Key trails include along the western side Barkers Creek, through the grove of Monterey Pines and around the bushland area.

Some of the trails in the bushland section have eroded significantly due to the steep gradient of the slope and channeling of water. These trails require ongoing repair and maintenance to ensure they are in good enough condition to encourage walkers and prevent injury. Ideally the trails should be assessed by an engineer, however methods that may be effective include plugging the gully erosion along trails with crushed rock or jute matting, whilst small sets of basic stairs could be constructed on some of the steepest sections. It is essential that any future trail works avoid impacting on native vegetation which closely follows the edge of the trail. All future works should be undertaken by a contractor experienced in working in sensitive environmental sites and disturbance always minimized as much as possible.



**Plate 15** Erosion along the hillside trail in the northern section of the reserve.



#### **Trails - Priorities and Actions:**

- Repair and maintain all trails, particularly those on the steeper slopes in the bushland section.
- Ensure that native vegetation adjacent to the trail is not impacted during future works.
- All future works to be undertaken by a contractor experienced in working in sensitive environmental sites and disturbance always minimized as much as possible.

### **6.5 Vehicle Parking**

There are two small gravel parking areas close to the reserve on Froomes Road, including an area adjacent to the bushland section (western carpark) and a second just north of Barkers Creek (eastern carpark). Other options for parking include within the well established parking lots on the east side of the gardens on Downes Street, although this requires a brief walk and crossing of Barkers Creek across one of two bridges.

The Froomes Road carpark adjacent to the bushland area could be improved by filling in rill erosion that has developed along the sides of the road. Installation of a welcome sign as described above would also compliment this work by creating a more official and appealing entrance to the reserve. It is also recommended that the old barbed wire fence at the entrance from the eastern carpark be replaced with a visually appealing timber fence with gate. The old bollards at the western carpark could also be similarly replaced and the small gravel crossing over the drain (just inside the bollards) needs repair.

#### **Vehicle Parking - Priorities and Actions:**

- Improve the eastern Froomes Road carpark adjacent to the bushland area by filling in and managing erosion
- Improve the entrances by replacing the old barbed wire fence at the eastern carpark with a visually appealing timber fence with gate

### **6.6 Froomes Roadside management**

The roadside vegetation along Froomes Road directly adjacent to the reserve is of high significance and includes stands of Sweet Bursaria that are potential host plants for the Eltham Copper Butterfly. A significant roadside vegetation sign should be installed along the road to alert council staff and contractors to the sensitivity and significance of the Froomes Roadside vegetation. This sign should mention the presence of the Eltham Copper Butterfly and suggest that all workers contact the Council environmental officer prior to commencing any works. Council should also ensure that policy is within place to prevent any staff from carrying out works along the roadside without first seeking input from the Natural Environment Officer.

#### **Froomes Roadside management - Priorities and Actions:**

- Install a significant roadside vegetation sign to alert council staff and contractors to the sensitivity and significance of the Froomes Roadside vegetation
- Ensure policy is in place within Council to prevent council workers or contractors carrying out works that may affect the roadside vegetation

### **6.7 Community involvement**

The Castlemaine Botanical Gardens Flora and Fauna Reserve has been valued by the Castlemaine community for over one hundred years, first due to its inclusion within the botanical gardens reserve in the 1800's and later due to the discovery of the Eltham Copper Butterfly at the reserve in the late 1980's.

Although there has yet to be a specific Friends group for the bushland area, the Castlemaine Field Naturalists Club have invested extensive time and resources into the reserve, particularly in the first 15 years following the discovery of the butterfly. The group have also spent significant time into controlling invasive needle-grass species on the flats of Barkers Creek in the last several years. The Barkers Creek Landcare and Wildlife Group predominately operate to the north of the botanical gardens but recently assisted with needle-grass control within the reserve. This group also expressed an interest in taking part in further activities within the reserve during consultation undertaken for the preparation of this document. The Friends of the Box Ironbark Forests have had a long-term interest in the reserve and have recently supported work to control needle-grass species.

Council should consider initiating the formation of a Friends Group for the reserve in order to assist with the ongoing works that are required to conserve and enhance ecological values. Key actions that should be central to any group that is formed include:

- Weed control, particularly removal of woody weeds (such as Montpellier Broom) around Eltham Copper Butterfly habitat and control of needle-grasses on the lower flats adjacent to Barkers Creek.
- Revegetation and species enrichment plantings, including planting patches of Sweet Bursaria to improve Eltham Copper Butterfly habitat.
- Planning and consultation, including for signage and interpretation.
- Monitoring of the Eltham Copper Butterfly
- Being the eyes and ears for the reserve and alerting council to any illegal or damaging activities.

**Community involvement - Priorities and Actions:**

- Continue to support environmental groups that conduct works within the reserve to benefit the overall site and its ecological values.
- Consider initiating the formation of a Friends Group for the reserve.



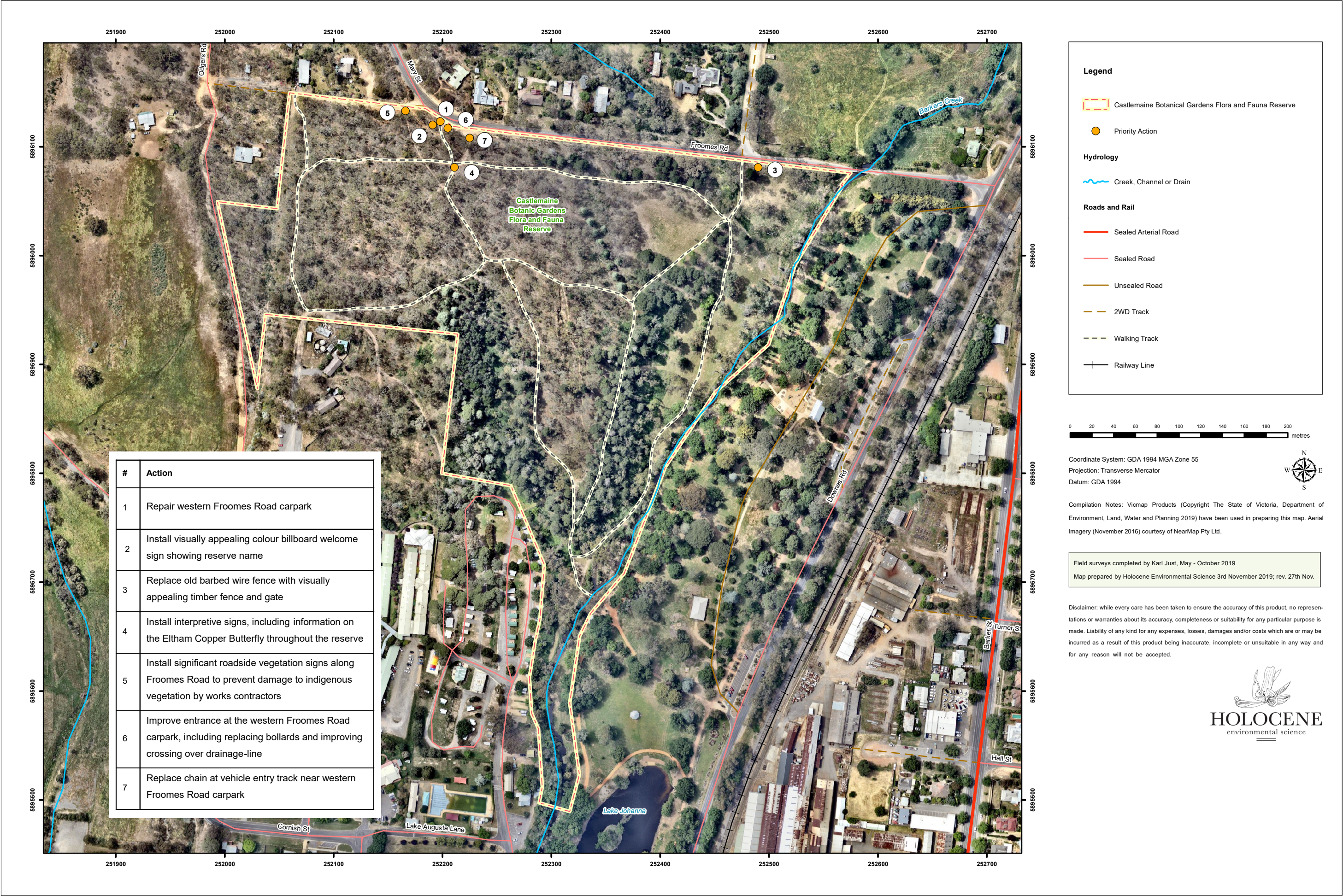


Figure 3: Infrastructure Works for the Castlemaine Botanical Gardens Flora and Fauna Reserve



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## 7.0 Monitoring

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### 7.1 Monitoring methods

Monitoring is an essential component of ecological management. Successful monitoring allows land managers to detect important changes across time, which can be particularly useful for assessing weed control works, threatened species recovery programs or broad structural and floristic changes. Although detailed monitoring requires a relatively high level of time and resources, some simple methods could potentially be adopted at the Castlemaine Botanical Gardens Flora and Fauna Reserve to assist with management.

#### ***Photopoints***

Establishing photopoints is one of the easiest and most effective ways to monitor broad changes. As many photopoints should be established across the reserve as possible, with focus given to areas where management is likely to be targeted. The photopoint should be taken from an obvious feature (such a tree stump) and geographically referenced with a GPS. Photos can be taken as often as resources permit, but ideally should be repeated at least once a year. Previous photos should always be taken on site to ensure that the new photo is lined up as accurately as possible with previous image.

#### ***Vegetation quadrats***

The Castlemaine Field Naturalists Club set up four 10 x 10m vegetation monitoring quadrats in 2001, which were resurveyed in 2006, 2010 and 2014. These quadrats should be reassessed every 1-2 years during the spring period in order to determine floristic change. Further plots could potentially be set up in other areas of the reserve.

#### **Significant species monitoring**

Monitoring methods for the Eltham Copper Butterfly are outlined in Section 4. The population of Late-flowering Flax-lily (*Dianella tarda*) could also be monitored to determine the overall health of the population, with recovery management implemented if necessary.

#### **Monitoring - Priorities and Actions:**

- Implement a monitoring program to assist in evaluating management works and identifying changes to vegetation and habitat attributes.

## **7.2 Evaluation of management**

The management program should be reviewed on a yearly basis. The priority actions outlined for each year should be assessed against the works actually achieved in that time, to determine the overall progress towards the intended outcomes. The ten year action plan takes an adaptive approach, so that any part of the program can be adapted each year based on the progress of specific works. At the end of each year, land managers should assess the success of important management aims to determine if works proposed for the following year require variation.

### **Evaluation of management - Priorities and Actions:**

Land managers to assess the success of important management aims at the end of each year, to determine if works proposed for the following year require variation.



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## 8.0 Management Zones

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The Castlemaine Botanical Gardens Flora and Fauna Reserve has been divided into six separate management zones to order and prioritise works. A description of each zone as well as key ecological values and management recommendations are provided below. All zones are shown in Figure 4.



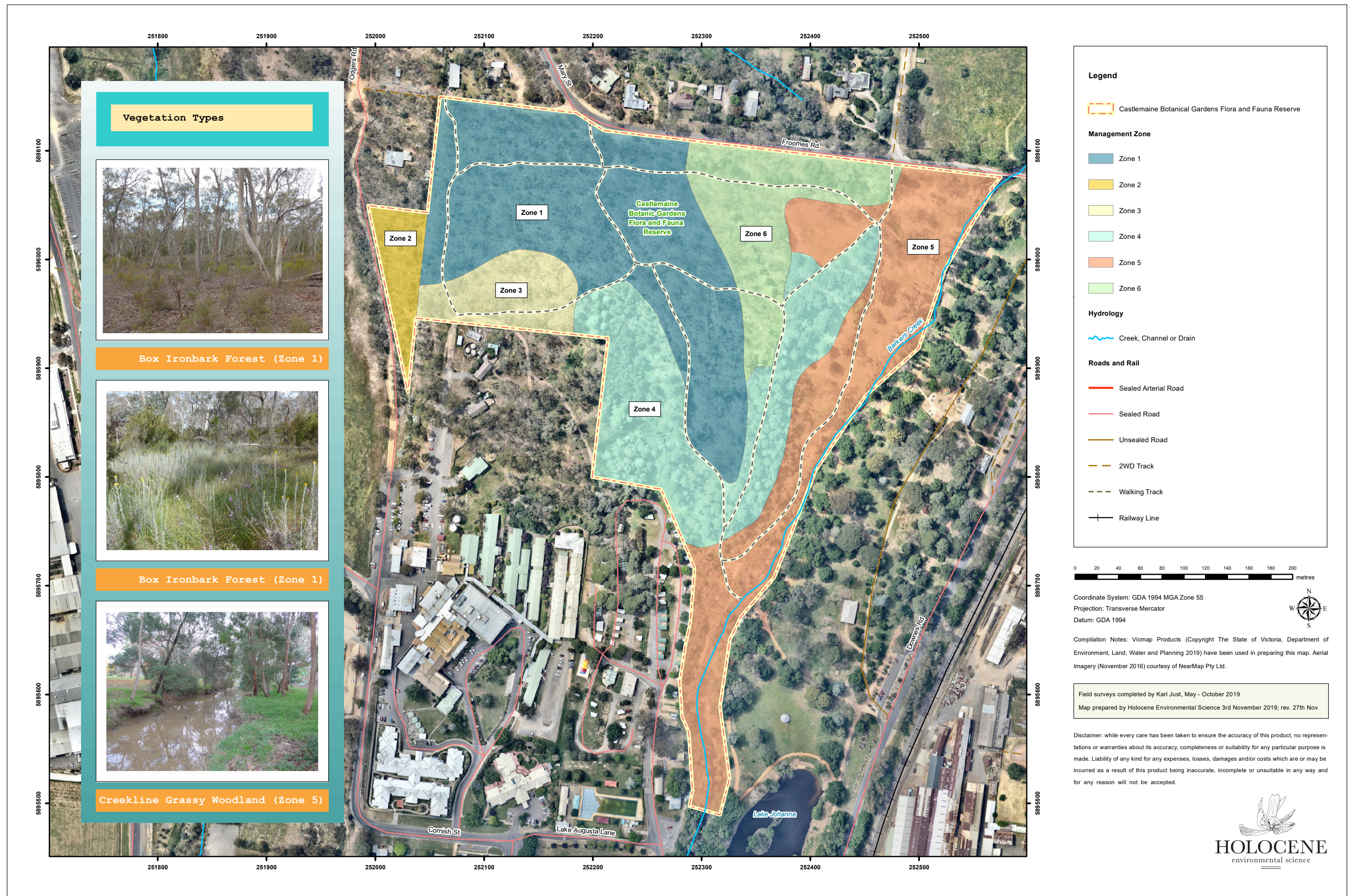


Figure 4: Management Zones at the Castlemaine Botanical Gardens Flora and Fauna Reserve



Management Zone 1	
Ecological Vegetation Classes	<ul style="list-style-type: none"> <li>Box Ironbark Forest (EVC 61)</li> </ul>
Description	<ul style="list-style-type: none"> <li>Management Zone 1 encompasses the most intact areas of bushland and the majority of known and potential Eltham Copper Butterfly habitat. The vegetation is mostly in good condition and supports a highly diverse shrub and ground layer, however there are numerous weed species that threaten the area.</li> </ul>
Threatened Flora Recorded	<ul style="list-style-type: none"> <li>Late-flowering Flax-lily</li> </ul>
Threatened Fauna Recorded	<ul style="list-style-type: none"> <li>Eltham Copper Butterfly</li> </ul>
Key Management Priorities	<ul style="list-style-type: none"> <li>Control woody weeds throughout the zone. Scattered Broom in in the north-west section is a high priority.</li> <li>Reduce the cover of annual grassy weeds around host Sweet Bursaria plants.</li> <li>Control Angular Pigface and other succulents along Froomes Road</li> <li>Monitor the Eltham Copper Butterfly and its habitat.</li> <li>Repair the northern trail that leads from the carpark to the top of the hill.</li> <li>Develop and install interpretative signage.</li> <li>Improve western Froomes Rd carpark and install visually appealing welcome sign.</li> <li>Install significant roadside vegetation signs along Froomes Road.</li> <li>Monitor and prevent formation of new walking trails.</li> </ul>



**Plate 16 Management Zone 1**



Management Zone 2	
Ecological Vegetation Classes	<ul style="list-style-type: none"> <li>Box Ironbark Forest (EVC 61)</li> </ul>
Description	<ul style="list-style-type: none"> <li>Management Zone 2 encompasses the triangular shaped parcel of land that extends between Management Zone 1 and Odgers Road. This area is mostly dominated by grassy and woody weeds, however there are a small number of Sweet Bursaria plants and the Eltham Copper Butterfly has been recorded within the zone.</li> </ul>
Threatened Flora Recorded	<ul style="list-style-type: none"> <li>None recorded</li> </ul>
Threatened Fauna Recorded	<ul style="list-style-type: none"> <li>Eltham Copper Butterfly</li> </ul>
Key Management Priorities	<ul style="list-style-type: none"> <li>Control woody weeds throughout the zone.</li> <li>Plant additional patches of Sweet Bursaria.</li> <li>Include the zone in the Eltham Copper Butterfly monitoring program.</li> </ul>



**Plate 17 Management Zone 2**



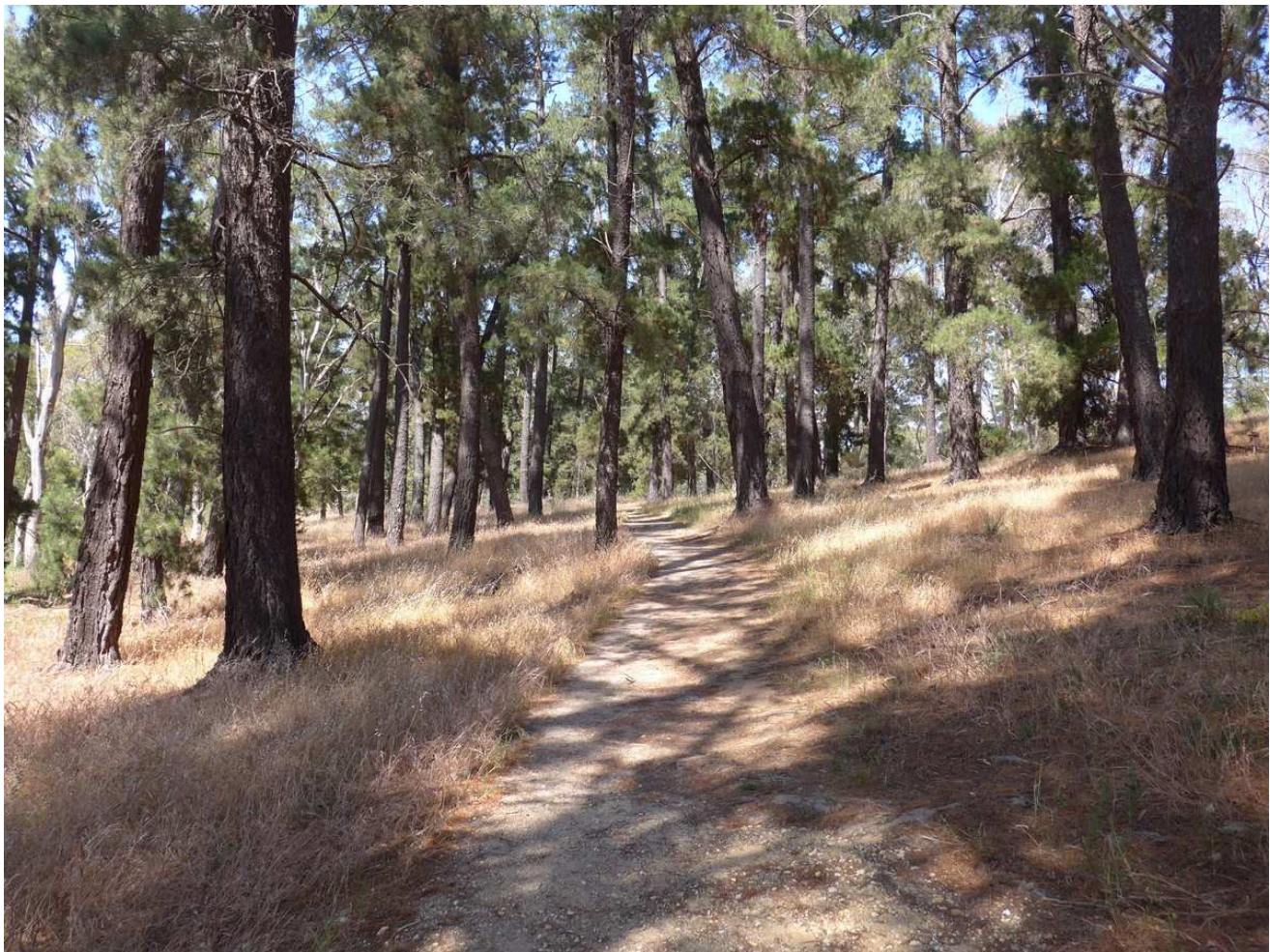
Management Zone 3	
Ecological Vegetation Classes	<ul style="list-style-type: none"> <li>Box Ironbark Forest (EVC 61)</li> </ul>
Description	<ul style="list-style-type: none"> <li>Management Zone 3 is situated to the south of Management Zone 1 and differs in the more degraded state of the understorey vegetation that contains only a sparse cover of indigenous plants and high cover of grassy weeds.</li> </ul>
Threatened Flora Recorded	<ul style="list-style-type: none"> <li>None recorded</li> </ul>
Threatened Fauna Recorded	<ul style="list-style-type: none"> <li>Eltham Copper Butterfly within 20 meters of the zone.</li> </ul>
Key Management Priorities	<ul style="list-style-type: none"> <li>Control woody weeds throughout the zone.</li> <li>Plant additional patches of Sweet Bursaria.</li> <li>Include the zone in Eltham Copper Butterfly monitoring program.</li> </ul>



**Plate 18 Management Zone 3**



Management Zone 4	
Ecological Vegetation Classes	<ul style="list-style-type: none"> <li>Box Ironbark Forest (EVC 61)</li> <li>Creekline Grassy Woodland (EVC 68)</li> </ul>
Description	<ul style="list-style-type: none"> <li>Management Zone 4 includes several areas that are dominated by pine trees, mostly of Radiata Pine (some which have been described to be of heritage significance (JPLA 2019). Scattered areas of the periphery contain remnant indigenous groundflora, but most areas have a high cover of woody and herbaceous weeds.</li> </ul>
Threatened Flora Recorded	<ul style="list-style-type: none"> <li>None recorded.</li> </ul>
Threatened Fauna Recorded	<ul style="list-style-type: none"> <li>None recorded.</li> </ul>
Key Management Priorities	<ul style="list-style-type: none"> <li>Progressively remove younger Radiata Pine from the central gully, starting from the north and proceeding south.</li> <li>Control Needle-grass species recorded throughout the zone – Chilean Needle-grass, Texas Needle-grass and Cane Needle-grass.</li> </ul>



**Plate 19 Management Zone 4**



Management Zone 5	
Ecological Vegetation Classes	<ul style="list-style-type: none"> <li>• Creepline Grassy Woodland (EVC 68)</li> </ul>
Description	<ul style="list-style-type: none"> <li>• Management Zone 5 encompasses Barkers Creek and the adjacent floodplain and creek flats. The zone supports several large River Red Gum trees and scattered areas of revegetation, but most indigenous understorey has previously been cleared.</li> </ul>
Threatened Flora Recorded	<ul style="list-style-type: none"> <li>• None recorded</li> </ul>
Threatened Fauna Recorded	<ul style="list-style-type: none"> <li>• None recorded</li> </ul>
Key Management Priorities	<ul style="list-style-type: none"> <li>• Control woody weeds throughout the zone.</li> <li>• Control Needle-grass patches across the flats – Chilean Needle-grass, Texas Needle-grass and Cane Needle-grass.</li> <li>• Establish further areas of revegetation.</li> <li>• Stabilise creek banks through planting grasses, sedges and rushes.</li> <li>• Develop and install interpretative signage.</li> <li>• Replace barbed wire fence at eastern Froomes Rd carpark entrance and replace with visually appealing timber fence and gate.</li> <li>• Install picnic table and chairs near Barkers Creek.</li> </ul>



**Plate 20 Management Zone 5**



Management Zone 6	
Ecological Vegetation Classes	<ul style="list-style-type: none"> <li>Box Ironbark Forest (EVC 61)</li> </ul>
Description	<ul style="list-style-type: none"> <li>Management Zone 6 encompasses the lower slopes of the bushland area. Although the zone supports a good diversity of indigenous understorey, there is a much higher cover of woody weeds than within the adjacent Management Zone 1. Part of the zone has a good cover of native grass dominated by Kangaroo Grass.</li> </ul>
Threatened Flora Recorded	<ul style="list-style-type: none"> <li>None recorded</li> </ul>
Threatened Fauna Recorded	<ul style="list-style-type: none"> <li>None recorded but potential habitat for Eltham Copper Butterfly is present.</li> </ul>
Key Management Priorities	<ul style="list-style-type: none"> <li>Control woody weeds throughout the zone, including reducing cover of Montpellier Broom and Flax-leaf Broom and removing stand of Atlantic Cedar.</li> <li>Develop and install interpretative signage.</li> <li>Repair the east-west walking trail (in the northern section) that runs through the zone.</li> </ul>



**Plate 21 Management Zone 6**

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## 9.0 Overview of Management Techniques

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The Action Plan in Section 10 includes reference to various techniques for weed control and revegetation. A description of these techniques is provided in the paragraphs below.

### ***Hand-weeding***

Hand weeding refers to any removal of exotic plants undertaken by hand. This is the preferred method when controlling exotic herbs and grasses within high quality patches of groundflora due to the potential for off-target damage when using herbicide. Hand-weeding is also the preferred method for juvenile woody weeds that have yet to develop deep root systems, while smaller Needle-grass (*\*Nassella* spp.) plants may also be removed 'by hand' by chipping out with a tool. It is important that all exotic herbs and grasses that bear seed are removed from the reserve and disposed of appropriately.

At the Castlemaine Botanical Gardens, this method may be used for removing Large Quaking-grass (*\*Briza maxima*) and Annual Veldt-grass (*\*Ehrharta longiflora*) around host Sweet Bursaria plants. In this instance it must only be undertaken by highly skilled practitioners taking great care to avoid excessive ground disturbance around *Notoncus* ant nests.

### ***Herbicide application***

Herbicide application refers to any spot-spraying of herbicide, typically undertaken using a knapsack. There are various methods and types of herbicides, the use of which depends on the target weed and the quality of the vegetation. These include grass-specific herbicides that do not affect surrounding non-grass species, herbicides that are suited to broad leaf weeds and others that are suitable for woody species. Due to the high potential for off-target damage when spraying herbicide, it is essential that practitioners have a high level of plant identification skills. Spraying near waterbodies, with the exception of the dry margins of streams, should be avoided. Additionally, no herbicide is to be sprayed within 10 meters of host Sweet Bursaria plants.

Herbicide application using a grass-specific product is likely to be essential when controlling needle-grass species west of Barkers Creek.



### ***Cut-paint***

The 'cut-paint' method involves cutting woody plants at ground level and then immediately painting the stem with a systemic herbicide, usually Glyphosate. This can be undertaken throughout the year but is best implemented when the plant is actively growing, generally over the warmer months of the year. Treatment using this method may have a poor result if the plant is dormant (e.g. deciduous plants over winter) or if applied during very hot weather.

This method is likely to be useful for controlling more localised patches of woody weeds in Eltham Copper Butterfly habitat areas. As long as herbicide is applied carefully to the stem of the woody weed, there is unlikely to be any adverse impacts to surrounding flora or fauna. As a precautionary measure, no cut-paint should be undertaken closer than one metre from a host *Bursaria* plant.

### ***Drill-fill***

The 'drill-fill method is implemented by drilling a series of short holes around the base of the stem of exotic woody plants and then injecting a systemic herbicide, usually Glyphosate. This method is ideal for larger woody plants that may have thick stems/trunks that are difficult to cut through. Similar to the 'cut-paint' method, treatment using this method may have a poor result if the plant is dormant (e.g. deciduous plants over winter) or if applied during very hot weather.

### ***Species enrichment plantings***

Species enrichment plantings generally involve planting of forbs, grasses and shrubs that are appropriate to the EVC but which have been lost from many remnants. A variety of daisies, lilies and peas are generally the most desirable for species enrichment plantings as many of these groups have been depleted. It is essential that digging and ground disturbance is minimised when planting into areas containing intact groundflora. This can be achieved by using a long handle crow bar rather than a mattock which tends to cause more disturbance. Species enrichment plantings are only likely to succeed if properly planned, protected from grazing and subject to follow-up watering and weed control.

## 10.0 Action Plan

The following action plan outlines proposed management works at the Castlemaine Botanical Gardens Flora and Fauna Reserve over the next ten years (2020-2030). An adaptive management approach requires that land managers assess the progress of works at regular intervals and adapt the management regime where considered necessary. The indicative cost provided in the resources section is an approximate estimate only, as the cost will depend on the rate of the contractor or supplier as well as the finer details of any works carried out.

Objective 1 – Weed control									
Action No.	Action	Zone(s)	Priority locations	Years	Frequency and timing	Responsibility	Priority	Cost/Resources	Additional information
1.1	Control high threat woody weeds, with priority species including Montpellier Broom, Flax-leaf Broom and Mock Privet. Plants to be removed by hand where possible with larger patches controlled using cut-paint or herbicide application if necessary.	All zones	Priority to be given to Management Zone 1 in areas of Eltham Copper Butterfly habitat and sites supporting diverse indigenous groundflora, expanding into less intact areas (e.g. Zones 2, 3 and 6). Scattered Broom plants in the north-west section of Management Zone 1 are a high priority.	1 to 10	Annually. Winter-spring is the best time for hand pulling due to the moister soils. Spring-summer is the most effective season for cut-paint, excluding during very hot conditions.	MASC with support from volunteer groups	High	Contractor \$50-80 per hour. 16-20 hrs each year.	Woody weed control will require regular follow-up works due to persistent soil seed banks.
1.2	Control Large Quaking-grass, Annual Veldt-grass and other herbaceous weeds around host Sweet Bursaria plants by hand removal only. De-heading seeds and removal from the reserve could be considered where disturbance of the soil needs to be avoided.	1, 2, 3 and 6	Management Zone 1 is the highest priority as this is where the majority of host Bursaria plants for Eltham Copper Butterfly have been recorded in the past (mostly top of ridge in western section). If future monitoring highlights new areas as supporting host plants, this work should be prioritised accordingly.	1 to 10	Annually. Late winter through to early spring, prior to seed maturing.	MASC with support from volunteer groups	Moderate	Contractor \$50-80 per hour. 16-20 hrs each year.	This action should be trialled around several patches of Bursaria, rather than across the whole site. It is only to be undertaken by highly skilled workers who take care to avoid disturbing nests of <i>Notoncus</i> ants. Quaking-grass has relatively short-lived seed so 2-3 consecutive years of control in one area will drastically reduce cover.
1.3	Control and where possible eradicate needle-grass species – Chilean Needle-grass, Cane Needle-grass and Texas Needle-grass. Control by hand removal, herbicide application and mulching.	4, 5 and 6	The largest infestations currently occur in Zone 4 and 5, although any new infestations detected in other zones require immediate control.	1 to 10	Annually. These weeds are most easily detected in October-November prior to seed maturing.	MASC with support from volunteer groups	High	Contractor \$50-80 per hour. 16-20 hrs each year.	Larger patches likely to be best controlled using grass-specific herbicide. Seed can persist for up to ten years so follow-up control essential. Treated areas could be mulched and possibly revegetated to prevent reinvasion.
1.4	Remove row of Atlantic Cedar to prevent loss of native understorey vegetation.	6	-	1-3	Anytime	MASC	Moderate	Removal of entire stand \$3,000-5,000	Care must be taken to avoid excessive disturbance to the grassy native understorey when removing these trees.
1.5	Remove younger Radiata Pine trees that are not of heritage significance.	4 and 6	The gully in Zone 4 is the highest priority for this action, beginning in the northern portion and removing as many Pines as possible to the south. Removal of the Pines in Zone 6 should also be considered to aid the remnants of native	1-10	Anytime	MASC	Moderate	Smaller trees less than \$1,000 each. 3-5,000 per large tree	Removal of Pines from Zone 6 is desirable but would also likely require follow-up rehabilitation if not natural recruitment of indigenous species occurs.



Objective 1 – Weed control									
Action No.	Action	Zone(s)	Priority locations	Years	Frequency and timing	Responsibility	Priority	Cost/Resources	Additional information
			understorey, prioritizing trees in the northern part of the stand, progressing to the south..						
1.6	Control Angular Pigface ( <i>*Malephora crocea</i> ) and other succulent weeds along northern section of Froomes Road. Control by hand removal.	1	Most plants occur along the edge of the road cutting.	1-3	Anytime, plants most easily detected when flowering in October.	MASC	Moderate	<\$200 (first 1-2 years).	All plants must be removed from the reserve due to the ability to re-sprout from broken stems.
1.7	Remove any dumped garden waste found within the reserve due to potential to spread weeds.	All zones	Management Zone 1 is the highest priority due to the presence of high-quality vegetation and ECB habitat.	1-10	When detected	MASC	High	<\$200 (when required).	-

Objective 2 – Protect, manage and enhance the Eltham Copper Butterfly population									
Action No.	Action	Zone(s)	Priority locations	Years	Timing and frequency	Responsibility	Priority	Cost/Resources	Additional information
2.1	Control high threat weeds around core areas of Eltham Copper Butterfly habitat (see Actions 1.2 and 1.2)	1, 2 and 3	Core areas of Eltham Copper Butterfly habitat – hotspots for larvae food plants and adult flight paths. Scattered Broom plants in the north-west section of Management Zone 1 are a high priority.	1 to 10	Dependant on target weed.	MASC with support from volunteer groups and funding from DELWP.	High	Contractor \$50-80 per hour. 16-20 hrs each year.	This action is only to be undertaken by highly skilled workers who take care to avoid disturbing nests of <i>Notoncus</i> ants.
2.2	Monitor the number of adult ECB butterflies each summer	1, 2 and 3	Across the seven transects established by Bayes (2011)	1 to 10	Ideally conducted twice a month between the months of November-February. At a minimum, twice a month over November and December.	MASC with support from volunteer groups and funding from DELWP.	High	Contractor \$90-130/hr. 6 visits x 2hrs = 12 hrs each year.	Conducting this monitoring each year consistently is essential in order to determine overall health of the ECB population over time.
2.3	Monitor Sweet Bursaria health and consider monitoring ECB larvae, particularly their distribution within the reserve.	1, 2 and 3	Monitor Sweet Bursaria in quadrats established by Bayes (2011).	1 to 10	Sweet Bursaria anytime, but ideally in November when flowering. Larvae monitoring in October-November.	MASC with support from volunteer groups and funding from DELWP.	Moderate	Contractor \$90-130/hr. 6-8 hrs each year.	Monitoring ECB larvae is very time consuming and is not recommended as the main method for monitoring the overall population (see adult counts Action 2.2). However, determining where the larvae are concentrated within the reserve each season would be of great value to better target management works. Larvae searches best undertaken with the help of at least five volunteers.

Objective 2 – Protect, manage and enhance the Eltham Copper Butterfly population									
Action No.	Action	Zone(s)	Priority locations	Years	Timing and frequency	Responsibility	Priority	Cost/Resources	Additional information
2.4	Do not carry out any burning within areas of potential ECB habitat unless part of a small trial designed and informed by ECB experts.	1, 2 and 3	Areas supporting Sweet Bursaria	1 to 10	Anytime	MASC	High	NA	Inappropriate burning of ECB habitat would likely lead to decline or local extinction of the species and trigger the EPBC Act.
2.5	Plant further patches of Sweet Bursaria to increase host plant availability for ECB (see Action 6.1)	1 and 3	Areas that contain limited indigenous plant cover but are near existing ECB habitat, particularly all of Zone 3.	1-5	Plant in autumn after first rains.	MASC	High	\$1-2,000 (one-off cost)	Plants should be planted in dense clusters to improve chance of ECB utilisation. This could include groups of 10-20 plants planted 1-2 meters apart. Weed control and follow-up watering over late spring and summer will be required with any planting.
2.6	Install interpretive signs with information on the ECB throughout the reserve, including at front entrances	1	Key entrance points including carparks on Froomes Road and beginning of trails in the east and south.	1 to 3	Anytime	MASC	High	\$5-10,000 (one-off cost)	
2.7	Install significant roadside vegetation signs along Froomes Road to prevent damage to indigenous vegetation.	1	Along Froomes Road.	1 to 3	Anytime	MASC	High	\$1-2,000 (one-off cost)	These signs should alert contractors to the presence of an EPBC listed species and recommend contacting Council environmental officer prior to beginning any works.

Objective 3 – Improve community awareness and raise profile of the reserve									
Action No.	Action	Zone(s)	Priority locations	Years	Timing and frequency	Responsibility	Priority	Cost/Resources	Additional information
3.1	Install welcome signs to the reserve at key entry points.	1 and 5	Froomes Road carparks, beginning of trails near bushland area and near Barker Creek.	1-2	Anytime	MASC	High	\$5-10,000 (one-off cost)	These signs should ideally be small, visually appealing colour billboards with information about the reserve and its ecological values. The signs should clearly state which activities are not permitted, such as dumping of garden waste and rubbish.
3.2	Prepare and install interpretive signage. Key themes to include the Eltham Copper Butterfly, its ecology and threats, as well as general flora and fauna.	1 and 5	Along trail network in Zone 1 and along Barkers Creek.	1 to 3	Anytime	MASC	High	\$5-10,000 (one-off cost)	



Objective 3 – Improve community awareness and raise profile of the reserve									
Action No.	Action	Zone(s)	Priority locations	Years	Timing and frequency	Responsibility	Priority	Cost/Resources	Additional information
3.3	Consider developing a podcast that walkers can listen to while walking through the reserve.	All zones	-	1-5	NA	MASC, could partner with other local environmental organisations	Moderate	\$1-2,000 (one-off cost)	The podcast could focus on the story of the Eltham Copper Butterfly and its conservation
3.4	Establish a Friends of the Castlemaine Botanical Gardens Flora and Fauna Reserve group	All zones	Management Zones 1, 2 and 3 where ECB occur, as well as Barkers Creek	1-3	NA	MASC	High	-	This group could drive key management programs such as weed control and monitoring of the ECB.

Objective 4 – Visitor use									
Action No.	Action	Zone(s)	Priority locations	Years	Timing and frequency	Responsibility	Priority	Cost/Resources	Additional information
4.1	Enforce dogs on-lead and restrict bike riding to the designated trails.	All zones	-	1-10	-	MASC	High	-	These changes, and any others should be made clear on new signs to be installed (See Action 3.1)
4.2	Continue to support the Castlemaine Bush Kinder Group	All zones	-	1-10	-	MASC, Castlemaine Bush Kinder	High	-	Castlemaine Bush Kinder should be allowed to continue using the reserve and their activities supported by Council where possible.
4.3	Prevent establishment of new walking trails across the bushland area	1, 3 and 6	Areas with a high cover of native groundflora or Sweet Bursaria plants.	1-10	Check reserve at least twice a year to monitor for new trails	MASC	High	-	The creation of new trails can be discouraged by placing logs, rocks or other features near the starting point from existing trails, therefore discouraging visitors from taking these routes.

Objective 4 – Visitor use									
Action No.	Action	Zone(s)	Priority locations	Years	Timing and frequency	Responsibility	Priority	Cost/Resources	Additional information
4.4	Install picnic table and chairs near Barkers Creek	5	Best situated in a shady location near the walking trail.	1-3	Anytime	MASC	Moderate	\$1-2,000 (one-off cost)	-
4.5	Monitor visitor impacts	All zones	Management Zone 1 is the highest priority due to the presence of high-quality vegetation and ECB habitat.	1-10	A walk over of the reserve should be conducted at least once every two months.	MASC	High	\$1-200 (per assessment).	-

Objective 5 – Trails, carparks and other infrastructure									
Action No.	Action	Zone(s)	Priority locations	Years	Timing and frequency	Responsibility	Priority	Cost/Resources	Additional information
5.1	Repair trails in the bushland section, including filling in pot holes and ruts and possibly constructing small sets of stairs.	1 and 6	The northern trail that runs through Zone 1 and 6 is in most need of repair, including the connecting trail from the western Froomes Rd carpark.	1-2	Anytime	MASC	High	\$5-10,000 (one-off cost)	It is essential that all works do not impact on adjacent native vegetation. Works should be conducted by operators experienced in working in sensitive environmental sites and no-go zones should be marked adjacent to the trail. No soil can be dumped onto native vegetation and no drainage lines cut off the trail into the bushland area. Machinery must be cleaned before entering site.
5.2	Repair the western Froomes Road carpark.	1	-	1-2	Anytime	MASC	High	\$10-20,000 (one-off cost)	The carpark should be improved by levelling and filling in ruts so that all cars can easily drive onto the carpark. It is essential that all works do not impact on adjacent native vegetation.
5.3	Replace the current barbed-wire fence at the entrance to the eastern Froomes Road carpark with a visually pleasing timber fence and gate.	5	-	1-2	Anytime	MASC	High	\$10-20,000 (one-off cost)	The current barb wire fence is a potential hazard to both visitors and native wildlife.



Objective 5 – Trails, carpark and other infrastructure									
Action No.	Action	Zone(s)	Priority locations	Years	Timing and frequency	Responsibility	Priority	Cost/Resources	Additional information
5.4	Improve entrance at the western Froomes Road carpark, including replacing bollards and improving crossing over drainage-line.	1	-	1-2		MASC	Moderate	\$10-20,000 (one-off cost)	The current bollards could be replaced with a visually appealing timber fence and gate or some better bollards. The gravel crossing over the drainage line needs to be widened and improved for visitor access.
5.5	Replace chain at vehicle entry trail near western Froomes Road carpark.	1	-	1-2	Anytime	MASC	Moderate	\$2-300 (one-off cost)	This trail should be maintained to allow access by Council staff but needs to be locked with a chain to prevent access by trespassing vehicles.

Objective 6 – Revegetation and species enrichment plantings									
Action No.	Action	Zone(s)	Priority locations	Years	Timing and frequency	Responsibility	Priority	Cost/Resources	Additional information
6.1	Plant further patches of Sweet Bursaria to increase host plant availability for ECB.	1 and 3	Areas that contain limited indigenous plant cover but are near existing ECB habitat, particularly all of Zone 3.	1-5	Plant in autumn after first rains.	MASC	High	\$1-2,000 (one-off cost)	Plants should be planted in dense clusters to improve chance of ECB utilisation. This could include groups of 10-20 plants planted 1-2 meters apart. Weed control and follow-up watering over late spring and summer will be required with any planting.
6.2	Improve groundflora species diversity and abundance through planting less common herbaceous species.	1	Best undertaken in small patches with limited remnant groundflora, adjacent to better vegetation.	1-5	Plant in autumn after first rains.	MASC	Moderate	\$1-2,000 (one-off cost)	Smaller plants are always best planted in high densities, app. 30cm apart, to reduce weed competition. Weed control and follow-up watering over late spring and summer will be required with any planting.

Objective 6 – Revegetation and species enrichment plantings									
Action No.	Action	Zone(s)	Priority locations	Years	Timing and frequency	Responsibility	Priority	Cost/Resources	Additional information
6.3	Revegetate areas along Barkers Creek and nearby flats	5 and 6	Northern section of Barkers Creek, depression to the west of the eastern Froomes Road entrance, scattered patches across the currently open floodplain.	1-5	Plant in autumn after first rains.	MASC, NCCMA, with support of local volunteer groups such as Barkers Creek Landcare and Wildlife Group and care Group	Moderate	\$3-5,000 (one-off cost)	The central section of Barkers Creek should be kept relatively open to maintain views across the gardens, with denser plantings undertaken in the northern section. Scattered copses should be established across the currently open floodplain. Areas successfully treated for needle-grass (see Action 1.3) could potentially be mulched and revegetated.

Objective 7 – Barkers Creek									
Action No.	Action	Zone(s)	Priority locations	Years	Timing and frequency	Responsibility	Priority	Cost/Resources	Additional information
7.1	Support Waterwatch activities along Barkers Creek	5	-	1-10	-	MASC, NCCMA, with support of local volunteer groups such as Barkers Creek Landcare and Wildlife Group	High	-	
7.2	Revegetate areas along Barkers Creek and nearby flats (see Action 6.3)	5	Northern section of Barkers Creek	1-5	Plant in autumn after first rains.	MASC, NCCMA, with support of local volunteer groups such as Barkers Creek Landcare and Wildlife Group	Moderate	\$3-5,000 (one-off cost)	The central section of Barkers Creek should be kept relatively open to maintain views across the gardens, with denser plantings undertaken in the northern section.
7.3	Report any water quality contamination issues to the EPA	5	-	1-10	When required	MASC, EPA, NCCMA	High	-	-



Objective 8 – Pest animal control									
Action No.	Action	Zone(s)	Priority locations	Years	Timing and frequency	Responsibility	Priority	Cost/Resources	Additional information
8.1	Fill in any rabbit and fox warrens/dens recorded within the reserve.	All zones	-	1-10	As soon detected.	MASC	High	\$2-400 (per warren).	Care should be taken not to disturb native vegetation and habitat when filling in warrens or dens.
8.2	Treat any wasp nests recorded within the reserve.	All zones	-	1-10	Spring-summer	MASC	High	\$1-200 (per nest)	-

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*Wild plants of the Castlemaine District* (<https://www.castlemaineflora.org.au>)

**Appendix 1 Flora species recorded within the Castlemaine Botanical Gardens Flora and Fauna Reserve**

Legend	
*	exotic taxa
#	non-indigenous native taxa
P	planted indigenous taxa
CFN	recorded by Castlemaine Field Naturalists Club
CE	listed as 'critically endangered' under the Flora and Fauna Guarantee Act 1988
E	listed as 'endangered' under the Flora and Fauna Guarantee Act 1988

Origin	Scientific name	Common name	Status
	<i>Acacia acinacea</i> s.s.	Gold-dust Wattle	
	<i>Acacia aspera</i>	Rough Wattle	
#	<i>Acacia baileyana</i>	Cootamundra Wattle	
#	<i>Acacia baileyana</i> x <i>decurrens</i>	Hybrid Wattle	
P	<i>Acacia dealbata</i> subsp. <i>dealbata</i>	Silver Wattle	
#	<i>Acacia decurrens</i>	Early Black-wattle	
#	<i>Acacia euthycarpa</i>	Wallowa	
	<i>Acacia genistifolia</i>	Spreading Wattle	
	<i>Acacia implexa</i>	Lightwood	CFN
#	<i>Acacia iteaphylla</i>	Flinders Range Wattle	
	<i>Acacia mearnsii</i>	Black Wattle	
P	<i>Acacia melanoxylon</i>	Blackwood	
P	<i>Acacia paradoxa</i>	Hedge Wattle	
#	<i>Acacia pravissima</i>	Ovens Wattle	
#	<i>Acacia prominens</i>	Gosford Wattle	
P	<i>Acacia provincialis</i>	Wirilda	
	<i>Acacia pycnantha</i>	Golden Wattle	
	<i>Acaena agnipila</i>	Hairy Sheep's-burr	CFN
	<i>Acaena echinata</i>	Sheep's Burr	
*	<i>Acetosella vulgaris</i>	Sheep Sorrel	CFN
*	<i>Agave americana</i>	Century plant	
*	<i>Agrostis capillaris</i> var <i>capillaris</i>	Brown-top Bent	CFN
*	<i>Aira cupaniana</i>	Quicksilver Grass	
*	<i>Aira elegantissima</i>	Delicate Hair-grass	
*	<i>Allium triquetrum</i>	Angled Onion	
*	<i>Allium vineale</i>	Crow Garlic	
	<i>Amyema miquelii</i>	Box Mistletoe	
	<i>Anthosachne scabra</i> s.s.	Common Wheat-grass	
*	<i>Aphanes arvensis</i>	Parsley Piert	
	<i>Aphanes australiana</i>	Australian Piert	CFN
*	<i>Arctotheca calendula</i>	Cape Weed	
	<i>Arthropodium minus</i>	Small Vanilla-lily	CFN
	<i>Arthropodium strictum</i> s.s.	Chocolate Lily	
*	<i>Asparagus asparagoides</i>	Bridal Creeper	



Origin	Scientific name	Common name	Status
*	<i>Asparagus officinalis</i>	Asparagus	CFN
	<i>Astroloma humifusum</i>	Cranberry Heath	
*	<i>Atriplex prostrata</i>	Hastate Orache	CFN
	<i>Austrostipa blackii</i>	Crested Spear-grass	CFN
	<i>Austrostipa densiflora</i>	Dense Spear-grass	CFN
	<i>Austrostipa mollis</i>	Spear-grass	
	<i>Austrostipa nodosa</i>	Knotty Spear-grass	CFN
	<i>Austrostipa oligostachya</i>	Fine-head Spear-grass	CFN
	<i>Austrostipa rudis</i>	Veined Spear-grass	CFN
	<i>Austrostipa scabrassp. Falcata</i>	Rough Spear-grass	
	<i>Austrostipa stuposa</i>	Quizzical Spear-grass	CFN
*	<i>Avena barbata</i>	Bearded Oat	CFN
*	<i>Billardiera heterophylla</i>	Bluebell Creeper	
	<i>Brachyloma daphnoides</i>	Daphne Heath	CFN
?P	<i>Brachyscome multifida</i>	Cut-leaf Daisy	
*	<i>Briza maxima</i>	Large Quaking-grass	
*	<i>Briza minor</i>	Lesser Quaking-grass	
*	<i>Bromus catharticus</i>	Prairie Grass	
*	<i>Bromus diandrus</i>	Great Brome	
*	<i>Bromus hordeaceus subsp. hordeaceus</i>	Soft Brome	
	<i>Burchardia umbellata</i>	Milkmaids	CFN
	<i>Bursaria spinosa subsp. spinosa</i>	Sweet Bursaria	
	<i>Caesia calliantha</i>	Blue Grass-lily	CFN
	<i>Caladenia carnea s.l.</i>	Pink Fingers	CFN
#	<i>Callistemon citrinus</i>	Crimson Bottlebrush	
P	<i>Callistemon sieberi</i>	Bottlebrush	
#	<i>Callistemon spp.</i>	Bottlebrush	
	<i>Calocephalus citreus</i>	Lemon Beauty-heads	
*	<i>Cardamine hirsuta s.s.</i>	Common Bitter-cress	
	<i>Carex appressa</i>	Tall Sedge	
	<i>Carex inversa</i>	Knob Sedge	
	<i>Cassinia sifton</i>	Sifton Bush	
*	<i>Cerastium glomeratum s.s.</i>	Sticky Mouse-ear Chickweed	
	<i>Cheilanthes austrotenuifolia</i>	Green Rock-fern	
	<i>Cheilanthes sieberi</i>	Narrow Rock-fern	CFN
	<i>Chrysocephalum apiculatum s.s.</i>	Common Everlasting	
	<i>Chrysocephalum semipapposum</i>	Clustered Everlasting	
*	<i>Cichorium intybus</i>	Chicory	
*	<i>Cirsium vulgare</i>	Spear Thistle	
*	<i>Claytonia perfoliata</i>	Miner's Lettuce	
*	<i>Conyza bonariensis</i>	Flaxleaf Fleabane	
P	<i>Correa glabra var. glabra</i>	Rock Correa	
	<i>Corunastylis despectans</i>	Sharp Midge-orchid	
*	<i>Cotoneaster franchetii</i>	Grey Cotoneaster	
*	<i>Cotoneaster glaucophyllus var. serotinus</i>	Large-leaf Cotoneaster	
*	<i>Cotoneaster pannosus</i>	Velvet Cotoneaster	
#	<i>Cotula coronopifolia</i>	Water Buttons	CFN
	<i>Craspedia variabilis</i>	Variable Billy-buttons	
	<i>Crassula decumbens var. decumbens</i>	Spreading Crassula	
	<i>Crassula helmsii</i>	Swamp Crassula	CFN
	<i>Crassula peduncularis</i>	Purple Crassula	CFN

Origin	Scientific name	Common name	Status
	<i>Crassula sieberiana</i> s.s.	Sieber Crassula	
*	<i>Crataegus monogyna</i>	Hawthorn	
*	<i>Cynodon dactylon</i> var. <i>dactylon</i>	Couch	
	<i>Cynoglossum suaveolens</i>	Sweet Hound's-tongue	CFN
*	<i>Cynosurus echinatus</i>	Rough Dog's-tail	
*	<i>Cyperus eragrostis</i>	Drain Flat-sedge	
*	<i>Cytisus scoparius</i>	English Broom	
*	<i>Dactylis glomerata</i>	Cocksfoot	
	<i>Daucus glochidiatus</i>	Australian Carrot	
	<i>Daviesia leptophylla</i>	Narrow-leaf Bitter-pea	
	<i>Daviesia ulicifolia</i> subsp. <i>ruscifolia</i>	Gorse Bitter-pea	
?P	<i>Derwentia perfoliata</i>	Digger's Speedwell	
	<i>Desmodium varians</i>	Slender Tick-trefoil	
	<i>Dianella revoluta</i> s.l.	Black-anther Flax-lily	
	<i>Dianella tarda</i>	Late-flower Flax-lily	CE
	<i>Dichelachne crinita</i>	Long-hair Plume-grass	CFN
	<i>Dichelachne rara</i>	Common Plume-grass	CFN
*	<i>Digitaria sanguinalis</i>	Summer Grass	CFN
	<i>Dillwynia cinerascens</i> s.s.	Grey Parrot-pea	
	<i>Dillwynia sericea</i>	Showy Parrot-pea	
	<i>Diuris chryseopsis</i>	Golden Moths	CFN
	<i>Diuris pardina</i>	Leopard Orchid	CFN
?P	<i>Dodonaea viscosa</i>	Sticky Hop-bush	
	<i>Drosera aberrans</i>	Scented Sundew	
*	<i>Ehrharta erecta</i> var. <i>erecta</i>	Panic Veldt-grass	CFN
*	<i>Ehrharta erecta</i> var. <i>erecta</i>	Panic Veldt-grass	
*	<i>Ehrharta longiflora</i>	Annual Veldt-grass	
	<i>Einadia nutans</i> subsp. <i>nutans</i>	Nodding Saltbush	
	<i>Epilobium billardierianum</i> subsp. <i>cinereum</i>	Grey Willow-herb	
	<i>Epilobium hirtigerum</i>	Hairy Willow-herb	CFN
*	<i>Erodium moschatum</i>	Musky Heron's-bill	
	<i>Eryngium ovinum</i>	Blue Devil	CFN
	<i>Eucalyptus camaldulensis</i> subsp. <i>camaldulensis</i>	River Red-gum	
	<i>Eucalyptus leucoxylon</i> subsp. <i>pruinosa</i>	Yellow Gum	
	<i>Eucalyptus macrorhyncha</i>	Red Stringybark	
	<i>Eucalyptus melliodora</i>	Yellow Box	
	<i>Eucalyptus microcarpa</i>	Grey Box	
	<i>Eucalyptus nortonii</i>	Silver Bundy	
	<i>Eucalyptus polyanthemos</i> subsp. <i>vestita</i>	Red Box	
	<i>Exocarpos cupressiformis</i>	Cherry Ballart	
*	<i>Festuca arundinacea</i>	Tall Fescue	
*	<i>Fraxinus angustifolia</i>	Desert Ash	
*	<i>Freesia alba</i> x <i>Freesia leichtlinii</i>	Freesia	
*	<i>Fumaria bastardii</i>	Bastard's Fumitory	
*	<i>Fumaria muralis</i> ssp. <i>muralis</i>	Wall Fumitory	CFN
*	<i>Galium aparine</i>	Cleavers	
	<i>Galium gaudichaudii</i>	Rough Bedstraw	CFN
*	<i>Gazania linearis</i>	Gazania	
*	<i>Genista linifolia</i>	Flax-leaf Broom	
*	<i>Genista monspessulana</i>	Montpellier Broom	
	<i>Geranium gardneri</i>	Austral Cranesbill	CFN

Origin	Scientific name	Common name	Status
	<i>Geranium retrorsum</i>	Grassland Cranesbill	CFN
	<i>Geranium sp. 2</i>	Variable Crane's-bill	
	<i>Glossodia major</i>	Wax-lip Orchid	
	<i>Gompholobium huegelii</i>	Common Wedge-pea	CFN
	<i>Gonocarpus tetragynus</i>	Common Raspwort	
	<i>Goodenia pinnatifida</i>	Cut-leaf Goodenia	CFN
	<i>Grevillea alpina</i>	Cat's Claw Grevillea	
*	<i>Grevillea robusta</i>	Silky Oak	
#	<i>Grevillea rosmarinifolia</i> hybrids	Rosemary Grevillea hybrids	
	<i>Grevillea rosmarinifolia X alpina</i>	Grevillea	CFN
#	<i>Grevillea spp.</i>	Grevillea	
	<i>Hakea decurrens</i>	Bushy Needlewood	
#	<i>Hakea laurina</i>	Pincushion Hakea	
	<i>Hardenbergia violacea</i>	Purple Coral-pea	CFN
*	<i>Hedera helix</i>	English Ivy	
	<i>Hibbertia exutiacies</i>	Spiky Guinea-flower	CFN
*	<i>Holcus annuus</i>	Annual Fog	CFN
*	<i>Holcus lanatus</i>	Yorkshire Fog	CFN
	<i>Hovea heterophylla</i>	Common Hovea	
	<i>Hydrocotyle laxiflora</i>	Stinking Pennywort	
*	<i>Hypochaeris glabra</i>	Smooth Cat's-ear	
*	<i>Hypochaeris radicata</i>	Flatweed	
	<i>Hypoxis glabella</i> var. <i>glabella</i>	Tiny Star	CFN
	<i>Indigofera australis</i>	Austral Indigo	CFN
#	<i>Isolepis marginata</i>	Little Club-rush	CFN
*	<i>Juncus acutus</i> subsp. <i>acutus</i>	Spiny Rush	
	<i>Juncus amabilis</i>	Hollow Rush	
*	<i>Juncus articulatus</i>	Jointed Rush	
#	<i>Juncus bufonius</i>	Toad Rush	CFN
*	<i>Juncus capitatus</i>	Capitate Rush	CFN
	<i>Juncus remotiflorus</i>	Diffuse Rush	
	<i>Juncus subsecundus</i>	Finger Rush	
*	<i>Juniperus oxycedrus</i>	Common Juniper	
	<i>Lachnagrostis filiformis</i>	Common Blown-grass	CFN
*	<i>Lactuca serriola</i>	Prickly Lettuce	CFN
	<i>Lagenophora huegelii</i>	Coarse Bottle-daisy	
*	<i>Lepidium africanum</i>	Common Peppercross	
	<i>Lepidosperma laterale</i> var. <i>laterale</i>	Variable Sword-sedge	
	<i>Leptorhynchus squamatus</i>	Scaly Buttons	CFN
	<i>Levenhookia dubia</i>	Hairy Stylewort	
*	<i>Limonium sinuatum</i>	Notch-leaf Sea-lavender	CFN
*	<i>Linaria pelisseriana</i>	Pelisser's Toad-flax	CFN
	<i>Linum marginale</i>	Native Flax	CFN
	<i>Lomandra filiformis</i> subsp. <i>coriacea</i>	Wattle Mat-rush	
P #	<i>Lomandra longifolia</i>	Spiny-headed Mat-rush	
	<i>Lomandra multiflora</i> ssp. <i>multiflora</i>	Many-flowered Mat-rush	CFN
	<i>Lomandra nana</i>	Dwarf Mat-rush	
*	<i>Lycium ferocissimum</i>	Box Thorn	
	<i>Lythrum hyssopifolia</i>	Small Loosestrife	
*	<i>Malus pumila</i>	Apple	
*	<i>Malva neglecta</i>	Dwarf Mallow	CFN



Origin	Scientific name	Common name	Status
*	<i>Malva parviflora</i>	Small-flower Mallow	
*	<i>Medicago lupulina</i>	Black Medic	CFN
*	<i>Medicago polymorpha</i>	Burr Medic	CFN
#	<i>Melaleuca decussata</i>	Totem-poles	
*	<i>Melaleuca styphelioides</i>	Prickly Paperbark	
*	<i>Melilotus indicus</i>	Sweet Melilot	CFN
*	<i>Mesembryanthemum spp.</i>	Ice Plant	
	<i>Microlaena stipoides var stipoides</i>	Weeping Grass	CFN
	<i>Microseris walteri</i>	Yam Daisy	
	<i>Microtis unifolia</i>	Common Onion-orchid	CFN
*	<i>Modiola caroliniana</i>	Red-flower Mallow	
*	<i>Muscari armeniacum</i>	Grape Hyacinth	
*	<i>Nassella hyalina</i>	Cane Needle-grass	
*	<i>Nassella leucotricha</i>	Texas Needle-grass	
*	<i>Nassella neesiana</i>	Chilean Needle-grass	
*	<i>Opuntia stricta</i>	Common Prickly-pear	
*	<i>Oxalis brasiliensis</i>	Brazilian Wood-sorrel	
*	<i>Oxalis debilis var corymbosa</i>	Pink Shamrock	CFN
*	<i>Oxalis pes-caprae</i>	Soursob	
*	<i>Oxalis purpurea</i>	Large-flower Wood-sorrel	
	<i>Ozothamnus obcordatus</i>	Grey Everlasting	
*	<i>Panicum capillare</i>	Witch Grass	CFN
*	<i>Papaver dubium</i>	Long-headed Poppy	CFN
*	<i>Paspalum dilatatum</i>	Paspalum	
	<i>Pauridia glabella var. glabella</i>	Tiny Star	
	<i>Pelargonium rodneyanum</i>	Magenta Stork's-bill	
*	<i>Petrorhagia dubia</i>	Velvety Pink	
*	<i>Phalaris aquatica</i>	Toowoomba Canary-grass	
*	<i>Phillyrea indica</i>	Mock Privet	
*	<i>Phillyrea latifolia</i>	Broad-leaf Jasmine-box	
	<i>Philotheca verrucosa</i>	Fairy Wax-flower	
	<i>Phragmites australis</i>	Common Reed	
	<i>Pimelea curviflora s.l.</i>	Curved Rice-flower	CFN
	<i>Pimelea linifolia</i>	Slender Rice-flower	
*	<i>Pinus halepensis</i>	Aleppo Pine	CFN
*	<i>Pinus pinea</i>	Stone Pine	CFN
*	<i>Pinus radiata var. radiata</i>	Radiata Pine	
*	<i>Pinus sabiniana</i>	Digger Pine	CFN
*	<i>Piptatherum miliaceum</i>	Rice Millet	
	<i>Plantago gaudichaudii</i>	Narrow Plantain	
*	<i>Plantago lanceolata</i>	Ribwort	
*	<i>Plantago major</i>	Greater Plantain	
	<i>Plantago varia</i>	Variable Plantain	
*	<i>Poa annua</i>	Annual Meadow-grass	
*	<i>Poa bulbosa</i>	Bulbous Meadow-grass	
P	<i>Poa labillardierei var. labillardierei</i>	Common Tussock-grass	
	<i>Poa morrisii</i>	Soft Tussock-grass	CFN
*	<i>Poa pratensis</i>	Kentucky Blue-grass	
	<i>Poa sieberiana var. hirtella</i>	Grey Tussock-grass	
	<i>Poa sieberiana var. sieberiana</i>	Grey Tussock-grass	
*	<i>Poa trivialis</i>	Rough Meadow-grass	CFN

Origin	Scientific name	Common name	Status
	<i>Podolepis jaceoides s.s.</i>	Showy Podolepis	CFN
*	<i>Polygonum aviculare</i>	Prostrate Knotweed	CFN
*	<i>Populus alba</i>	White Poplar	
#	<i>Prostanthera melissifolia</i>	Balm Mint-bush	
*	<i>Prunella vulgaris</i>	Self-heal	
*	<i>Prunus cerasifera</i>	Cherry Plum	
*	<i>Prunus cerasifera 'Nigra'</i>	Purple-leaf Cherry-plum	
	<i>Pterostylis nana</i>	Dwarf Greenhood	CFN
	<i>Pterostylis nutans</i>	Nodding Greenhood	
	<i>Pterostylis rubescens</i>	Red-tip Greenhood	E, CFN
	<i>Pterostylis sp. aff. revoluta (Inland)</i>	Large Autumn Greenhood	
	<i>Pultenaea largiflorens</i>	Twiggy Bush-pea	
	<i>Pultenaea pedunculata</i>	Matted Bush-pea	
*	<i>Pyrus spp.</i>	Pear	
*	<i>Quercus canariensis</i>	Algerian Oak	
*	<i>Ranunculus muricatus</i>	Sharp Buttercup	
*	<i>Rhamnus alaternus</i>	Italian Buckthorn	
*	<i>Romulea minutiflora</i>	Small-flower Onion-grass	CFN
*	<i>Romulea rosea var. australis s.s.</i>	Common Onion-grass	
*	<i>Rosa rubiginosa</i>	Sweet Briar	
*	<i>Rubus anglocandicans</i>	Common Blackberry	
	<i>Rumex brownii</i>	Slender Dock	
*	<i>Rumex conglomeratus</i>	Clustered Dock	
*	<i>Rumex crispus</i>	Curled Dock	
	<i>Rytidosperma caespitosum</i>	Common Wallaby-grass	CFN
	<i>Rytidosperma erianthum</i>	Hill Wallaby-grass	CFN
	<i>Rytidosperma fulvum</i>	Copper-awned Wallaby-grass	
	<i>Rytidosperma geniculatum</i>	Kneed Wallaby-grass	CFN
	<i>Rytidosperma pallidum</i>	Silvertop Wallaby-grass	
	<i>Rytidosperma penicillatum</i>	Slender Wallaby-grass	CFN
	<i>Rytidosperma pilosum</i>	Velvet Wallaby-grass	CFN
	<i>Rytidosperma racemosum var racemosum</i>	Striped Wallaby-grass	CFN
	<i>Rytidosperma setaceum</i>	Bristly Wallaby-grass	
	<i>Rytidosperma spp.</i>	Wallaby Grass	
	<i>Schoenus apogon</i>	Common Bog-sedge	CFN
*	<i>Secale cereale ssp cereale</i>	Rye	CFN
*	<i>Sedum rupestre</i>	Stonecrop	
	<i>Senecio phelleus</i>	Stony Fireweed	
	<i>Senecio quadridentatus</i>	Cotton Fireweed	CFN
*	<i>Setaria verticillata</i>	Whorled Pigeon-grass	CFN
*	<i>Silybum marianum</i>	Variegated Thistle	CFN
*	<i>Solanum nigrum s.s.</i>	Black Nightshade	
	<i>Solenogyne dominii</i>	Smooth Solenogyne	CFN
*	<i>Sonchus asper</i>	Rough Sow-thistle	CFN
*	<i>Sonchus oleraceus</i>	Common Sow-thistle	
*	<i>Stellaria media</i>	Chickweed	
*	<i>Stellaria pallida</i>	Lesser Chickweed	CFN
	<i>Stellaria pungens</i>	Prickly Starwort	CFN
	<i>Stuartina muelleri</i>	Spoon Cudweed	
*	<i>Symphotrichum subulatum</i>	Aster-weed	
*	<i>Taraxacum officinale spp. agg.</i>	Garden Dandelion	

Origin	Scientific name	Common name	Status
	<i>Templetonia stenophylla</i>	Leafy Templetonia	CFN
	<i>Tetradlea ciliata</i>	Pink-bells	
	<i>Thelymitra pauciflora</i>	Slender Sun-orchid	CFN
	<i>Thelymitra</i> spp.	Sun Orchid	
	<i>Themeda triandra</i>	Kangaroo Grass	
	<i>Thysanotus patersonii</i>	Twining Fringe-lily	
*	<i>Tribolium oblitterum</i>	Desmazeria	
	<i>Tricoryne elatior</i>	Yellow Rush-lily	CFN
*	<i>Trifolium angustifolium</i> var. <i>angustifolium</i>	Narrow-leaf Clover	
*	<i>Trifolium arvense</i> var. <i>arvense</i>	Hare's-foot Clover	
*	<i>Trifolium campestre</i> var. <i>campestre</i>	Hop Clover	CFN
*	<i>Trifolium dubium</i>	Suckling Clover	CFN
*	<i>Trifolium fragiferum</i> var. <i>fragiferum</i>	Strawberry Clover	
*	<i>Trifolium glomeratum</i>	Cluster Clover	
*	<i>Trifolium repens</i> var. <i>repens</i>	White Clover	
*	<i>Trifolium subterraneum</i>	Subterranean Clover	
*	<i>Ulex europaeus</i>	Gorse	
*	<i>Ulmus procera</i>	English Elm	
	<i>Velleia paradoxa</i>	Spur Velleia	
*	<i>Veronica arvensis</i>	Wall Speedwell	CFN
*	<i>Veronica hederifolia</i>	Ivy-leaf Speedwell	
*	<i>Viburnum tinus</i>	Laurestinus	
*	<i>Vicia hirsuta</i>	Tiny Vetch	
*	<i>Vicia sativa</i>	Common Vetch	CFN
*	<i>Vinca major</i>	Blue Periwinkle	
*	<i>Vulpia bromoides</i>	Squirrel-tail Fescue	CFN
*	<i>Vulpia ciliata</i>	Fringed fescue	CFN
	<i>Wahlenbergia stricta</i> subsp. <i>stricta</i>	Tall Bluebell	
*	<i>Watsonia meriana</i> var. <i>bulbillifera</i>	Bulbil Watsonia	
	<i>Wurmbea dioica</i>	Common Early Nancy	
	<i>Xerochrysum viscosum</i>	Shiny Everlasting	



## Appendix 2 Fauna species recorded within the Castlemaine Botanical Gardens Flora and Fauna Reserve

Legend	
*	exotic taxa
En	listed as 'endangered' under the Environment Protection and Biodiversity Conservation Act
L	listed as 'threatened' under the Flora and Fauna Guarantee Act
e -	listed as 'endangered' under the Victorian Advisory List

Origin	Common	Scientific	Status
<b>Birds</b>			
	Australian Magpie	<i>Cracticus tibicen</i>	
	Australian Raven	<i>Corvus coronoides</i>	
	Australian Wood Duck	<i>Chenonetta jubata</i>	
	Brown Thornbill	<i>Acanthiza pusilla</i>	
	Brown-headed Honeyeater	<i>Melithreptus brevirostris</i>	
	Crimson Rosella	<i>Platycercus elegans</i>	
	Eastern Spinebill	<i>Acanthorhynchus tenuirostris</i>	
	Galah	<i>Eolophus roseicapillus</i>	
	Golden Whistler	<i>Pachycephala pectoralis</i>	
	Grey Fantail	<i>Rhipidura albiscapa</i>	
	Grey Shrike-thrush	<i>Colluricincla harmonica</i>	
	Little Corella	<i>Cacatua sanguinea</i>	
	Little Raven	<i>Corvus mellori</i>	
	Long-billed Corella	<i>Cacatua tenuirostris</i>	
	Mistletoebird	<i>Dicaeum hirundinaceum</i>	
	Musk Lorikeet	<i>Glossopsitta concinna</i>	
	New Holland Honeyeater	<i>Phylidonyris novaehollandiae</i>	
	Pacific Black Duck	<i>Anas superciliosa</i>	
	Pied Currawong	<i>Strepera graculina</i>	
	Powerful Owl	<i>Ninox strenua</i>	
	Rainbow Lorikeet	<i>Trichoglossus moluccanus</i>	
	Red Wattlebird	<i>Anthochaera carunculata</i>	
	Rufous Whistler	<i>Rufous Whistler</i>	
	Scarlet Honeyeater	<i>Myzomela sanguinolenta</i>	
	Silvereye	<i>Zosterops lateralis</i>	
	Spotted Pardalote	<i>Pardalotus punctatus</i>	
	Striated Pardalote	<i>Pardalotus striatus</i>	
	Striated Thornbill	<i>Acanthiza lineata</i>	
	Sulphur-crested Cockatoo	<i>Cacatua galerita</i>	
	Superb Fairy-wren	<i>Malurus cyaneus</i>	
	Weebill	<i>Smicrornis brevirostris</i>	
	White-faced Heron	<i>Egretta novaehollandiae</i>	
	White-naped Honeyeater	<i>Melithreptus lunatus</i>	
	Yellow-faced Honeyeater	<i>Lichenostomus chrysops</i>	
	Yellow-rumped Thornbill	<i>Acanthiza chrysorrhoa</i>	

Origin	Common	Scientific	Status
<b>Invertebrates</b>			
	Eltham Copper Butterfly	<i>Paralucia pyrodiscus lucida</i>	En, L, e
<b>Frogs</b>			
	Common Froglet	<i>Crinia signifera</i>	
	Southern Borwn Treefrog	<i>Litoria ewingii</i>	
	Spotted Marsh-frog	<i>Limnodynastes tasmaniensis</i>	
<b>Mammals</b>			
	Eastern Grey Kangaroo	<i>Macropus giganteus</i>	
*	Red Fox	<i>Vulpes vulpes</i>	
	Short-beaked Echidna	<i>Tachyglossus aculeatus</i>	
<b>Reptiles</b>			
	Garden Skink	<i>Lampropholis guichenoti</i>	

### Appendix 3 Location of monitoring sites

**Table 1 Location of Eltham Copper Butterfly Transects**

Feature	Zone	East	north
Transect 1 - end	55H	252051	5896019
Transect 1 - start	55H	252067	5896123
Transect 2 - end	55H	252100	5895969
Transect 2 - start	55H	252103	5896084
Transect 3 - end	55H	252140	5896018
Transect 3 - start	55H	252239	5896050
Transect 4 - end	55H	252300	5895975
Transect 4 - start	55H	252304	5895877
Transect 5 - end	55H	252308	5896044
Transect 5 - start	55H	252302	5895995
Transect 6 - end	55H	252090	5896108
Transect 6 - start	55H	252176	5896100
Transect 7 - end	55H	252025	5895986
Transect 7 - start	55H	252015	5896042