

STREAMLINE RESEARCH P. LAN.

Clyde North PSP Cardinia Creek: Threatened Fauna

Conservation Management Plan

Project: 09-100

Prepared for:

Growth Areas Authority



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Contents

1 Introduction 9			
1.1 Study Area 10			10
1.2	Те	rminology	10
2 0	Growl	ing Grass Frog Conservation Management Plan	11
2.1	Ва	ckground Information	13
2.1	1.1	Growling Grass Frog Regional Distribution	14
2.1	.2	Growling Grass Frog Habitat in the Study Area	15
2.1	.3	Vegetation values	17
2.2	Po	tential impacts of the development	18
2.3	Co	nservation Management Plan	21
2.3	3.1	Objectives	21
2.3	3.2	Timeframes	21
2.3	3.3	Responsibilities	22
2.4	Ма	nagement Actions	22
2.4	1.1	Pre-construction: Habitat Protection and Enhancement	22
2.4	1.2	Construction period: Habitat Creation – Wetland Design and Management	25
2.4	1.3	Buffers and Habitat Connectivity	30
2.4	1.4	Revegetation	33
2.4	1.5	Weed Management	42
2.4	1.6	Pest Animal Management	47
2.4	4.7	User related issues	48
2.4	1.8	Roads, pathways, future creek crossings and fencing	53
2.4	1.9	Salvage and Relocation protocols for the Growling Grass Frog	56
2.4	1.10	Monitoring	57
3 C	Dwarf	Galaxias Conservation Management Plan	58
3.1	Inti	roduction	59
3.1	1.1	Study area	59
3.1	.2	Waterways in the study area	59
3.2	Dw	arf Galaxias Background Information	60
3.2	2.1	Status	60
3.2	2.2	Description	60
3.2	2.3	Regional distribution	61
3.2	2.4	Clyde North Precinct	63
3.2	2.5	Habitat requirements	65
3.2	2.6	Populations under threat	65
3.2	2.7	Threatening processes	65
3.2	2.8	National Recovery Plan	66



3.3 Co	onservation Management Plan	67
3.3.1	Objectives	67
3.3.2	Timeframes	67
3.3.3	Responsibilities	68
3.4 M	anagement issues and mitigation measures	68
3.4.1	Overview of floodplain management considerations	68
3.4.2	Floodplain hydrology	70
3.4.3	Protection of existing habitat	70
3.4.4	Floodplain watercourses	71
3.4.5	Cardinia Creek water quality	72
3.4.6	Revegetation of Dwarf Galaxias habitat	73
3.4.7	Pest species	75
3.4.8	Monitoring	75
3.5 Im	plementation and mitigation schedule	76
4 Austi	alian Grayling Conservation Management Plan	79
4.1 In	troduction	79
4.1.1	Study area	80
4.1.2	Waterways in the study area	80
4.2 Au	ustralian Grayling Background Information	80
4.2.1	Status	80
4.2.2	Description and habitat (from Backhouse et al., 2008a)	80
4.2.3	Regional distribution	81
4.2.4	Clyde North Precinct	84
4.2.5	Populations under threat	84
4.2.6	Threatening processes due to human activities (from Backhouse et al., 2008a)	85
4.2.7	National Recovery Plan	86
4.3 Co	onservation Management Plan	86
4.3.1	Objectives	86
4.3.2	Timeframes	87
4.3.3	Responsibilities	87
4.4 M	anagement issues and mitigation measures	87
4.4.1	Overview of floodplain management considerations	87
4.4.2	Protection of existing habitat	89
4.4.3	Water quality and quantity	90
4.4.4	Monitoring	90
4.5 Im	plementation and mitigation schedule	91
5 Threatened Species - Summary of Management Requirements and Implementation Schedule for Development 93		
5.1 De	evelopment Sequencing Schedule	106
5.2 Fu	unding	109
Refere	nces	111

-



6 Acknowledgments

Tables

Table 1 Clyde North PSP Cardinia Creek CMP: Revegetation Zones and management aims.	35
Table 2 Clyde North PSP Cardinia Creek CMP: Plant species suitable for use in terrestrial revegetation.	38
Table 3 Clyde North PSP Cardinia Creek CMP: plant species suitable for use in wetland revegetation.	40
Table 4 Clyde North PSP Cardinia Creek CMP: Weed species identified for elimination or conwithin the study area.	ntrol 44
Table 5 Clyde North PSP Cardinia Creek CMP: Interpretive signage required for the study ar	ea.51
Table 6 Clyde North PSP Cardinia Creek CMP: Native flora in Cardinia Creek areas where the Dwarf Galaxias has been recorded near the Pakenham Bypass (McGuckin, 2005).	าe 73
Table 7 Clyde North PSP Cardinia Creek CMP: Summary of management issues and mitigat measures for Dwarf Galaxias	tion 78
Table 8 Clyde North PSP Cardinia Creek CMP: Summary of management issues and mitigat measures for Australian Grayling.	ion 92
Table 9 Clyde North PSP Cardinia Creek CMP: Management Actions and Performance Meas for protection and enhancement of threatened fauna species habitat in the study area	sures 94
Table 10 Clyde North PSP Cardinia Creek CMP: Development sequencing schedule.	106
Table 11Cardinia Creek Growling Grass Frog CMP: List of sites assessed for potentialGrowling Grass Frog surveys along Cardinia Creek study area, 16 November and 10 Decem2009.118	ber
Table 12Cardinia Creek Growling Grass Frog CMP: Habitat descriptions for selected siteassessed along Cardinia Creek (December 2009).	es 121
Table 13 Cardinia Creek Growling Grass Frog CMP: Weather data collected during diurnal nocturnal surveys (November and December 2009)	al and 123

Figures

Figure 1 Clyde North PSP Cardinia Creek CMP: Study area location, sites surveyed during theassessment and Growling Grass Frog records in the surrounding landscape.20

Figure 2 Clyde North PSP Cardinia Creek CMP: Wetland design - cross section of vegetation zones 1, 2 and 3. 27

Figure 3Clyde North PSP Cardinia Creek CMP: Preliminary recommendations for various awaterway zones and the 'no-go' zone for vehicles and heavy machinery accessing Cardinia Creekfor future bridge construction.55

-



61

Figure 4 Clyde North PSP Cardinia Creek CMP: Dwarf Galaxias.

Figure 5 Clyde North PSP Cardinia Creek CMP: Locations where Dwarf Galaxias have been found in recent years. 62

Figure 6 Clyde North PSP Cardinia Creek CMP: Locations examined for Dwarf Galaxias in the Clyde North Precinct. 64

Figure 7 Clyde North PSP Cardinia Creek CMP: Australian grayling. 81

Figure 8 Clyde North PSP Cardinia Creek CMP: Australian Grayling records for Cardinia Creek in the past 10 years and the proximity of the Bunyip and Lang Lang Rivers (where populations are also known).83

Figure 9 Clyde North PSP Cardinia Creek CMP: Summary of general management actions to be implemented in the study area for Growling Grass Frog, Dwarf Galaxias and Australian Grayling. 102

Figure 10 Clyde North PSP Cardinia Creek CMP: Vegetation communities and proposed revegetation within the study area. 103

Figure 11Clyde North PSP Cardinia Creek CMP: Core habitat for threatened fauna species(Growling Grass Frog, Dwarf Galaxias and Australian Grayling).104

Figure 12Clyde North PSP Cardinia Creek CMP: No-Go Zones during construction periods(e.g. construction within: corridor; road/bridge crossing; and residential development). Approximatedimensions of the conservation area are also shown.105

Figure 13Clyde North PSP Cardinia Creek CMP: Potential habitat for Growling Grass Frog,Dwarf Galaxias and Australian Grayling within the greater Clyde North PSP area. Figure modifiedfrom Ecology Australian (2010).110

Appendices

Appendix 1	Cardinia Creek Draft Master Plan	117
Appendix 2	Survey Methodology and Results	118
Appendix 3 Exaugmentation,	xamples of drift fencing (wildlife fencing) and wetland creation/habitat used previously for the Growling Grass Frog or closely-related Green and	
Golden Bell Fr	og, for Cardinia Creek CMP.	124
Appendix 4 R	elocation Protocols for the Growling Grass Frog along Cardinia Creek	
between Thompsons and Grices Road 129		
Appendix 5 M	onitoring procedures for the Growling Grass Frog	134
Appendix 6 M	onitoring Procedures for Dwarf Galaxias and Australian Grayling	137
Appendix 7 Pl	ates	138
Appendix 8 Cost estimate for works associated with the implementation of the Clyde		
North Precinct	Structure Plan CMP	140
Appendix 9 B	reakdown of CMP costs per property	147



Appendix 10: Statutory Mechanism / requirement for land to be transferred to MelbourneWater (including the buffer requirement for existing wetlands: Clyde North PSP).

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Executive Summary

Ecology Australia Pty Ltd and Streamline Research Pty. Ltd were commissioned by the Growth Areas Authority (GAA) in December 2009 to prepare a Conservation Management Plan (CMP) for the western side of Cardinia Creek in the Clyde North Precinct Structure Plan (PSP) area, between Grices Road and Thompsons Road. The key issues for management within this corridor of Cardinia Creek relate to three species listed as threatened under the Federal *Environment Protection and Biodiversity Conservation Act 1999*:

- Growling Grass Frog Litoria reniformis;
- Dwarf Galaxias Galaxiella pusilla ; and
- Australian Grayling Prototroctes maraena.

The CMP study area (including Wetland B and floodplain) has been identified as supporting suitable habitat for Dwarf Galaxias and Growling Grass Frog. Growling Grass Frog is also considered likely to use the creek corridor intermittently for dispersal. There are known records of Australian Grayling within the reach of Cardinia Creek in the study area. Potential habitat for Growling Grass Frog and Dwarf Galaxias has also been identified via desktop assessment outside the study area within the greater Clyde North PSP area.

The three species are addressed within the CMP in regards to actions for habitat protection, enhancement, creation and management. These works include initial implementation of habitat enhancement works plus on going maintenance and monitoring over a 10 year period from approval of the CMP.

An estimate of costs associated with the CMP works/actions and a breakdown of costs per property has been provided by the GAA. Each land owner is obligated to contribute towards the implementation, maintenance and monitoring of works outlined in this CMP prior to statement of compliance. These works would be undertaken by the land owner, unless transferred to a public authority (e.g. Melbourne Water). Each land owner is to make a financial contribution by entering into an agreement with Melbourne Water and DSE (under Section 173 of the *Planning and Environment Act 1987* or other appropriate mechanism as agreed with Melbourne Water and DSE). Melbourne Water has agreed to implement and maintain the CMP works once land is transferred and funds provided by land owners. Works undertaken in the corridor are to be in accordance with the CMP.



1 Introduction

Ecology Australia Pty Ltd and Streamline Research Pty. Ltd were commissioned by the Growth Areas Authority (GAA) in December 2009 to undertake habitat assessments, targeted fauna surveys and to prepare a Conservation Management Plan (CMP) for the western side of Cardinia Creek between Grices Road and Thompsons Road, Clyde North. Works proposed for this area include: infrastructure; high use and passive recreation; wetland development; revegetation of ecological vegetation communities and maintenance and enhancement of threatened species habitat. A Master Plan has been drafted for the corridor by the GAA in conjunction with preparing the Conservation Management Plan (See Appendix 1). The CMP will be implemented through the Clyde North Precinct Structure Plan.

The key issues for management within this corridor of Cardinia Creek relate to three species listed as threatened:

- Growling Grass Frog *Litoria raniformis* [listed as Vulnerable under the Federal *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act); Listed as Nationally Vulnerable by Tyler (1997) – National Action Plan for Frogs; Listed as threatened under the Victorian *Flora and Fauna Guarantee Act 1988* (FFG Act); and Listed as Endangered in Victoria by DSE (2007b)].
- Dwarf Galaxias *Galaxiella pusilla* [listed as Vulnerable under the EPBC Act, threatened under the FFG Act and classified as Vulnerable in Victoria (DSE 2007b)]; and
- Australian Grayling *Prototroctes maraena* [listed as Vulnerable under the EPBC Act, threatened under the FFG Act and classified as Vulnerable in Victoria (DSE 2007b)].

Ecology Australia was engaged to prepare the conservation management plan for Growling Grass Frog. Streamline Research were engaged to report on Dwarf Galaxias and Australian Grayling.

The three species are addressed within the CMP in regards to habitat protection, enhancement, creation and management. The aim of this assessment was to:

- Undertake a habitat assessment for Growling Grass Frog, Dwarf Galaxias and Australian Grayling within selected sites in the study area;
- Conduct targeted surveys for the three threatened species within selected sites;
- Map previous records of the three threatened species within 5 km of the study area; and
- Outline Growling Grass Frog, Dwarf Galaxias and Australian Grayling distribution in the region and availability of habitat in the study area; survey methodology; management actions and performance measures; and implementation schedule for mitigation measures and other actions.

The CMP is separated into sections for Growling Grass Frog (See Section 2), Dwarf Galaxias (Section 3) and Australian Grayling (Section 4). Section 5 summarises the management actions



required for each of the species (Table 9) and also summarises the implementation schedule for management actions (Table 10).

Vegetation protection/enhancement works within Cardinia Creek Corridor may also benefit other threatened fauna species known to occur or with some potential to occur in the area. These include:

- Southern Brown Bandicoot *Isoodon obesulus obesulus* [listed as Endangered under the EPBC Act; listed as threatened under the FFG Act and classified as Vulnerable in Victoria];
- Southern Toadlet *Pseudophryne semimarmorata* [listed as Vulnerable in Victoria (DSE 2007b)]; and
- Glossy Grass Skink *Pseudemoia rawlinsoni* [listed as Near Threatened in Victoria (DSE 2007b)].

These species, however, are not addressed in detail within the CMP.

1.1 Study Area

The study area is located along the western side of Cardinia Creek, between Grices Road and Thompsons Road, approximately 9 km north-east of Cranbourne, Victoria (See Appendix 1 and Figure 1). The study area is located mostly on private land, with small sections owned and managed by Melbourne Water. The site is located within the City of Casey and the Gippsland Plain Bioregion.

Under the Casey Planning scheme, the study area is zoned as Urban Growth Zone (UGZ), Special Use Zone 3 (SUZ3), Public Use Zone Service and Utility (PUZ1) and is subject to a Land Subject to Inundation Overlay (LSIO).

1.2 Terminology

The following terminology is used throughout the CMP:

- **Pre-construction period** the period prior to any development occurring within the Cardinia Creek corridor. The objective of this phase is to protect current habitat values for the threatened fauna species and maintain the long-term viability of populations currently occupying the study area.
- **Construction Period** the stage in which the development works (e.g. any earthworks and/or vegetation removal) area initiated.
- **Waterbodies** used as a collective term to describe any existing body of water including Cardinia Creek and those that will be created as habitat.

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2 Growling Grass Frog Conservation Management Plan

Executive Summary

Ecology Australia was engaged by the Growth Areas Authority (GAA) in December 2009 to prepare a Conservation Management Plan (CMP) for Growling Grass Frog on the western side of Cardinia Creek between Grices Road and Thompsons Road, Clyde North, approximately 9 km north-east of Cranbourne, Victoria. Works proposed for this corridor include: infrastructure; high use and passive recreation; wetland development; revegetation of ecological vegetation communities and maintenance and enhancement of threatened species habitat. A Master Plan has been drafted for the corridor by the GAA in conjunction to preparing the Conservation Management Plan. The CMP will be implemented through the Precinct Structure Plan.

Growling Grass Frog

Despite the absence of records for the Growling Grass Frog within the study area, this species is well known in the surrounding landscape and was recently recorded south of the study area along Cardinia Creek. As such, this species is assumed to be present or at least individuals may use the corridor intermittently for dispersal, movement, foraging and/or shelter. Key habitat attributes for the Growling Grass Frog within the study area include:

- Connectivity along Cardinia Creek (within the study area and beyond) and the north-south drainage line that provides potential dispersal, foraging and shelter habitat.
- Close proximity to permanent to semi-permanent still water bodies (e.g. farm dams) that support potential breeding habitat.
- Emergent and submergent vegetation within the wetlands/dams.
- Terrestrial ground-layer that provides potential over-wintering and shelter habitat (e.g. grasses and other ground debris).

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The objective of the CMP is to outline management actions and pre-construction/construction protocols required within the Cardinia Creek corridor to ensure there are no significant impacts on the Growling Grass Frog and their habitats prior to, during, or post-development. The CMP does not cover any creek crossings including the proposed road bridge. Preliminary recommendations for crossings are provided but a detailed Conservation Management Plan will be required once creek crossings are designed in consultation with the Department of Sustainability and Environment (DSE).

Management strategies and habitat creation and maintenance requirements for the study area are summarised below:

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Pre-construction period

• Obtain relevant permits from DSE.



- Designate all existing wetlands/dams and the entire riparian zone along Cardinia Creek a No-Go Zone during construction activities within the creek corridor by implementing sediment fencing and clear signage. Sediment fencing should be implemented around the entire construction zone and be at least 30 m from the edge of a waterbody. No-Go Zone signage should be implemented adjacent to all existing wetlands in close proximity to construction areas. Sediment fences and signage should delineate construction areas from No Go Zones by excluding humans and machinery from entering the site but also allow for movement of frogs.
- Establish wetland B as future recipient site for salvaged frogs by undertaking enhancement plantings and implementing No-Go Zone around the site for all equipment, vehicles and contractors throughout the entire construction period.
- Residential development is likely to be staggered along the creek corridor. Prior to each development stage, Cardinia Creek corridor should be designated as a No-Go Zone during construction activities by implementing fencing, sediment controls and clear signage.
- The proposed road bridge crossing is not covered within the CMP. Preliminary recommendations are provided. Prior to development of road and bridge crossings, the creek and riparian vegetation outside construction zone should be designated as a No-Go Zone with fencing, sediment controls and clear signage. No-go zones should exclude humans and machinery from sensitive areas of the creek i.e. flood plain and low flow zone (see Figure 3).
- Salvage and translocate any frogs immediately prior to any construction works throughout the remainder of the study area (wetland B has been selected as recipient site).

Construction and post-construction period

- On-site environmental induction for key construction staff.
- Construction of pathways to occur prior to creating dedicated Growling Grass Frog wetlands. All works to be in accordance with the CMP.
- Implement the revegetation and weed management plan.
- Appoint an experienced wetland rehabilitation and revegetation specialist to implement revegetation plan.
- Construct all dedicated Growling Grass Frog wetlands and design/implement buffers and habitat corridors in accordance with the CMP.
- Undertake habitat augmentation in existing wetlands.
- Implement staged weed removal, in association with revegetation works.

- Temporarily fence revegetation zones and created wetlands.
- Provide interpretive signage for areas of interest.



- Undertake pest animal and weed control as required.
- Undertake regular monitoring and maintenance of Growling Grass Frog habitat elements including water quality, vegetation, hydrology, introduced pests and weeds, as outlined by established monitoring protocols and in accordance with the CMP.
- Undertake population monitoring for the potential colonisation of Growling Grass Frog within existing/created habitat.

The implementation and monitoring of conservation works associated with the CMP will be funded by land owners that develop land in the PSP that contains potential Growling Grass Frog habitat. The management strategies outlined in this plan will be implemented once the CMP has been approved by DSE as part of the planning scheme amendment process. The CMP will operate from this date of DSE approval, throughout construction and then for ten years post-construction. Monitoring will commence from approval of CMP for existing wetlands. However, for created wetlands, the 10 year post construction management/monitoring will commence once wetlands are certified by DSE (application to DSE). Once properties adjacent to the creek have been subdivided and the creek corridor land has been transferred to Melbourne Water, Melbourne Water will manage all areas of the Cardinia Creek corridor to the east of the Main Cardinia Creek Trail (i.e. with a primary function of conservation). City of Casey will manage public open space west of the Main Cardinia Creek Trail (e.g. passive recreational and active open space).

Ongoing liaison between the relevant stakeholders will ensure actions outlined in this CMP are implemented.

2.1 Background Information

The Growling Grass Frog is a relatively large and highly mobile species that inhabits a diverse range of wetlands such as swamps, marshes, backwaters of rivers/streams, lakes, drainage lines and artificial water bodies (e.g. farm dams, reservoirs and former quarry pits), usually with emergent, submergent, floating and fringing aquatic vegetation such as pondweed (*Potamogeton* spp.), sedges and Cumbungi (Pyke 1992, Tyler 1997, Robertson et al. 2002).

The species breeds in permanent or near-permanent water bodies, but has also been recorded breeding in ephemeral waterbodies (Heard et al. 2004; Ecology Australia 2006). The Growing Grass Frog spends the non-breeding season (approximately May to August) sheltering in terrestrial environments (e.g. rocks, fallen timber or dense ground vegetation) some distance from water. Waterbodies with extensive cover of wetland vegetation (e.g. fringing, floating, emergent or submergent), reasonable water quality and an absence of predatory fish are preferred by this species for breeding. The aquatic vegetation provides calling stages for male frogs, sites for egg deposition and development, and food and shelter for tadpoles. Dense submergent vegetation is important for protecting eggs and tadpoles from predation. The Growling Grass Frog will use degraded habitat, particularly where adjacent off-line waterbodies, such as farm dams or quarry



pits, provide this breeding habitat (Pyke 2002; Robertson and Heard 2002; Heard and Robertson 2003; Robertson et al. 2002; Wilson 2003; Heard et al. 2004; Organ 2005).

Furthermore, a number of suitable wetlands in close proximity to one another (e.g. less than 500 m apart), is essential to accommodate for dispersal, provided there are no or few barriers such as sealed roads or housing (Wildlife Profiles 2002).

2.1.1 Growling Grass Frog Regional Distribution

Growling Grass Frogs are well known in the wider landscape (see Figure 1) and have a broad distribution to the south-east and north-east of the study area including, Cardinia, Koo Wee Rup, Pakenham and Officer (Biosis 2003, 2005, Ecology Australia 2006a, b, 2008c, Ecology Partners 2007). Habitats occupied by the species in these areas include creeks, drains, and farm dams; their habitats are effectively linked through a large network of drainage lines, low lying areas and open pasture.

Records in close proximity to the study area include, a population 3.1 km north-east of the study area, on both the north and south sides of the Princes Freeway. At least sixteen waterbodies comprising multiple records for Growling Grass Frog (DSE 2007a) are present within approximately two kilometres of each other. These records form part of an 'important population' of Growling Grass Frog as defined under the EPBC Act (Ecology Partners 2007).

Growling Grass Frog was recently recorded in January 2010 along Mc Cormacks Road, 500 m from Cardinia Creek and 2.8 km south of the study area (R. Marr pers. obs.). This species was also recently recorded in December 2009, 4.3 km south-west of the study area within a farm dam, in Clyde (Christina Renowden and Ruth Marr pers. obs.). Both these records are very interesting, the former confirming the species movement along or within close proximity to Cardinia Creek and the later appears to be one of the first records west of Cardinia Creek.

Other records of Growling Grass Frog in the surrounding landscape include:

- A large breeding colony occurring at the market garden dam along Ballarto Road to the east of the Healesville Koo Wee Rup Road (where 49 frogs were recorded) (Ecology Australia 2008b);
- Large colony in farm dam adjacent to Cardinia Creek Drain along Manks Road (Ecology Australia 2008a);
- Over 30 records in farm dams, west of McGregor Rd, Pakenham (2004) (DSE 2007a);
- Fifteen records at Pakenham and District Golf Course, south of Princess Highway (2002 and 2003) (DSE 2007a);
- Fifteen records at Mary Street, west of Pakenham (2002) (DSE 2007a);
- Five records in a dam along Lecky Road, next to Gum Scrub Creek (2002) (DSE 2007a);
- Three records at Kaduna Park property, 4 km west of Pakenham (2002) (DSE 2007a);



- Three records in dam c. 300 m south of Lecky Road (December 2002) (DSE 2007a);
- Ten records within dams located along Key Lane, c. 2 km south of Pakenham (2002) (DSE 2007b); and
- Twenty-two records in farm dam north of railway-line, just south of Princess Highway (December 2002) (DSE 2007a);

2.1.2 Growling Grass Frog Habitat in the Study Area

No records for Growling Grass Frog exist for the study area (DSE 2007b). Recent survey undertaken in April/May (e.g. outside the main breeding period) did not record this species on-site (Practical Ecology 2009). Furthermore, this species was not recorded within the study area during the current assessment. However, the study area supports potential and suitable habitat for this species (see plates in Appendix 7). Key existing habitat attributes for the Growling Grass Frog within the study area include:

- Connectivity along Cardinia Creek (within the study area and beyond) and the Baillieu Creek that provides potential dispersal, foraging and shelter habitat;
- Close proximity to permanent to semi-permanent still water bodies (e.g. farm dams);
- Emergent and submergent vegetation within the wetlands/dams; and
- Terrestrial ground-layer that provides potential over-wintering and shelter habitat (e.g. grasses and other ground debris).

Cardinia Creek and its riparian environs provide an important habitat link for dispersing and/or moving during the breeding season (September to March), as well as for foraging. The dense ground layer cover of vegetation would also provide shelter for over-wintering during the non-breeding season (April to August) and during the day during the breeding season.

The majority of the creek is unlikely to provide breeding habitat for Growling Grass Frog. A large proportion of the creek forms a narrow channel with a moderate to fast flow and mostly lacks open pools. The creek supports dense over-hanging riparian vegetation that may exclude Growling Grass Frog regularly using the site, as the species prefers more open areas for basking and tends to avoid areas which are overgrown, or those areas with a dense canopy cover (i.e. highly shaded areas) (Robertson and Heard 2002). The creek also appears to have an abundance of fish that could potentially predate upon frogs eggs and tadpoles. The introduced and predatory Eastern Gambusia (*Gambusia holbrooki*) is likely to be present within this waterway and has the potential to reduce the likelihood of successful breeding by predating frog eggs. This species has been implicated in the decline of the Growling Grass Frog (Tyler 1997, Anstis 2002, Heard et al. 2004a).

A small proportion of the creek supports more open areas with grassy vegetation on the banks which may provide more suitable habitat for this species.

The existing off-line wetlands/dams within the study area (e.g. wetlands B and G) provide potential breeding habitat for this species. These waterbodies support important habitat



characteristics including structurally diverse aquatic vegetation such as emergent, submergent, floating and fringing vegetation [(e.g. Spike-rush (*Eleocharis* sp.), Rush (*Juncus* sp.), and Water Ribbon (*Triglochin* spp.) and filamentous algae)]. The emergent vegetation, fringing grassy vegetation and areas of exposed banks provide potential perching, shelter, basking and foraging habitat for the species. Wetland B also appears to be free of Eastern Gambusia. The floodplain habitat between the creek and the wetlands may provide suitable foraging and over-wintering sites for this species, and also currently provides an important east-west link between the creek and off-line waterbodies.

The configuration of water bodies in the surrounding landscape is also favourable for Growling Grass Frogs. Numerous large dams are present in the greater area, many within 500 m of Cardinia Creek. The predominantly pastoral landscape may also permit unimpeded movement and therefore provide habitat links between potential breeding sites.

The existing drainage-line to the west of Cardinia Creek also provides dispersal habitat for this species and potentially ephemeral breeding habitat within the existing wetlands (see Figure 10 and 12, wetland B). The drainage channel (Baillieu Creek), located to the west of the study area is likely to provide dispersal habitat only during times of inundation. Melbourne Water is proposing to build a retarding basin adjacent to this drainage channel to the south-west of the study area. This retarding basin should be designed to provide habitat elements suitable for Growling Grass Frog. A greenlink will connect the retarding basin to the study area corridor.

Survey methodologies and results of the Growling Grass Frog assessment are presented in Appendix 2.

<u>Note</u>: The study area provides known and/or potential habitat for a number of other threatened fauna species. A pair of Baillon's Crake *Porzana pusilla palustris* (listed as threatened under the FFG Act, classified as Vulnerable in Victoria (DSE 2007b) and listed under the Marine Schedules of the EPBC Act) were recorded within wetland B during the assessment (R. Marr and C. Renowden pers. obs). Practical Ecology (2009) also recorded Southern Toadlet *Pseudophryne semimarmorata* (listed as Vulnerable in Victoria (DSE 2007b)) and Glossy Grass Skink *Pseudemoia rawlinsoni* (listed as Near Threatened in Victoria (DSE 2007b)) in close proximity to the study area (i.e. within the greater Clyde North PSP). The study area provides potential habitat for both of these threatened fauna species.

Practical Ecology (in prep.) have identified Cardinia Creek as a dispersal corridor for Southern Brown Bandicoot *Isoodon obesulus obesulus* [(listed as Endangered under the EPBC Act, threatened under the FFG Act and listed as Near Threatened in Victoria (DSE 2007b)] within the Sub-Regional Strategy. Although, the plan does not specifically address these species, habitat protection and enhancement works within the study area are also likely to benefit these additional threatened fauna species.

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2.1.3 Vegetation values

Plant species

A total of 126 remnant and naturalised plant species was recorded from the study area, of which 55 (44 %) were indigenous and 71 (56 %) were exotic. Excluded from this total are non-naturalised planted species.

No plant species listed as rare or threatened under the Commonwealth *Environment Protection and Biodiversity Conservation* (EPBC) *Act 1999*, the Victorian *Flora and Fauna Guarantee* (FFG) *Act 1988* or the Advisory List of Rare or Threatened Plants in Victoria (DSE 2005) were recorded during the field survey, or are considered likely to occur within the study area.

Vegetation communities

The Department of Sustainability and Environment extant Ecological Vegetation Class (EVC) modelling of the study area (DSE 2010) identifies EVC 83 Swampy Riparian Woodland as comprising all vegetation occurring along Cardinia Creek, and EVC 897 Plains Grassland/Plains Grassy Woodland Mosaic as occurring in scattered patches west of the creek. Data collected during fieldwork for this assessment confirmed the presence of EVC 83 Swampy Riparian Woodland though much of the vegetation mapped as this EVC is in fact EVC 53 Swamp Scrub or plantings of non-indigenous eucalypts. A few small patches of EVC 55 Plains Grassy Woodland were recorded in the north of the study area, however the vast majority of vegetation mapped as EVC 897 Plains Grassy Woodland Mosaic was exotic plantings.

A brief outline of vegetation communities occurring within the study area is provided below. See Figure 10 for the indicative location of each community.

EVC 53 Swamp Scrub

Swamp Scrub comprises the majority of remnant vegetation in the northern section of the study area. Characterised by a variously dense overstorey of Swamp Paperbark (*Melaleuca ericifolia*) over an open to dense understorey dominated indigenous and exotic herbaceous species. Medium shrubs (in particular Tree Violet *Melicytus dentatus*) and understorey trees (Blackwood *Acacia melanoxylon* and Black wattle *A. mearnsii*) were scattered throughout. Weed cover was \pm high throughout, with dominant species including Blackberry **Rubus anglocandicans*, Japanese Honeysuckle **Lonicera japonica* and Phalaris **Phalaris aquatica*.

While a few scattered eucalypts were present, the density was not enough to consider this vegetation EVC 83 Swampy Riparian Woodland. It is uncertain whether this vegetation previously comprised woodland vegetation.

EVC 55 Plains Grassy Woodland

Occurring in several small patches in the north of the study area, Plains Grassy Woodland was characterised by an open canopy of Narrow-leaf Peppermint *Eucalyptus radiata* ssp. *radiata* (grading into Manna-gum towards Cardinia Creek) over an understorey dominated by Austral



Bracken *Pteridium esculentum* and indigenous and exotic grasses. This vegetation was highly degraded with poor indigenous species diversity and a high cover of weeds.

EVC 83 Swampy Riparian Woodland

Swampy Riparian Woodland within the study area is floristically similar to Swamp Scrub, though structurally more open, with an overstorey of eucalypts (Manna-gum *Eucalyptus viminalis* ssp. *viminalis* and Swamp Gum *E. ovata* var. *ovata*). Weed cover was \pm high throughout.

Wetland vegetation

The study area contains several wetlands/dams (Figure 10), all of which contain a low cover of ubiquitous indigenous wetland species. The condition of indigenous vegetation is generally poor (i.e. low species diversity and cover), and due to the low overall area of vegetation, it has not been attributed an EVC in this report. Commonly occurring species include Rushes *Juncus* spp., Water Ribbons *Triglochin procera* ('long floating leaves' and 'broad erect leaves'), Pacific Azolla *Azolla filiculoides*, Common Spike-sedge *Eleocharis acuta* and Tall Spike-sedge *Eleocharis sphacelata*.

Planted non-indigenous woodland

Occurring in the southern portion of the study area, this vegetation community comprised a mature stand of planted, non-indigenous eucalypts (Southern Blue-gum **Eucalyptus globulus* ssp. *globulus*, Southern Mahogany **Eucalyptus botryoides* and Spotted Gum **Corymbia maculata*) as well as several indigenous eucalypt species of questionable provenance (Manna-gum, Narrow-leaf Peppermint and River Red-gum *E. camaldulensis*). The understorey was dominated by exotic grass species.

2.2 Potential impacts of the development

The creation of a variety of off-line wetlands will benefit the Growling Grass Frog in the study area by creating suitable breeding habitat and increasing habitat diversity. Cardinia Creek and adjacent created/existing wetlands will be maintained as a core area of habitat for this species, with all pathways and facilities situated outside the core area.

The proposed road alignment crosses Cardinia Creek in the north of the study area. The use of a large clear span bridge should minimise barrier impacts and maximise opportunities for fauna movement. It is presumed that any movement of Growling Grass Frog along Cardinia Creek will not be disrupted using this design. Note that creek crossings are not covered by this CMP. Preliminary recommendations are made for the proposed vehicle crossings (and any future creek crossings), however, the design and locations of future creek crossings will need to be discussed in conjunction with DSE. A separate CMP will be required for all future creek crossings (DSE pers. comm.).

Potential impacts to the Growling Grass Frog and their habitat may occur as a result of the overall works may include:

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- Vegetation removal and disturbance during construction activities i.e. permanent and temporary loss of habitat.
- Habitat fragmentation and barriers to movement through the creation of pathways, road and/or other facilities.
- Increased sedimentation and pollution of the creek and off-line wetlands from uncontrolled run-off (e.g. from proposed housing development and oval) and accidental fuel/oil spills from construction machinery on site.
- General habitat degradation due to increased recreational use of the area including trampling by pedestrian traffic, rubbish dumping and increased frequency of disturbance and/or predation by domestic dogs and cats. Pathway and street lighting may also potentially impact foraging behaviour of this species.
- Pest and pathogen invasion. During construction, there is potential for feral animals, weeds and pathogens to be introduced to or spread further around the study area, and/or to be taken offsite. This includes:
 - Weed species;
 - o Predation by feral animals such as foxes and cats; and
 - Fungal diseases such as Chytridiomycosis. Chytridiomycosis (Chytrid infection) has been implicated in the decline of frog species worldwide, and is listed as a key threatening process under the EPBC Act 1999. The cause of infection is the waterborne, parasitic *Batrachochytridium dendrobatidis* fungus, which infects the skin of amphibians, causing up to 100% mortality in some populations, by suffocation (NSW NPWS 2001). Free-living saprophytic forms of the fungus are found in water and soil, and can easily be transmitted between different sites and between individuals.
- Death and/or injury to Growling Grass Frog during construction activities:
 - The Salvage and Relocation Plan for this species must be implemented prior to vegetation clearance and construction commencing along Cardinia Creek or its associated wetlands. The Plan sets in place procedures designed to locate any Growling Grass Frogs within the proposed construction area and to relocate salvaged live individuals to suitable areas identified nearby, to avoid potential injury or mortality.
- Potential mortality due to road kill and/or domestic cats and dogs.

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Clyde North PSP Cardinia Creek: Threatened Fauna Conservation Management Plan





Figure 1 Clyde North PSP Cardinia Creek CMP: Study area location, sites surveyed during the assessment and Growling Grass Frog records in the surrounding landscape.



2.3 Conservation Management Plan

2.3.1 Objectives

The objective of the Conservation Management Plan (CMP) is to outline management actions and pre-construction, construction and post-construction protocols required to ensure the protection and enhancement of potential Growling Grass Frog habitat in the study area. Specific management actions and their associated performance measures are provided in Section 2.4 and summarised for all three threatened fauna species in Table 9. The Growling Grass Frog CMP covers the following key elements:

- Pre-construction: Habitat protection and enhancement.
- Construction period: Habitat creation wetland design and management.
- Buffers and habitat connectivity.
- Revegetation.
- Pest management (e.g. feral animal and weed control).
- User related issues.
- Fencing and preliminary recommendations for roads and road crossing structures.
- Salvage and translocation.
- Post construction: Monitoring.

2.3.2 Timeframes

The management strategies outlined in this plan will be implemented once the CMP has been approved by DSE as part of the planning scheme amendment process. The CMP will operate from this date of approval and throughout construction. The CMP will continue to apply to Growling Grass Frog habitat within the Cardinia Creek Corridor for 10 years post completion of each wetlands/group of wetlands. DSE will certify each parcel of construction and identify when the 10 year timeframe commences. The CMP will continue to operate during construction for all works between the creek corridor and Baillieu Creek (north-south drainage line) to the west. The CMP will be reviewed at 1, 3, 5 and 10 years by a zoologist in conjunction with DSE, Melbourne Water and the City of Casey to determine if any changes to habitat management and/or monitoring are required. A review should also be undertaken for any design changes and if Growling Grass Frogs are found to have colonised the wetlands.

The works required to fulfil the aim of the CMP will vary year to year and the timing of work will be important for maintenance of Growling Grass Frog habitat. Table 9 gives a timeline for implementation of each management regime and the responsible party(s). Table 10 provides a schedule for implementation of management actions.



2.3.3 Responsibilities

The implementation and monitoring of conservation works outlined in the CMP will be funded by land owners that develop land in the PSP that contains potential Growling Grass Frog habitat. Appendix 9 provides a breakdown of CMP costs per property.

The requirements detailed in this CMP may be incorporated into a site environmental management plan for contractors undertaking works as part of the overall development of the study area. Ongoing liaison between DSE, Melbourne Water, Council, contractors, and qualified biologists will ensure actions outlined in this CMP are implemented.

Land Owners will be responsible for undertaking works unless transferred to a public authority (e.g. Melbourne Water). Melbourne Water will manage all areas of the Cardinia Creek corridor to the east of the Main Cardinia Creek Trail. This incorporates all core habitat area for threatened fauna species (e.g. creek, wetlands, terrestrial foraging and over-wintering habitat, movement corridor and all other EVC revegetation areas). City of Casey will manage public open space west of the Main Cardinia Creek Trail (passive recreational and active open space e.g. sports oval).

Appendix 10 is a series of letter that outline the statutory mechanism / requirement for land to be transferred to Melbourne Water (including the buffer requirement for existing wetlands.

2.4 Management Actions

2.4.1 Pre-construction: Habitat Protection and Enhancement

While no Growling Grass Frogs have been recorded within the study area, Cardinia Creek, and its associated riparian environs provide suitable habitat elements for Growling Grass Frog. The creek, and existing (Figure 9 and 11, wetlands B and G see also Appendix 1) and created (see Figure 9 and 11, wetlands A, C, D, E, F, H, I J) wetlands will be maintained as a core area of habitat for Growling Grass Frog.

Most importantly, the creek may act as a habitat corridor for the species to access areas north and south where there are other local populations of Growling Grass Frogs. Maintaining this habitat link between populations is important to maintain genetic, as well as habitat diversity, for the species within the local area.

The existing off-line wetlands which provide potential breeding habitat for this species will be retained under the proposed development plans. Existing areas of habitat must be protected from vegetation removal and potential habitat disturbance throughout the construction period. To avoid or minimise habitat loss and disturbance during construction and protect and enhance remaining habitat the following management actions will be implemented.

Management Actions

Habitat Protection: Maintain the core area of habitat for the Growling Grass Frog within the corridor during any construction works through the following measures:



- Protect creek line and existing wetlands prior to construction works with appropriate fencing and sediment and pollution control measures (also refer to Section 2.4.2 and 2.4.8 for more detail on these measures that can also be incorporated into existing wetlands). Sediment control fences should have intermittent gaps (one metre) approximately every 30 m to 50 m to allow for any movement of frogs.
- Signage will be placed around existing habitats to demonstrate to contractors these are 'NO-GO ZONES' during any adjoining construction works (see Table 5).
- See Section 2.4.7 and 2.4.8 for further detail on pre-construction habitat protection measures.

Note: Existing wetland B has been selected as the recipient site for any Growling Grass Frogs found during the salvage operation. Mitigation measures as outlined above for Wetland B must be implemented for this wetland to ensure protection throughout the entire construction period.

If access to wetland B is not available, then an alternative site will be selected to DSE satisfaction.

Habitat Enhancement/Management: to enhance and manage the creek line and existing wetland prior to and during any works in the core area, the following measures will be implemented:

- Wetlands will be filled through flooding events from Cardinia Creek. Ideally the water bodies would not dry out completely, particularly over the spring and summer months (i.e. the breeding period). This is to ensure habitat is available for tadpoles over the summer months to metamorphose. Ideally, water levels in wetlands would be between 0.5 m and 1 m in vegetation zone 3 (see Section 2.4.2 Wetland design). Plantings may be used to minimise evaporation and reduce drying out. For example, taller plantings on the north and western sides of the waterbody while still maintaining open areas suitable habitat for basking on the opposite side.
- Water will not be pumped into the wetlands (from Cardinia Creek) to maintain water levels for fauna (Melbourne Water pers. comm.). Stormwater run-off may be an exception to this in the future. Use of these wetlands for stormwater run-off is not covered within the CMP.
- Undertake enhancement plantings in retained wetlands.
 - Example sites requiring enhancement plantings include existing off-line wetlands B and G (Figure 9 and 10).
 - Planting regimes will incorporate at least three vegetation zones (see Section 2.4.2 for detail on wetland planting zones).
 - Enhancement plantings will aim to increase the structural diversity of habitat and include emergent (e.g. rushes and reeds), submergent (e.g. pond weed and water ribbon), floating and fringing aquatic vegetation. Species selected will be compatible with Growling Grass Frog habitat requirements (see Section 2.1).



- Enhancement plantings or revegetation along Cardinia Creek will maintain a mosaic of open and closed canopy to provide habitat attributes required for both Growling Grass Frog and Dwarf Galaxias. As the Growling Grass Frog is a basking species, they generally prefer more open areas.
- For areas managed specifically for Growling Grass Frog, the riparian zone will be kept quite sparse in overstorey vegetation to avoid over-shading the wetlands (also see Section 2.4.2 and 2.4.4). A mosaic of open and more closed plantings can be used. For example, plantings on the north and western side with allow cooler temperatures and shading (as required for Dwarf Galaxias) while also decreased evaporation of water and allowing open areas for basking of frogs on the opposite bank.
- A revegetation management plan is provided below in Section 2.4.4. Revegetation species lists will be compatible with Ecological Vegetation Classes and indigenous species to the region.
- Wetland B has been selected as the recipient site for frogs found during salvage work. Establish wetland B as a No-Go Zone before construction activities commence throughout the study area. Wetland B now consists of two small shallow waterbodies that are separated by a 5 – 10 m strip of exotic grasses. Enhancement plantings for wetland B should be undertaken before establishment as recipient site for salvaged frogs as per Section 2.4.4.
- Provide additional shelter sites (e.g. rocks and logs) adjacent to retained wetlands and any cleared areas along Cardinia Creek (see Section 2.4.2 for further information).
- Management of grasslands or other vegetation types in the core area of habitat will be compatible with Growling Grass Frog habitat requirements, including:
 - Intermittent slashing may be required to keep open grassy areas in proximity to the creek and existing/created wetlands (the Growling Grass Frog appears to preferentially forage in more open grassy areas). Current grassy vegetation can be retained within the study area to maintain open areas. All new plantings will use indigenous flora species of local provenance.
 - Staged weed removal and replacement with indigenous species. Weed removal should be ideally undertaken by hand removal with immediate rehabilitation of the area through appropriate revegetation.
 - Herbicide use will be avoided where possible, particularity in close proximity to water bodies. Hand removal or 'wick-wiping' is preferred (also refer to Section 2.4.2, 2.4.3 and 2.4.5).
 - Undertake measures to reduce habitat quality to exclude Eastern Gambusia. For example, dense submergment aquatic plantings and riparian plantings on the north and western side of the water body will reduce the temperature and provide partial shading



of the waterbody, while still allowing basking sites for Growling Grass Frog on the opposite side (see also Section 2.4.4).

• Undertake fox control as part of a catchment wide program (See Section 2.4.6).

2.4.2 Construction period: Habitat Creation – Wetland Design and Management

The existing draft Master Plan proposes the creation of a chain of multiple off-line wetlands on the west side of Cardinia Creek (see Appendix 1 and Figure 9). The creek, habitat corridors and wetlands will be managed as a core area of habitat for this species, with important habitat attributes for the Growling Grass Frog incorporated into wetland design (see Figure 11).

Wetland construction must be completed and operational prior to the removal, modification or disturbance of any existing potential breeding habitat. This is to ensure there is suitable habitat available for the Growling Grass Frog before disturbing existing habitats.

The creation of wetlands will benefit Growling Grass Frog by increasing the availability of potential breeding habitat, and increasing habitat diversity through the corridor.

Wetland design and creation will be in accordance with Melbourne Waters key principals for Water Sensitive Urban Design (WSUD) as stated in the *Urban Stormwater - Best Practice Environmental Management Guidelines* (Victorian Stormwater Committee 1999) and Constructed Wetland System: Design Guidelines for Developers (Melbourne Water 2005).

Specific recommendations relating to wetland plantings, refuge/shelter sites and water quality requirements in created wetlands are described below.

Wetland planting and design

Vegetation floristics, composition and structural characteristics within and around the created wetlands will replicate habitat used by the species elsewhere. Wetland plantings will be designed to allow a relatively 'open' design with a diversity of indigenous macrophyte vegetation around and within the wetlands. Plantings will be indigenous to the area and low growing with a maximum of around 1.5 metres.

Wetland configuration

• Wetlands will be clustered within 300 – 500 m of each other to allow movement and dispersal between areas of habitat. This is within the dispersal capabilities of the Growling Grass Frog.

Vegetation of created wetlands and surrounds

Three vegetation zones will be implemented. These zones are consistent with planting regimes at other constructed or proposed wetlands specifically designed for Growling Grass Frogs (Heard et al. 2004 b; Organ 2005). Figure 2 below illustrates the various vegetation zones. These are also briefly summarised below:



- Zone I (shallow marsh, soft edge) amphibious tussock-forming grasses, herbs, rushes (suitable for basking, shelter, perching and male calling sites);
- Zone II Shallow inundation (marsh) amphibious and emergent aquatic herbs, grasses and sedges (suitable for basking, shelter, perching and male calling sites); and
- Zone III Permanent water (open water, submerged marsh, deep marsh); submergent and emergent aquatic herbs (e.g. e.g. water ribbons and pond weed). Required for egglaying sites, protection of tadpoles and prey ambush sites. A high cover of pond weed (*Potamageton spp.*) has been found to be correlated with the abundance of Growling Grass Frogs in the Pakenham area (Hamer and Organ 2006a).
- A revegetation list is provided in Section 2.4.4.
- It is important to maintain open grassy areas which allow frogs to forage adjoining the waterbodies and allow movement and dispersal between potential breeding sites and to the creek. Dedicated habitat corridors of between 30 and 50 m will be created between the wetlands and the creek (e.g. east-west connectivity) and between wetlands (e.g. north-south connectivity) for Growling Grass Frog. Grassy vegetation occurring within the study area (predominantly exotic) will be retained. Where possible all new plantings will use indigenous flora species of local provenance. Plantings within habitat corridors will be maintained as open areas with sedges, tussock-grasses (e.g. *Poa* spp.), rocks and occasional low lying shrubs for shelter (see Section 2.4.3 for more detail on habitat corridors and connectivity).
- In areas managed specifically for Growling Grass Frog (e.g. existing wetlands B and G, created wetlands and habitat corridors (see Figure 9 and 11)), plantings of indigenous trees will be kept quite sparse, particularly within the riparian zone, to avoid over-shading the waterbodies (exception of north and western sides to allow some shading and cooler temperatures for Dwarf Galaxias while allowing basking sites on the opposite side.

Clyde North PSP Cardinia Creek: Threatened Fauna Conservation Management Plan









Wetland design

- Depth will vary across each wetland, with permanent and ephemeral water areas. Water depth will be a maximum of 1 m.
- Created wetland gradients slope will grade from 1 in 8; 1 in 5; to 1 in 3 (according the vegetation zones above). Steep sided wetlands are less favourable for the Growling Grass Frog.
- The wetlands will be created off the main channel of Cardinia Creek which will allow draining if a build up of sedimentation occurs.
- Wetlands will be filled through flooding events from Cardinia Creek. Ideally these wetlands would not dry out completely, particularly over the spring and summer months (i.e. the breeding period). This is to ensure habitat is available for tadpoles over the summer months to metamorphose. Changes to the hydrological regime also impacts Growling Grass Frog habitat through the alteration of aquatic vegetation communities, given the sensitivity of these plants to water depths and length of inundation (Heard and Scroggie 2009). Ideally, water levels in wetlands would be between 0.5 m and 1 m in vegetation zone 3. Plantings may be used to minimise evaporation. For example, taller plantings on the north and western sides of the waterbody while still maintaining open areas suitable habitat for basking on the opposite side.

Also refer to *Constructed Wetland System: Design Guidelines for Developers* (Melbourne Water 2005). See Section 2.4.4 for revegetation management plan.

Refuge and shelter sites

As stated, sites which provide diurnal shelter/refuge and over-wintering habitat are critical components to Growling Grass Frog habitat. The Growling Grass Frog utilises thick vegetation cover at ground level, rocks and other solid ground cover for diurnal shelter and over-wintering refuge (Gillespie and Clemann 1999, Wilson 2003). Recommendations for provision of rocks, logs and fringing vegetation (e.g. rushes and sedges) are made to provide shelter and refuge sites:

- Rocky areas (e.g. large boulders and rock jumbles) and logs will be provided for shelter/cover and over-wintering habitat around created wetlands and cleared areas along Cardinia Creek. This also increases habitat diversity if vegetated:
 - Dense areas of rocks and logs will be scattered along cleared areas of created/existing wetland banks and open sections along Cardinia Creek and can extend 5 metres from the waters edge, and 1 metres below the maximum water depth. Rocks will vary in size from 300 mm to 1500 mm in diameter and c. 40 % of the bank area. The spaces between the refuge sites should vary to optimise habitat diversity and variability. No mortar will be used within the rock work to ensure crevices are available for frogs to shelter in.



- Rock matrixes (large number of smaller basalt rocks in meshed wire) will also be installed (c. 20 % of the bank area) (see Appendix 3 for examples).
- Provision of fringing vegetation around waterbodies such as indigenous rushes, sedges and tussock-grasses that provide shelter habitat.

Water quality

Water quality tolerances and preferences for Growling Grass Frogs are poorly known, however, recent studies have revealed that, whilst frogs are likely to tolerate a range of water conditions (Ashworth 1998, Hamer et al. 2002, Pyke 2002), frogs generally prefer water bodies possessing low levels of nutrients and salinity levels for successful breeding and recruitment to occur (Ashworth 1998, Organ 2002, 2003, 2005, Hamer and Organ 2006b). As such, the water quality of the wetlands will be maintained within the ranges known at sites occupied by the Growling Grass Frog. Recommendations for waterway design to ensure water quality are provided below.

- Install sediment traps to wetlands if stormwater run-off is directed into the wetland system. These will be positioned at each proposed drain entry.
- Gross pollutant traps will be required if flows from future development enter the creek system or created wetlands. Gross pollutant traps will be incorporated into the drainage system for any future subdivision works adjacent to the Cardinia Creek corridor. The traps will be located immediately upstream of the creek so as to treat flows before they enter the creek system.
- Treatment measures required to achieve the Best Practice water targets will be in place prior to any proposed future development adjacent to the creek. Water Sensitive Urban Design must be implemented in accordance with the 'Urban Stormwater Best Practice Environmental Management Guidelines'.
- Best management practices will be implemented through erosion and sediment control fencing/traps during construction.
 - Sediment control must be in accordance with "Construction Techniques for Sediment Control" (EPA Publication No. 275, 1991) and "Environmental Guidelines for Major Construction Sites" (EPA Publication no. 480, 1995).
 - Sediment control fences should have intermittent gaps (one metre) approximately every 30 m to 50 m to allow for any movement of frogs.
- Wetlands are designed to minimise turbidity (suspended particles) by planting dense areas of aquatic plants and by using a loam or sand substrate instead of clay. Low water turbidity is particularly important for tadpole development (Organ 2005).
- The use of herbicides and fertilisers will be avoided in areas adjacent to wetlands and Cardinia Creek to reduce the potential for non-target impacts and reduce the source of nutrient enrichment and decrease the likelihood of algal blooms.



- Any weeds or flora species considered to be undesirable for the Growling Grass Frog will be removed. While mechanical (hand) removal of weeds will be the primary control method, herbicides may be used selectively. If required, herbicides which are commonly applied around aquatic environments will be used (e.g. Roundup Bi-active).
- The source of water for wetlands will be from flooding events from Cardinia Creek (ponds will inundate every two to five years based on Melbourne Water flood modelling – David Reginato Melbourne Water pers. comm.), rain, surface run-off and potentially from stormwater run-off from future development. Therefore, water quality monitoring will be crucial in ensuring conditions are suitable for the Growling Grass Frog. Once the wetlands are established, monitoring will be conducted annually. Several sampling points will be established throughout the wetlands. Parameters to sample and monitor may include: pH; dissolved oxygen content; electrical conductivity; turbidity; temperature; and total suspended solids (Heard et al. 2004b). These parameters will be measures in the field. No laboratory analysis will be required for these standard water quality samples.
- Sampling programs will follow Environment Protection Agency guidelines. If monitoring detects harmful levels of particular water quality attributes, remedial action will be undertaken in consultation with EPA, DSE and Council.

2.4.3 Buffers and Habitat Connectivity

A 'buffer' is an environmental management tool used to protect the environmental values of the waterbody (Steedman and France 2000; Biosis Research 2003; DSE 2004).

To maintain the long-term viability of Growling Grass Frog habitat, the DEWHA Growling Grass Frog Workshop (March 2008) suggested a buffer width of 200 m around waterways where populations are present (DEWHA 2009). The value is based on movement data (radio tracking) between water bodies and foraging sites (Nick Clemann, Arthur Rylah Institute, pers comm., Peter Robertson Wildlife Profiles, pers comm.). A minimum buffer width of 200 m was also recommended for protecting habitat within the Merri Creek environs (Sub-regional Conservation Strategy for Growling Grass Frog - Ecology Australia 2006c).

It is important to maintain a suitable buffer width around Cardinia Creek and the wetlands (core area of Growling Grass Frog habitat) to protect from over use by residents, edge effects and deterioration of habitat. A width of 200 m obviously requires large reservations of land and is unlikely to be available or practical around the area of core habitat within the Cardinia Creek corridor. This represents the entire available width of land in some areas, with the width from one side of the creek to another ranging from 250 m to 600 m. DSE have suggested a minimum width of 30 m around each of the wetlands to buffer from potential impacts (i.e. no development within this area), noting that the wetlands will be retained within a larger terrestrial system that provides for additional terrestrial habitat. This 30 m buffer is specifically provided to protect the wetland and therefore does not necessarily support the required terrestrial habitat for Growling Grass Frog.



This width will be implemented as the minimum buffer width around wetlands, with wider widths implemented as feasible to protect and provide the necessary terrestrial habitats.

The area core habitat protected along Cardinia creek lies outside the 100 m offset line from the creek. This is necessary, as if Growling Grass Frog colonise the study area, the wetlands (within the 100 m offset) and terrestrial environs (outside the 100 m creek offset line) will almost certainly be utilised for foraging and/or over-winter aestivation (hibernation). This area outside the 100 m offset is considered vital to maintain a population of Growling Grass Frog should they colonise the study area and as such should be managed for conservation values. Under the current design, the buffer widths between the trail and the wetlands are: 50 m buffer for wetland A; 60 m buffer for wetland D, G and H; 70 m buffer for wetland C and E; and 80 m buffer for wetland B and F. The Main Cardinia Creek trail has thus been located outside these buffer widths to protect both breeding habitat (i.e. wetlands) and terrestrial environs required for foraging, shelter and overwintering. A buffer management plan for the protection of Growling Grass Frog wetland and terrestrial habitat is shown in the Cardinia Creek Master Plan (see Appendix 1).

Management Actions

- Land east of the Main Cardinia Creek Trail will be managed purely for conservation and or core habitat. Exclude all recreational facilities, pathways and horse trails from core habitat (includes buffers);
- Implement buffers around each wetland to minimise impacts as per DSE requirements. The following buffer widths will be provided between the existing / created wetlands and the main Cardinia Creek trail:
 - o 50 m buffer for wetland A;
 - 60 m buffer for wetland D, G and H;
 - o 70 m buffer for wetland C and E; and
 - 80 m buffer for wetland B and F.
- Despite the total buffer width varying between the wetlands (as above), the following treatments will be applied for the minimum 30 m buffer around wetlands as per DSE requirements:
 - Manage for vegetation values and ensure these are compatible with terrestrial frog habitat (see Section 2.4.1. and 2.4.2);
 - Vegetation will be continuous and may include open grassy areas which are regularly mowed to provide foraging habitat and unhindered movement (current exotic grassy vegetation can be retained to maintain open areas);



- Provision of rocks, logs and other ground-layer cover will be implemented to ensure suitable shelter and refuge sites around wetlands (as stated in Section 2.4.2); and
- Exclusion of all recreation facilities.

Habitat Corridors

To enable Growling Grass Frog the opportunity to colonise the created wetlands, it is essential to maintain connectivity and a suitable passage for movement of frogs within the core area of Growling Grass Frog habitat in the Cardinia Creek corridor. Habitat corridors in the study area relate to:

- 1. The existing 'habitat link' or corridor along Cardinia Creek (see Section 2.4.3); and
- 2. East west connectivity between created/existing wetlands, Cardinia Creek and Baillieu Creek (the north-south drainage line).

The creek and existing/created wetlands will be managed as an area of core habitat for Growling Grass Frog (see Figure 11). Existing corridor values along Cardinia Creek will be maintained and enhanced. East – west connectivity will be retained by creating dedicated corridors of 30 - 50 m width between the wetlands and the creek and avoiding fragmentation where possible through placement of pathways outside the 100 m creek offset line (exception to this may be where future pathways cross the creek). Furthermore, proposed revegetation between the creek and the wetlands will include appropriate plantings to ensure suitability for movement, basking and foraging of Growling Grass Frog (see below for recommendations). Outside the dedicated habitat corridors, core EVC revegetation will be implemented (see Revegetation Plan - Section 2.4.4).

To create suitable habitat corridors and maintain connectivity throughout the corridor for the Growling Grass Frog, the following elements will be provided:

Management Actions

- Connectivity along Cardinia Creek will be retained through appropriate plantings and design of infrastructure. This will include:
 - Planting appropriate terrestrial vegetation that is compatible with Growling Grass Frog habitat requirements and creates a mosaic of open grassy (current grassy vegetation can be retained to maintain open areas) and dense revegetation suitable for foraging and movement along the creek.
 - Plantings of indigenous trees will be kept quite sparse, particularly within the dedicated habitat corridors to allow movement.
 - Minimisation of and staging of vegetation removal/disturbance during construction activities (e.g. path construction).

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• The road crossing over the creek is not covered within this CMP. However, it is recommended that a large, clear span bridge be considered as this will not



create a barrier to movement and will maximise opportunities for dispersal along the creek (see Section 2.4.8).

- Implementation of sensitive design options for any future pedestrian crossings over the creek and those pathways directed towards a wetland. For example, raised boardwalks will minimise trampling by foot traffic, while still allowing movement along the creek (Section 2.4.3 and 2.4.8).
- East-west connectivity will be retained by dedicating habitat corridors of 30 50 m width between the wetlands and the creek.
- North south connectivity will be maintained by dedicating habitat corridors between existing and created wetlands and maintaining vegetation along Cardinia Creek. Raised boardwalks will be used to maintain connectivity in areas crossing the creek and in close proximity to wetlands.
- Corridors will be comprised of sedges, tussock-grasses, rocks/logs and only occasional low-lying shrubs for shelter. This may include:
 - Vegetation will be continuous and may include open grassy areas which are regularly mowed to provide foraging habitat and unhindered movement (current exotic grassy vegetation can be retained to maintain open areas).
 - Clumped plantings of tussock-grass (*Poa* spp.) and/or moisture-tolerant vegetation (e.g. sedges *Carex* spp.) positioned at c. 20 m intervals along the corridor.
- Corridors will include rocks, large boulders and logs that will maintain an open structure (by taking place of weeds) and also provide important diurnal shelter/over-wintering refuge.
- All recreational facilities will be located outside the area of core habitat (as identified as east of the main Cardinia Creek Trail comprising core EVC revegetation area in Appendix 1). This reduces fragmentation and maintains connectivity between the creek and wetlands. Raised boardwalks should be implemented (see comment above) when designing future creek crossing or where future pathways are located within 30 m of a waterbody (Section 2.4.8 and Figure 9).
- Areas west of the Cardinia Creek Trail (Appendix 1) will have a recreational and conservation function. If Growling Grass Frog colonise the wetlands, this area is highly likely to be used for foraging and over wintering habitat.

2.4.4 Revegetation

Revegetation within the study area is recommended:

• as a follow-up measure associated with particular weed-control activities;

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• to provide suitable wetland habitat for Growling Grass Frog;



- to enhance existing stands of remnant vegetation;
- to enhance habitat for a suite of indigenous fauna species including Southern Brown Bandicoot, Glossy Grass Skink and Southern Toadlet; and
- to enhance natural landscape amenity.

The planting of trees and shrubs will provide competition for exotic species where weed removal has created opportunities for invasion/reinvasion of the same or other undesirable exotic species. Such competition will assist in reducing germination and establishment of some weed species (particularly in higher quality vegetation). In lower quality vegetation characterised by high-threat, ubiquitous herbaceous species, revegetation of the large shrub and tree strata will enhance landscape amenity values, habitat contiguity, and habitat values for a suite of common indigenous fauna throughout the Cardinia Creek riparian corridor. Additionally, revegetation utilising a range of indigenous shrub species suffering from local population decline (e.g. Hemp Bush *Gynatrix pulchella*), will bolster population numbers within the study area, as natural recruitment of these species is being hampered by varying processes (e.g. weed competition, altered hydrological regimes, indigenous and exotic mammal browsing).

Vegetation enhancement measures for the corridor may also benefit other fauna species. For example:

- Protection of existing riparian vegetation and additional revegetation along Cardinia Creek creating sufficient cover is likely to benefit Southern Brown Bandicoot. The mosaic of dense riparian vegetation and open areas (Growling Grass Frog foraging/dispersal corridors) may provide shelter and foraging habitat for this species.
- Enhancement works at existing wetlands and revegetation of created wetlands may provide habitat for Glossy Grass Skink. Reeds, tussock grasses, rushes and other low dense vegetation fringing wetlands would provide potential habitat for this species.
- The addition of rocks and logs for Growling Grass Frog may also benefit Southern Toadlet. This species would also benefit from an accumulation of leaf litter and small damp depressions off the main body of water which could potentially be used as breeding habitat.

Revegetation Zones

Several revegetation zones have been identified for the study area, with management actions varying between each zone. Figure 10 identifies two revegetation zones based EVCs ('Plains Grassy Woodland' and 'Swampy Riparian Woodland'); these zones are used only to identify species selection for planting (see Tables 2 and 3). Appendix 1 (Cardinia Creek Master Plan) identifies two separate terrestrial revegetation zones ('Core EVC revegetation area' and 'EVC revegetation area'); these zones identify the level of revegetation required as outlined below in Table 1. Also shown on Figure 3 are the locations of existing and proposed wetlands.

Revegetation Zone	Works to be undertaken	
	• Extensive revegetation of predominantly woody species (trees and shrubs), ensuring Growling Grass Frog foraging habitat is retained (see Figure 10).	
	Revegetation to provide for other fauna species including Southern Brown Bandicoot, Southern Toadlet, and Glossy Grass Skink.	
Core EVC revegetation area	Ongoing replacement of non-indigenous eucalypts with indigenous eucalypts	
	Post-weed-control plantings (trees, shrubs and robust herbs) within remnant vegetation	
	• Plantings adjoining wetlands or Cardinia Creek to be sympathetic to both Growling Grass Frog and Dwarf Galaxias habitat requirements as outlined in Sections 2.4.2, 3.4.3, and 3.4.6.	
EV/C reversetation area	Creation of a scattered tree canopy throughout	
	Scattered patchwork of revegetation plots (trees and shrubs only)	
	• High quality revegetation of existing and proposed wetlands. Plantings to be sympathetic to Growling Grass Frog and Dwarf Galaxias requirements as outlined in Section 2.4.2 and 3.4.3, and 3.4.6	
	Planting zones (see Table 3)	
	Zone 1 will be densely planted with tussock-forming or rhizomatous perennials. The inter-tussock spaces will be vegetated with a sward of rhizomatous, stoloniferous or tufted perennials. The primary objective in Zone 1 is to achieve a closed cover of vegetation as quickly as possible after planting to stabilise banks (thus preventing erosion, particularly by wave action) and to exclude weeds.	
Wetlands	Vegetation in Zone 2 may be structurally diverse but the aim is to produce a dense cover to stabilise the substrate and prevent colonisation by weeds, particularly during the summer drawdown of the water. All species selected are emergent aquatic plants or amphibious species able to cope with exposure during draw-down. Several species are winter-deciduous because of low temperatures (e.g. <i>Bolboschoenus medianus</i>), or may be summer-dormant (e.g. <i>Eleocharis acuta</i>) when receding water levels impose drought stress. In each case the aerial parts die back to storage organs (rhizomes, tubers etc). Dormant plants resume growth in spring and summer respectively. Zone 3 will be dominated by submerged aquatic species of permanent water.	
	densely cover the substrate.	

Table 1 Clyde North PSP Cardinia Creek CMP: Revegetation Zones and management aims.

Revegetation methods

Three methods are generally used in revegetation exercises:

- 1. Direct seeding;
- 2. Planting of tubestock propagated from seeds, cuttings, or divisions; and

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3. Facilitation of natural recruitment from naturally dispersed *in situ* or off-site sources of propagules (mostly seeds) onto a suitable seed-bed.



The planting of tubestock is considered the only viable option within the study area because of massive competition from weeds in direct seeding or natural recruitment.

Revegetation strategy

The process of successful revegetation requires planning, documentation, implementation, monitoring and maintenance;

- 1. Site selection: should include consideration of the following issues:
 - Existing indigenous flora ensure revegetation activities do not negatively impact existing indigenous vegetation.
 - Weed flora ensure sufficient weed control has been undertaken pre-planting.
- 2. Site preparation: will be variously required throughout the study area and will include:
 - Weed control.
 - Tree-guarding and fencing (only recommended if grazing pressures are found to significantly increase mortality of plants). This includes 'netting' of wetland plantings.
 - Staking (to allow relocation of young plants for maintenance purposes, and so slashing contractors will be able to avoid plantings).
 - Jute matting.
- **3. Species selection:** plantings must make ecological sense, i.e. species 'belong' in particular environments and plant species associations.
- **4. Sources of propagating material:** all revegetation will utilise indigenous species propagated from material (seeds, cuttings, divisions) which must be obtained from the nearest natural populations, with the appropriate DSE permits and protocols to avoid harm to the source populations by overexploitation. All sources of material will be recorded by the contractor(s) or other parties involved in revegetation. Planted populations are unfortunately often unreliable as sources of material because much non-indigenous material is used in some sectors of the revegetation industry¹. All plants and propagation material must be correctly identified and named before being utilised in revegetation.
- **5. Propagation of production plants:** must be undertaken with sufficient lead time to achieve good growth by the time of planting. This will require that the contractor has been allocated sufficient time to undertake collection and growing-on of the tubestock before

¹ Contractors should be aware that some indigenous eucalypt species of questionable provenance have been planted in the southern portion of the study area (e.g. *E. camaldulensis*, *E. ovata* and *E. viminalis* ssp. *viminalis*).


the projected planting time. Conversely, over-grown or root-bound tubestock (depending upon the species involved) should be rejected.

- 6. Documentation: by documenting the various components of a revegetation program (e.g. locations and dates of seed collection, provenance of revegetated plants used at a particular site, weed control, monitoring, etc.) the success rates of future revegetation can be increased as a greater understanding of 'what works' is achieved and communicated to future practitioners.
- 7. Planting: autumn to spring planting (of terrestrial species) and spring planting (of wetland species) is recommended for the study area, allowing for optimal growing conditions (moisture availability and increasing soil temperature). Terrestrial plantings should be watered at the time of planting (to reduce air pockets around the root zone), though follow-up watering should not be necessary. The use of tree guards is not generally recommended though may be necessary if grazing pressures result in the loss of plantings. Similarly, wetland plantings should be 'netted' if over-grazing by waterfowl is observed.
- 8. Monitoring: is of utmost importance that all revegetation be monitored. Effectively timed monitoring will allow various degradation processes (weeds, grazing) to be managed before they adversely affect the plantings.
- **9. Maintenance:** timing will coincide with ecological timelines (e.g. undertake weed control before seed-set) and always seek to optimise the health of the plants used in the revegetation. All plant losses will be replaced unless mortality has been the result of unmanageable site conditions (e.g. prolonged drought).

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Table 2 Clyde North PSP Cardinia Creek CMP: Plant species suitable for use in terrestrial revegetation.

Structural Role of Plants

- A Structural dominant of the vegetation stratum the sole or predominant species locally or across broader expanses or the whole vegetation zone; with high overall cover within particular location
- **B** Localised structural co-dominant (with other species) in vegetation stratum
- **C** Scattered thinly or discontinuously as small groups or isolated individuals (trees/shrubs and perennial herbs); with low overall cover.
- **D** Scattered and infrequent across a wide area
- E Localised stands/aggregates in defined environment

Revegetation Zones

- Zone 1 Swampy Riparian Woodland
- Zone 2 Plains Grassy Woodland

Species	Common Name	Vegetation Zones		Structural Role of Plants	Notes
		Zone 1	Zone 2		
Trees					
Acacia dealbata ssp. dealbata	Silver Wattle			С	
Acacia mearnsii	Black Wattle	√	√	С	
Acacia melanoxylon	Blackwood	\checkmark	\checkmark	С	
Allocasuarina littoralis	Black Sheoak		\checkmark	С	
Eucalyptus cephalocarpa	Silver-leaf Stringybark	\checkmark	\checkmark	С	
Eucalyptus fulgens	Green Scentbark		\checkmark	С	
Eucalyptus melliodora	Yellow Box		√	С	
Eucalyptus ovata var. ovata	Swamp Gum	\checkmark		С	
<i>Eucalyptus radiata</i> ssp. <i>radiata</i>	Narrow-leaf Peppermint		✓	С	
Eucalyptus viminalis ssp. viminalis	Manna Gum	V		С	
Large and medium shrubs					
Acacia verticillata ssp. verticillata	Prickly Moses	~	~	С	
Bursaria spinosa ssp. spinosa	Sweet Bursaria	~	\checkmark	С	
Cassinia aculeata	Common Cassinia	\checkmark		С	
Cassinia arcuata	Drooping Cassinia		√	С	
Coprosma quadrifida	Prickly Currant-bush	\checkmark		С	
Goodenia ovata	Hop Goodenia	\checkmark	√	С	
Gynatrix pulchella	Hemp Bush	\checkmark		С	
Hakea nodosa	Yellow Hakea	\checkmark	\checkmark	С	
Leptospermum continentale	Prickly Tea-tree	\checkmark		С	
Leptospermum lanigerum	Woolly Tea Tree	\checkmark		Е	
Leptospermum scoparium	Manuka	\checkmark		С	
Melaleuca ericifolia	Swamp Paperbark	\checkmark		А	
Melaleuca squarrosa	Scented Paperbark	\checkmark		В	
Melicytus dentatus	Tree Violet	\checkmark	\checkmark	С	
Myrsine howittiana	Mutton-wood	\checkmark		С	
Olearia lirata	Snow Daisy-bush	\checkmark		С	
Ozothamnus ferrugineus	Tree Everlasting	\checkmark	\checkmark	С	
Ozothamnus rosmarinifolius	Rosemary Everlasting	\checkmark		С	
Pomaderris aspera	Hazel Pomaderris	\checkmark		С	
Pomaderris racemosa	Cluster Pomaderris	\checkmark		С	
Prostanthera lasianthos	Victorian Christmas-bush	\checkmark		С	
Rubus parvifolius	Small-leaf Bramble	\checkmark		С	
Solanum laciniatum	Large Kangaroo Apple	\checkmark	√	С	
Viminaria juncea	Golden Spray	✓		С	
Perennial herbs					
Acaena novae-zelandiae	Bidgee-widgee	✓	√	C	
Senecio glomeratus ssp. glomeratus	Annual Fireweed		✓	С	
Senecio minimus	Shrubby Fireweed	\checkmark		C	
Urtica incisa	Scrub Nettle	\checkmark		С	



Species	Common Name	Vegetatio	on Zones	Structural Role of Plants	Notes		
		Zone 1	Zone 2	-			
Grasses and graminoids							
Gahnia radula	Thatch Saw-sedge	\checkmark		С			
Gahnia sieberiana	Red-fruit Saw-sedge	\checkmark		С			
Hemarthria uncinata var. uncinata	Mat Grass	~		С			
Juncus amabilis	Hollow Rush			С	Tolerates dryness once established		
Juncus gregiflorus	Green Rush	\checkmark		С	Tolerates dryness once established		
Juncus pauciflorus	Loose-flower Rush	~		С	Tolerates dryness once established		
Juncus sarophorus	Broom Rush	\checkmark		С	Tolerates dryness once established		
Juncus procerus	Tall Rush	~		Е	Sheltered situations in damp, well-drained soil (SGAPM 1991)		
Lepidosperma laterale var. laterale	Variable Sword-sedge	~	\checkmark	С			
Lepidosperma laterale var. majus	Variable Sword-sedge	~		С			
Lepidosperma longitudinale	Pithy Sword-sedge	\checkmark		С			
Lomandra longifolia ssp. longifolia	Spiny-headed Mat-rush	~	~	С			
Poa ensiformis	Sword Tussock-grass	\checkmark		В			
Poa labillardierei var. labillardierei	Common Tussock-grass	~	✓	В			
Vines and climbers							
Calystegia sepium	Large Bindweed	\checkmark		D			
Cassytha pubescens	Downy Dodder-laurel	\checkmark	\checkmark	D			
Clematis aristata	Mountain Clematis	\checkmark					
Clematis microphylla	Small-leaf Clematis		\checkmark	D			
Ferns							
Blechnum minus	Soft Water fern	\checkmark		E			
Pteridium esculentum	Austral Bracken	\checkmark	\checkmark	C			

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Table 3 Clyde North PSP Cardinia Creek CMP: plant species suitable for use in wetland revegetation.

Structural Role of Plants

- A Structural dominant of the vegetation stratum the sole or predominant species locally or across broader expanses or the whole vegetation zone; with high overall cover within particular location
- **B** Localised structural co-dominant (with other species) in vegetation stratum
- C Scattered thinly or discontinuously as small groups or isolated individuals (trees/shrubs and perennial herbs); with low overall cover.
- **D** Scattered and infrequent across a wide area
- E Localised stands/aggregates in defined environment

Revegetation Zones

- **Zone 1** Permanently moist or seasonally wet margins; shallow seasonal inundation in lower part of zone.
- **Zone 2** Shallow inundation; upper minimum depth of inundation c. 10 cm; amphibious and emergent aquatic herbs, some straddling Zones 1 and 2.
- Zone 3 Permanent water; submergent and emergent aquatic-herbs, some straddling Zones 2 and 3.
- II
- III

Species	Common Name	Ve	getation Z	ones	Structural Role of Plants	Notes
		Zone 1	Zone 2	Zone 3		
Perennial herbs						
Alisma plantago-aquatica	Hairy Willow-herb		\checkmark		С	
Alternanthera denticulata	Lesser Joyweed	\checkmark				
Centella cordifolia	Centella	\checkmark			С	
Crassula helmsii	Swamp Crassula	\checkmark			С	
Epilobium billardierianum subsp. billardierianum	Smooth Willow-herb	\checkmark			С	
Epilobium hirtigerum	Hairy Willow-herb	\checkmark			С	
Gratiola peruviana	Austral Brooklime	\checkmark			С	
Lycopus australis	Australian Gipsywort	\checkmark	\checkmark		С	
Lythrum salicaria	Purple Loosestrife	\checkmark	\checkmark		С	
Marsilea drummondii	Common Nardoo	\checkmark	✓	\checkmark	C	If submerged plant only in shallow water (<30 cm deep) (SGAPM 1991)
Myriophyllum crispatum	Upright Water-milfoil			\checkmark	С	
Myriophyllum verrucosum	Red Water-milfoil			\checkmark	C	
Ottelia ovalifolia subsp. ovalifolia	Swamp Lily			\checkmark	С	
Persicaria decipiens	Slender Knotweed	\checkmark	\checkmark		С	
Persicaria praetermissa	Spotted Knotweed	~			С	
Persicaria subsessilis	Hairy Knotweed	\checkmark			C	
Potamogeton pectinatus	Fennel Pondweed			~	С	
Potamogeton tricarinatus s.l.	Floating Pondweed			✓	C	
Ranunculus inundatus	River Buttercup	\checkmark	\checkmark		С	
<i>Triglochin procerum</i> s.l. (broad erect leaves)	Water-ribbons	√	~		С	
<i>Triglochin procerum</i> s.l. (long floating leaves)	Water Ribbons			\checkmark	С	
Triglochin striatum	Streaked Arrow-grass	\checkmark			С	
Vallisneria americana var. americana	Eel Grass			\checkmark	С	
Villarsia reniformis	Running Marsh-flower	✓	✓		С	
Grasses and graminoids						
Amphibromus fluitans	River Swamp Wallaby-		✓			
Baumea rubiginosa s.l.	Soft Twig-rush	√	✓		С	
Bolboschoenus medianus	River Club-sedge	√	✓		С	
Carex appressa	Tall Sedge	√			С	
Carex fascicularis	Tassel Sedge	\checkmark	\checkmark		С	
Carex gaudichaudiana	Fen Sedge	~			С	
Cladium procerum	Leafy Twig-sedge	\checkmark	1		С	
Cyperus lucidus	Leafy Flat-sedge	\checkmark	\checkmark		С	
Eleocharis acuta	Common Spike-rush	\checkmark	\checkmark		С	
Eleocharis sphacelata	Tall Spike-sedge	\checkmark	\checkmark		С	



Species	Common Name	Ve	getation Z	ones	Structural Role of Plants	Notes
		Zone 1	Zone 2	Zone 3	-	
Glyceria australis	Australian Sweet-grass	~			С	
Isolepis fluitans	Floating Club-sedge		\checkmark		С	
Juncus holoschoenus	Joint-leaf Rush	\checkmark			С	
Juncus amabilis	Hollow Rush	\checkmark			С	
Juncus gregiflorus	Green Rush	\checkmark			С	
Juncus pauciflorus	Loose-flower Rush	\checkmark			С	
Juncus sarophorus	Broom Rush	\checkmark			С	
Juncus procerus	Tall Rush	\checkmark			С	
Phragmites australis	Common Reed	\checkmark	\checkmark		С	
Poa labillardierei var. labillardierei	Common Tussock-grass	~			В	
Schoenoplectus tabernaemontani	River Club-sedge		~		C	

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Management Actions

- Contract revegetation specialists to implement revegetation. The contractor must be suitably qualified to undertake revegetation/rehabilitation works as outlined in this document.
- Undertake propagation of tubestock in accordance with information provided above.
- Undertake revegetation works as outlined in Table 1.
- Implement a revegetation monitoring program, and ensure all plant losses are replaced.
- Ensure all revegetation activities are undertaken with reference to Growling Grass Frog and Dwarf Galaxias habitat requirements as outlined in Sections 2.4.2 and 3.4.3, 3.4.4 and 3.4.6.

2.4.5 Weed Management

The weed flora of the study area comprises seven noxious weed species (as listed under the *Catchment and Land Protection Act 1994* [CaLP Act] for the Port Phillip and Westernport CMA region), and numerous other environmental weed species. The weed flora is dominated by ubiquitous annual and perennial herbaceous weeds, with woody weeds (most notably Blackberry **Rubus anglocandicans*) scattered throughout.

Table 4 lists 24 weed species identified for elimination or control within the study area. These are a small proportion of the weed flora, but have been identified as species/populations that should be managed throughout the study area because of their seriousness as invaders, and/or are required to be managed under the CaLP Act. Other species will require management in certain circumstances (e.g. to allow for revegetation), but full-scale management would be untenable (e.g. Phalaris **Phalaris aquatica*).

It must be stated that the weed flora is not static, and new weed species are likely to appear within the study area over the duration of this management plan, introduced by a wide range of natural agents (e.g. wind and animals). The weeds listed for control in Table 4 should not be seen as exhaustive. Annual monitoring will allow for the identification of new weed species and their incorporation into the management program as appropriate.

Weed management operators must be suitably qualified and appropriately certified and possess the requisite weed and indigenous plant identification skills. Additionally, all aspects of the control program need to be appropriately documented (to an agreed standard) to enable the tracking and evaluation of control methods/activities, and to allow for refinement of procedures, as well as to inform future weed management activities. Finally, damage to indigenous vegetation (by herbicide or machinery and to soils) must be avoided at all times, and all health and safety, and environmental regulations, must be observed.



Herbicide use

All herbicide usage within the study area will be in accordance with the following:

- The use of herbicides in and adjacent to water-bodies (including riparian zones and wetlands) will be avoided where practicable. If unavoidable, herbicides only legally certified for use in such situations (as specified on the product label) will be used. Application methods resulting in low levels of off-target damage (e.g. cut/paint, and drill/fill) will be favoured over spray application.
- All use of herbicides (and associated additives) will be in accordance with the product label. Off-label use of herbicides may be permitted where approval has been granted from a state government department (e.g. Department of Sustainability and Environment or Department of Primary Industries).
- Site-specific herbicide planning (application methods, chemicals used, weather conditions, plant phenology, etc.) will be employed to reduce off-target herbicide damage. Off-target herbicide damage is the detrimental application of herbicide to plant species that have not been targeted for control. While this generally applies to plants in and around the point of herbicide application, it may also refer to organisms (flora and fauna) some distance away.

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Table 4 Clyde North PSP Cardinia Creek CMP: Weed species identified for elimination or control within the study area.

Life form (mostly after Carr et al. 1992)

Т	tree	А	annual	Pt	perennial herb (tufted or tussock forming)	В	biennial	Gc	cormous geophyte	V	vine
Ea	emergent aquatic	Ls	large shrub	Pr	perennial herb (rhizomatous or stoloniferous)	S	shrub	Gt	tuberous geophyte	Ss	subshrub

Noxious weed/WONS

C – listed as a Controlled weed species under the Catchment and Land Protection Act 1994 for the Port Phillip and Westernport Catchment Management Authority region

R - listed as a Restricted weed species under the Catchment and Land Protection Act 1994 for the Port Phillip and Westernport Catchment Management Authority region

Control method(s)

A Herbicide treatments

- 1 Herbicide applied to foliage with spray, wick applicator, etc.; annuals must be sprayed well before seed ripening.
- 2 Cut down and concentrated herbicide immediately applied to stump or stems, or bark "frilled" and herbicide applied.
- 3 Stem drilled and injected with concentrated herbicide.

B Physical treatments

- 4 Physical removal most plants can be physically removed by hand-weeding or with tools when small and/or isolated but soil disturbance is kept to a minimum.
- 5 Cut off at ground level (species that will not resprout from basal buds).
- 8 Ringbarking
- 9 Biological control with suitable agent (e.g. rust fungus or leaf hopper for Asparagus asparagoides)

Control/eliminate

Timing (preferred timing only, many species may be successfully controlled at other times)

E – eliminate all populations	Sp	spring	W	winter	(f)	when in flower
C – control weed populations	S	summer	All	Year round	(bl)	before leaves discolour
Ctn – contain weed populations	А	autumn	(bf)	before flowering	D	when water-body is dry

Miscellaneous

- ▲ Control only within wetlands (c.f. Cardinia Creek).
- All recruitment to be eliminated. Mature trees may be retained.
- Eliminate from all wetlands. Contain to banks of Cardinia Creek (i.e. control from top-of-bank landwards).

Clyde North PSP Cardinia Creek: Threatened Fauna Conservation Management Plan

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Species	Common Name	Life form	Family	Control Methods	Timing	Control/ eliminate
Acacia baileyana	Cootamundra Wattle	Т	Mimosaceae	5,8 (mature plants), 2 (young plants)	All	E
Asparagus asparagoides R	Bridal Creeper	Gt	Asparagaceae	1,4 (small infestations),9	W - Sp	E
Cirsium vulgare C	Spear Thistle	В	Asteraceae	1,4	Sp (bf)	С
Crataegus monogyna C	Hawthorn	Ls/T	Rosaceae	2	Sp - Su	E
Cotoneaster franchetii	Grey Cotoneaster	Ls	Rosaceae	1,2,4 (young plants)	All	E
Cyperus eragrostis ▲	Drain Flat-sedge	Pt	Cyperaceae	1,4	All	С
Echium plantagineum $\mathbf C$	Paterson's Curse	А	Boraginaceae	1,4	Sp (bf)	С
Eucalyptus botryoides	Southern Mahogany	Т	Myrtaceae	2,4	All	С
Eucalyptus cladocalyx ■	Sugar-gum	Т	Myrtaceae	2,4	All	С
Eucalyptus globulus ssp. globulus 🛛	Southern Blue-gum	Т	Myrtaceae	2,4	All	С
Festuca arundinacea	Tall Fescue	Pt	Poaceae	1	All	E
Lonicera japonica	Japanese Honeysuckle	V/S	Caprifoliaceae	1,2,4 (small infestations)	Sp - A	E
Lycium ferocissimum C	African Box-thorn	Ls	Solanaceae	2	All	Е
Melaleuca armillaris ssp. armillaris 🔳	Giant Honey-myrtle	Ls	Myrtaceae	2,3	All	С
Nymphaea sp.	Waterlily	Ea	Nymphaeaceae	1,4	D	Е
Paspalum distichum 🔺	Water Couch	Ea	Poaceae	1	All	С
Phytolacca octandra	Red-ink Weed	Ss	Phytolaccaceae	1,4	All	С

Clyde North PSP Cardinia Creek: Threatened Fauna Conservation Management Plan

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Species	Common Name	Life form	Family	Control Methods	Timing	Control/ eliminate
Pinus radiata	Radiata Pine	Т	Pinaceae	4 (young plants), 5 (mature plants)	All	Е
Pittosporum undulatum	Sweet Pittosporum	Т	Pittosporaceae	2,3,4 (young plants)	All	Е
Rubus anglocandicans C	Blackberry	Ls	Rosaceae	1,2	Sp – S (f)	Е
Salix alba var. vitellina C	Golden Willow	Т	Salicaceae	3 (mature plants), 2 (saplings)	A (bl)	Е
Salix X reichardtii	Pussy Willow	Т	Salicaceae	3 (mature plants), 2 (saplings)	A (bl)	Е
Solanum pseudocapsicum	Madeira Winter-cherry	S	Solanaceae	1,2,4	All	С
Tradescantia fluminensis 🔶	Wandering Tradescantia	Pr	Commelinaceae	1,4	All	E/Ctn



Management Actions

- Contract weed management specialists to implement weed control as outlined above. The contractor must be suitably qualified to undertake weed management works as outlined in this document.
- Implement a monitoring program to ensure weed control works are successful, and to identify ongoing works.

2.4.6 Pest Animal Management

Pest management, including weed and feral animal control is essential to protect and enhance Growling Grass Frog habitat in the study area. Recommendations for mitigating impacts of these threatening processes are outlined below.

Feral animal control

Introduced predators such as the European Fox and Eastern Gambusia pose a threat to Growling Grass Frog in the study area.

Fox Vulpes vulpes

Fox predation is outlined as a Threatening Process in the Action Statement produced under the FFG Act (Mansergh and Markes 1993), and is also a threatening process under the EPBC Act. As the fox is a highly mobile animal, and would occur in surrounding areas, any control action on foxes would be potentially futile unless surrounding land managers and owners also took similar action in a co-coordinated community-based scheme over a large area (Saunders et al. 1995, Morton et al. 1999).

Recommendations are provide below to minimise fox abundance in the study area.

Management Actions

- If practical, coordinate a community wide effort to control foxes. This will also benefit other threatened fauna species including, the EPBC and FFG-listed Southern Brown Bandicoot (*Isoodon obesulus obesulus*).
- Discuss control techniques with the DSE, Department of Primary Industries (DPI), local council, Parks Victoria, Melbourne Water, control contractors and local residents.
- Remove all food waste and utilise interpretive signage to notify visitors that leaving food waste and rubbish in open space areas may encourage foxes and other pest animals, such as rodents.

Eastern Gambusia Gambusia holbrooki

As stated above, Eastern Gambusia is a potential predator of Growling Grass Frog eggs and tadpoles (Anstis 2002) and has been implicated in the decline of this species (Robertson et al. 2002). Eastern Gambusia is likely to be present within Cardinia Creek. No fish were observed



within the off-line wetlands surveyed during the assessment. Wetlands located outside the study area to the south-west have a high abundance of this exotic species (John McGuckin pers. comm.).

As Eastern Gambusia is present throughout the catchment and as created wetlands will be filled through flooding events from Cardinia Creek, it is highly unlikely that this species can be controlled in the long term (John McGuckin 2010 in prep.). As per recommendations provided by John McGuckin (2010 in prep.) the wetlands could be designed to exclude or reduce habitat features that are suitable to Eastern Gambusia. For example, dense submergent aquatic plantings and riparian plantings on the north and western sides of the waterbody will reduce the water temperature and maintain some shaded areas (both compatible for Dwarf Galaxias), while still allowing open areas of suitable habitat for basking Growling Grass Frog on the opposite side.

Management Actions

- All stocking of exotic fish or non-indigenous fish within the creek and created wetlands is prohibited (see Section 2.4.6, 2.4.7, and 3.4.7).
- Undertake measures to reduce habitat quality and thus exclude Eastern Gambusia. For example, dense submergent aquatic plantings and riparian plantings on the north and western side of the water body will reduce the temperature and provide partial shading of the waterbody, while still allowing basking sites for Growling Grass Frog on the opposite side (see also Section 2.4.4).

2.4.7 User related issues

The draft Master Plan for the study area incorporates areas managed for fauna habitat and public open space. Activities in public open space may include active and passive recreation such as sporting activities, walking, horse riding, picnicking, fishing and nature study.

Both high use and passive recreational activities may impact on the biodiversity values of Growling Grass Frog habitat through direct (e.g. trampling by foot traffic) and indirect impacts (e.g. disturbance). Management of recreational activities is essential to ensuring the long-term sustainability of biodiversity values in the study area. Public education using interpretive signage can create community understanding of environmental issues and management within the Cardinia Creek Corridor (see Table 5 for examples). Recommendations are provided below to minimise or eliminate potential impacts from recreational use in the study area.

Roaming cats from adjacent residential areas to be developed will pose a threat to Growling Grass Frogs.

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Management Actions

• All pathways and facilities will be excluded from the core area of habitat (e.g. east of the Main Cardinia Creek trail comprising the core EVC revegetation and the Significant EVC Revegetation areas – see Appendix 1).



- Provide clear delineation of trails to encourage path use. Revegetation in the riparian zone and/or fencing may help to designate areas.
- Where future pathways intersect core habitat or are within 30 m of a waterbody (e.g. future creek crossings) raised boardwalks will be implemented. This will minimise trampling and damage to vegetation and in-stream environs, while still allowing the passage of frogs (see Section 2.4.3).
- Prohibit dogs if possible (or at least enforce a strict dogs 'on leash' policy) in areas of high conservation value (e.g. wetlands). This will also benefit other fauna species, such as wetland dependent birds (e.g. FFG-listed Baillon's Crake recorded during the assessment) utilising the area.
- Restrict cat movements in residential areas adjacent to Cardinia Creek and encourage and enforce responsible cat-owner behaviour offers (Casey Council).
- Prohibit riding of trail bikes and horses except on designated tracks as per draft Master Plan.
- Prohibit the removal of fallen timber and other plant material.
- Prohibit the introduction of exotic fish into the creeks or wetlands. This will be particularly important to maintain potential breeding habitat for Growling Grass Frog in wetland environs.
- Enforce a strict 'no dumping policy' for rubbish or litter (e.g. signs with litter fine amounts). Signage near public facilities would be helpful to explain that leaving food waste and rubbish may encourage pest animals such as foxes and rodents.
- Support community education programs (e.g. Melbourne Waters Water watch and Frog Census) and encouraging participation and support for local community groups (e.g. friends groups, Cardinia Environment Council).
- The greater area of public open space will be delineated from core areas of habitat for Growling Grass Frogs with appropriate fencing and signage (see Section 2.4.7).
- Temporarily fence (with appropriate signage) of revegetation zones.

- Artificial lighting originating from street lighting, sports floodlights, housing and security lighting on pathways can alter the habitat suitability for some species, particularly nocturnal native fauna. Minimise light spillage and impacts to fauna through the design of lighting by:
 - No lighting will be installed around the creek or created/existing wetlands.
 - o Directing street lighting away_from remnant vegetation and riparian habitats.
 - o Eliminating bare bulbs and lighting pointing upward (where practicable).



- Using narrow spectrum bulbs as often as possible to lower the range of species affected by lighting.
- Using 'down lights' that do not directly spill outside the area where light is required. Using a down light and motion sensor lighting in order to reduce light spill and the associated secondary impact on nocturnal fauna species potentially utilizing the adjoining vegetation.
- Shield or cut lighting to ensure that light reaches only areas needing illumination.
- Use embedded lights if possible to illuminate pathways.

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- Lighting should be located no closer than 30 m from a waterbody edge.
- Providing interpretive signage in areas of interest. Signage is important in order to educate the public on values that occur within the Cardinia Creek corridor. The existing Master Plan will be reviewed to identify opportunities to add interpretive elements to sites during the implementation stage. Table 5 below outlines the type of signage that should be provided within existing and created areas of habitat.



Table 5 Clyde North PSP Cardinia Creek CMP: Interpretive signage required for the study area.

Sites	/areas	Interpretative signs for values	Other signs required
Pre- Card	construction and inia Creek	construction	No-Go Zones - Entry by humans and machinery is prohibited.
Exist G)	ing wetlands (B,		No-Go Zones - Entry restricted to humans only. No-Go Zones - Entry by humans and machinery is prohibited.
Post Card Exist wetla	Construction inia Creek	 Information on the biology and ecology of Growling Grass Frogs. This would also highlight the importance of Cardinia Creek for dispersal and over-wintering habitat. Others types of threatened native fauna found within area (e.g. potential habitat for EPBC-listed Dwarf Galaxias and Australian Grayling). These signs will not give the detailed location of individual populations. Remnant vegetation. Revegetation. Weed hot spots. Signs would identify areas that are being managed for weed invasions and encourage avoidance of areas to eliminate the spread of seeds between sites. The impacts of dumped garden waste and the importance of controlling the invasion of environmental weeds or other exotics. Waterway health including: the prohibition of stocking with exotic fish; the potential non-target impacts of using pesticide/herbicides use near water; and the dumping of rubbish. The potential non-target impacts of using pesticide/herbicides use near water. Restrictions for cats and dogs including their potential impacts on fauna values. A map showing the location of on and off-leash areas for dogs. Information on the biology and ecology of Growling Grass Frogs. This would also highlight the importance of breeding, foraging and over-wintering habitat in off-line wetlands. Others types of threatened native fauna found within wetlands (e.g. Baillon's Crake). These signs will not give the detailed location of individual populations. 	Access via pathways and designated future crossings – pedestrians will be excluded from access to all areas of core habitat. Access via pathways - pedestrians will be excluded from access to all areas of core habitat.
		 Sensitive habitats (e.g. wetlands), their values and activities that could have a potentially degrading impact. 	



- Waterway health including: the prohibition of stocking with exotic fish.
- The potential non-target impacts of using pesticide/herbicides use near water.
- Restrictions for cats and dogs including their potential impacts on fauna values. A map showing the location of on and off-leash areas for dogs.
- Growling Grass Frog ecology and habitat and the importance of connectivity along Cardinia Creek and between the creek and the wetlands.
- Revegetation.

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Habitat Corridors

Exclude pedestrian access.



2.4.8 Roads, pathways, future creek crossings and fencing

To minimise risks associated with construction activities, the following mitigation measures and management actions will be implemented.

Note: Existing wetland B has been selected as the recipient site for any Growling Grass Frogs found during the salvage operation. As such, all enhancement plantings associated with this wetland will be completed before all other construction works in the study area. Once enhancement plantings on wetland B are completed, mitigation measures as outlined in Section 2.4.1 must be implemented to ensure protection of this wetland and any translocated/colonised frogs throughout the entire construction period.

Figure 3 provides an illustration of the preliminary recommendations for No-Go Zone for works associated with the bridge crossing over Cardinia Creek. The proposed road bridge (and any future pedestrian creek crossings) will be subject to further assessment and a separate CMP will be required. Location and design of crossings will be in conjunction with DSE.

Management Actions

- Minimise vegetation removal within construction footprints and implement post construction rehabilitation. For example:
 - Vegetation removal associated with bridge construction may result in the loss of potential sheltering habitat for the Growling Grass Frog. Vegetation disturbance within the construction zone will be kept to a minimum and no vegetation clearance to occur within the low flow zone. Heavy vehicles and machinery will not access the floodplain or low flow zone (i.e. No-Go Zone see Section 2.4.1, 2.4.8 and Figure 3). Only hand held equipment will be used in these areas. The site compound area will be situated away from the waterways, on nearby land which has been previously disturbed. Removal of vegetation is this area will be quickly followed by site rehabilitation measures to stabilise the banks and reinstate Growling Grass Frog habitat.
- Maintain north-south connectivity (e.g. along Cardinia Creek and between wetlands) and east-west connectivity (see Section 2.4.3). This includes:
 - The proposed road crossing will be subject to further assessment. Preliminary recommendation to implementation a large clear span bridge that aims to maximise opportunity for fauna movement under the bridge. It is anticipated that a clear span bridge would not create a barrier or disrupt any movement of Growling Grass Frog in this area. However, any frogs utilising this area should be discouraged from crossing the road through the use of drift fencing, directing movement under the bridge (see Section below).



- Existing pathways will be used where possible (e.g. Figure 9).
- Pathways will be located at least 30 m from a waterbody to maintain buffer zone (see Figure 9). Exceptions are possible future pathways and creek crossing.
- Pathways will be placed outside areas of core habitat to maintain east-west connectivity. Exceptions are possible future pathways and creek crossing.
- Where future pathways intersect core habitat or are within 30 m of a waterbody (e.g. future creek crossings) raised boardwalks will be implemented. This will minimise trampling and damage to vegetation and in-stream environs, while still allowing the passage of frogs (see Section 2.4.1 and 2.4.3).
- Implement 'Best Practice' procedures to minimise construction impacts (sedimentation and pollution) on the creek and existing wetlands (see Section 2.4.2 water quality).
- Raised boardwalks will be implemented at all future creek crossings, pathways intersecting core habitat and those located within 30 m of any waterbody (as above).
- Road crossing subject to additional assessment. Preliminary recommendation to utilise drift fencing to exclude animals crossing the proposed road alignment at the northern boundary of the study area and reduce risk associated with road kill. This would include:
 - Drift fencing to be installed upstream and downstream of the bridge on both sides of the creek line, along the boundary of the Creek corridor.
 - A solid (preferred) or mesh structure can be used such as plastic or durable mesh (see Appendix 3 for commercially available fences).
 - Drift fencing to be positioned at a 45 degree angle to the road verge to prevent frogs entering the road pavement.
 - If using the durable mesh (see Appendix 3), the fencing will be one metre in height and buried 0.2 m below ground with a 'floppy top' angled towards the creek line to stop frogs attempting to climb over the fence.
 - Some rock and other course woody debris be placed near the fencing to provide temporary shelter sites (e.g. 1 m + away from the fence to provide room for movement).
 - Vegetation within 0.5 metres of the drift fencing should be less than 0.5 metre high.
 - o Regular checks are required to ensure effectiveness (see Appendix 3).

Also refer to Robertson (2002) and Organ (2005).

• The Contractor shall undertake soil stabilisation of disturbed areas.

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• An experienced wetland rehabilitation and/or revegetation contractor will be engaged to undertake the works.



- If a delay is required between construction and rehabilitation due to seasonal constraints, then additional temporary soil stabilisation measures will be implemented.
- Weed control will be undertaken primarily by hand. However, if some targeted use of herbicides is required an environmentally sensitive herbicide (e.g. Roundup Bi-active) can be used near waterways.
- The need for weed control within the construction zone and at machinery wash down sites is to be determined during the revegetation monitoring and undertaken as required.
- A permit to remove native vegetation would be required from the relevant local councils.
- The key personnel from the contracting companies are to take part in a site induction. This will involve an on-site meeting with a qualified zoologist to relay information regarding the Growling Grass Frog, their aquatic and terrestrial habitat requirements, the importance of protecting these areas. All other employees of the contractor and new staff will be inducted by the Site manager.
- Train all workers during pre-construction induction to be aware of maintaining general housekeeping on-site so as to contain litter.



Figure 3 Clyde North PSP Cardinia Creek CMP: Preliminary recommendations for various a waterway zones and the 'no-go' zone for vehicles and heavy machinery accessing Cardinia Creek for future bridge construction.



2.4.9 Salvage and Relocation protocols for the Growling Grass Frog

A permit to salvage and translocate animals will be required from the Department of Sustainability and Environment (DSE) under the *Wildlife Act 1975*. Only persons listed on the Victorian *Wildlife Act 1975* Management Authorisation will be permitted to handle native fauna.

The current proposal includes the disturbance and/or removal of vegetation along Cardinia Creek. Salvage and relocation protocols would also apply to the proposed road bridge (and future pedestrian creek crossings). Existing wetlands will be retained on-site and newly created wetlands will augment potential breeding habitat within the study area.

Although no Growling Grass Frogs were recorded during the current or previous assessments in the study area, this species is likely to utilise Cardinia Creek as dispersal habitat. While no breeding population is known from within one kilometre of the study area, Growling Grass Frog was recently recorded 2.8 km south of the study area, along McCormacks Road within approximately 500 m of Cardinia Creek (R. Marr pers. obs). Thus as frogs are likely to move along the creek, short-distance relocation protocols are recommended to ensure individual frogs are not adversely affected by the construction (Robertson and Heard 2008). Although relocation of individuals should assist in preventing direct mortality of frogs within the construction zone, some individuals may be accidentally lost during construction. However, depending on the time of year and climatic conditions (e.g. low rainfall) there may be few frogs that require relocation.

Short distance relocation operations specifically for the Growling Grass Frog have been recommended and/or undertaken as part of other development and road infrastructure projects in the Greater Melbourne area (Robertson 2001; Organ 2002, 2003, 2005; Ecology Australia 2001, 2006c; Heard et al. 2004b, Wilson 2003).

Relocating Growling Grass Frogs involves some risk to frogs as the long-term effects of such operations are not fully understood. Consequently, there is a need to consider subsequent monitoring requirements to determine the effects of relocation (see below). Procedures have been designed to provide a course of action for relocating Growling Grass Frogs from Cardinia Creek to **existing wetland B** (see Appendix 1 and Figure 9). This wetland will be subject to enhancement works (e.g. enhancement plantings) that will be completed prior to any relocation of frogs. This wetland will be protected during construction works through fencing and signage illustrating NO-Go Zones. If access to Wetland B is restricted (i.e. during the appropriate time for enhancement plantings to provide a suitable recipient site for salvaged Growling Grass Frogs), then an alternative recipient site will be identified to the satisfaction of DSE.

A salvage and translocation plan is outlined in Appendix 4. This includes relocation protocols to ensure that individual frogs are not adversely affected by the construction.

The relocation operation is to occur immediately prior to areas being impacted by construction activities.

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The two key areas that will be impacted include:



- Existing wetlands and the Baillieu Creek (north-south drainage line) including any works (e.g. pathway construction) adjacent to these areas; and
- Proposed road bridge over Cardinia Creek and any future pedestrian crossings.

Monitoring protocols are detailed in Appendix 5. Growling Grass Frog habitat identified outside the study area within the Clyde North PSP area should also be salvaged following protocols outlined in 4 and 5.

2.4.10 Monitoring

It is essential that potential habitat for Growling Grass Frog continue to be monitored. Changes to management practices can lead to degradation of habitats and consequently the ability of the frog to disperse through or colonise the area. Thus, regular monitoring of the wetlands will be undertaken to determine whether this species has colonised the site. Furthermore, animals captured during salvage works will be marked through PIT tags (see Appendix 4), relocated into wetland **B**, and monitored to determine the success of these translocated animals. Monitoring of translocated animals will occur concurrently with monitoring for frog colonisation. The following monitoring program is recommended.

Landowners will be responsible engaging an appropriately qualified zoologist to monitor the potential colonisation and/or successful translocation of Growling Grass Frogs unless responsibility has been transferred to a public authority with associated costs provided. Monitoring would be undertaken within all wetlands and along Cardinia Creek during the breeding season (e.g. October – February). Each waterbody will be surveyed (total of two nights) during the active season each year from the date of approval of the CMP, throughout construction, and then for ten years post-construction. Monitoring of created wetlands will occur once established (timing and frequency as above). Monitoring of translocated frogs should occur one month after translocation (if during the active season) and then concurrent with the colonisation monitoring for a period of at least 2 years after relocation.

Important habitat elements and potential threats within Growling Grass Frog habitat must also be monitored. A proforma sheet for monitoring habitat elements is provided in Appendix 5.

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See Appendix 5 for methodology of population monitoring protocols.



3 Dwarf Galaxias Conservation Management Plan²

Executive Summary

Streamline Research was commissioned by the Growth Areas Authority to prepare a Conservation Management Plan for the Dwarf Galaxias (*Galaxiella pusilla*) for the Clyde North Precinct Structure Plan. The key risk of development is loss of habitat that is used by the Dwarf Galaxias and alteration to flooding frequency or duration of floodplain habitat.

The principal environmental objectives of the Dwarf Galaxias CMP is to:

- preserve known populations of Dwarf Galaxias in Cardinia Creek and on the Cardinia Creek floodplain
- provide, protect and maintain favourable aquatic habitat
- preserve existing flooding characteristics and aquatic passage
- preserve and improve water quality conditions
- protect and maintain vegetation in and adjacent to aquatic habitat
- provide operator awareness of the Dwarf Galaxias during works programs

Cardinia Creek habitat throughout the length of the study area is considered suitable for the Dwarf Galaxias. The Dwarf Galaxias was not captured in a targeted survey of the Cardinia Creek floodplain in the Clyde North Precinct, however, suitable habitat exists in a permanent pool on the Lecky Road Cardinia Creek anabranch (identified as location B).

Rehabilitation of the Lecky Road Cardinia Creek anabranch (locations A, B, C) and the sand pit to the south (location G) could improve existing waterway habitat for the Dwarf Galaxias.

Habitat similar to existing Cardinia Creek floodplain wetlands should be constructed. Newly constructed wetlands (D, E, F, H, I and J) should be similar to the existing wetland on the Lecky Road Cardinia Creek anabranch (location B). The wetlands should have shallow margins and some areas with up to 1.0 m in depth. The deeper water is advantageous to the Dwarf Galaxias, as it provides refuge when other parts of the wetland may dry up, preserving permanent water habitat throughout the year. Newly created wetlands can be constructed in a manner that is advantageous to both the Dwarf Galaxias and also to the growling grass frog.

During the proposed floodplain development the principal management issues are to maintain floodplain hydrology, protect aquatic habitat and prevent degradation of Cardinia Creek. Floodplain habitat for the Dwarf Galaxias should have connectivity with Cardinia Creek. Mitigation measures have been suggested to address these issues.

² Section 4 has been prepared by John McGuckin, Streamline Research Pty. Ltd.



This Dwarf Galaxias CMP provides background information on the Dwarf Galaxias and implementation of actions that can provide for the long term persistence of the Dwarf Galaxias both in Cardinia Creek and on the floodplain.

The Dwarf Galaxias CMP will be implemented from time of approval by DSE through the planning scheme amendment process.

3.1 Introduction

As part of the urban growth development of the Clyde North Precinct, the Growth Areas Authority is proposing to enhance recreational and environmental usage of the Cardinia Creek floodplain. The nationally threatened fish species, the Dwarf Galaxias (*Galaxiella pusilla*) is known to occur in both Cardinia Creek and on the nearby floodplain could be directly and indirectly influenced by the development.

This Dwarf Galaxias CMP addresses the development proposed for the floodplain on the western side of Cardinia Creek between Grices Road and Thompsons Road, Clyde North. It provides mitigation measures which will be applied to provide for the long term persistence of the Dwarf Galaxias in Cardinia Creek and on the floodplain. It also provides options for enhancing Dwarf Galaxias habitat in the development of the floodplain corridor.

The principal environmental objectives of the Dwarf Galaxias CMP is to:

- provide, protect and maintain favourable aquatic habitat
- preserve existing flooding characteristics and aquatic passage
- preserve and improve water quality conditions
- protect and maintain vegetation in and adjacent to aquatic habitat
- provide operator awareness of the Dwarf Galaxias during works programs

The key risk of development is loss of habitat that is used by the Dwarf Galaxias and alteration to flooding frequency or duration of floodplain habitat.

3.1.1 Study area

The Growth Areas Authority has provided a template of the overall Cardinia Creek Masterplan (Appendix 1). The portion of the plan addressed in this Dwarf Galaxias CMP is applicable only to the Clyde North Precinct (western floodplain side of Cardinia Creek between Lecky Road and Thompsons Road) as shown in Appendix 1.

3.1.2 Waterways in the study area

The main waterway in the Clyde North Precinct is Cardinia Creek.

There is a northern drainage channel which is hereby referred to as 'the Lecky Road Cardinia Creek anabranch' and a sandpit near Thompsons Road. The Lecky Road Cardinia Creek anabranch



(locations A, B, C, D, E and F) can provide important passage for Cardinia Creek floodwaters. One existing pool (location B) can be rehabilitated to enhance permanent habitat for the Dwarf Galaxias.

The waterway near Thompsons Road is a man-made sandpit (location g) which intercept underlying groundwater. It is connected to Cardinia Creek during flood periods. It does not have suitable habitat or water quality for supporting Dwarf Galaxias. Excavation and reshaping with a variable water depth could create favourable habitat for the Dwarf Galaxias.

3.2 Dwarf Galaxias Background Information

3.2.1 Status

The Dwarf Galaxias is considered of national significance and is listed as Vulnerable under the EPBC Act. In Victoria, the Dwarf Galaxias is considered a threatened species, identified as Vulnerable (DSE, 2007), and is listed for protection under the FFG Act.

3.2.2 Description

The Dwarf Galaxias is a small native fish species (maximum size of 50 mm) which has an exclusive freshwater lifecycle. The species is sexually dimorphic, the males are smaller and more slender than the females, having three longitudinal black stripes along each side of the trunk, and a distinct red strip between the mid and lower black strip. The black stripes are less distinct or absent in females (Cadwallader and Backhouse, 1983). Figure 4 shows an example of both a male and female Dwarf Galaxias.

The Dwarf Galaxias is a short lived species, with only a few individuals surviving through to a second year. The spawning period is mainly between winter and spring, but can extend throughout summer when conditions are favourable. Spawning adults are typically over 25 mm in size. Recently hatched young are about 5 mm in size.





Figure 4 Clyde North PSP Cardinia Creek CMP: Dwarf Galaxias.

3.2.3 Regional distribution

Although the Dwarf Galaxias has a natural range extending throughout south-eastern Australia, the species has a fragmented distribution throughout.

In the Cardinia Creek catchment Dwarf Galaxias populations have been recorded in Cardinia Creek and on the Cardinia Creek floodplain (McGuckin, 2008; NIWA and Streamline Research, 2004). In addition, the species has been found in a number of other nearby waterways including Grasmere Creek, a tributary of Cardinia Creek above Beaconsfield (McGuckin, 2006), a roadside channel near Grieves Road (McGuckin unpubl. data 2008), and roadside channels to the south of Narre Warren (McGuckin, 2008b). Figure 5 shows locations where Dwarf Galaxias have been found in close proximity to the Clyde North Precinct in recent years.

Draining and other physical modifications to habitat (e.g. piping) and changes to flow regimes associated with urban development are considered to be major factors contributing to the loss of Dwarf Galaxias populations.

The recent drought has further added to the demise of Dwarf Galaxias populations, as many known Dwarf Galaxias habitats have dried out. Survival of Dwarf Galaxias populations are linked to waters that do not dry out, or if they do, it is only for short periods (days or weeks, not months or years). Furthermore, as flood events are primarily responsible for the spread of Dwarf Galaxias, no opportunity for potential recolonisation has been possible during the recent drought. This means that even though Dwarf Galaxias may not currently be recorded for a particular water (or the waterway is dry), it is important to protect the habitat for when conditions again make the habitat favourable to the Dwarf Galaxias.





Figure 5 Clyde North PSP Cardinia Creek CMP: Locations where Dwarf Galaxias have been found in recent years.



3.2.4 Clyde North Precinct

The Dwarf Galaxias was not captured in a targeted survey of the Cardinia Creek floodplain in the Clyde North Precinct conducted on 4 January 2010. The investigation was only cursory and a dip net was the only sampling technique. As Cardinia Creek habitat throughout the length of the study area is considered suitable for the Dwarf Galaxias, the creek was not surveyed in this study.

A total of eight locations were examined (a, b1, b2, g, x1, x2, x3 and x4) as shown in Figure 6. Locations a, x1 and x2 were dry at the time of the field survey. No fish were found at the existing pool along the Lecky Road Cardinia Creek anabranch (locations B). The noxious eastern gambusia (*Gambusia holbrooki*) was captured at locations G, x3 and x4.

Even though the Dwarf Galaxias was not captured in the field investigation, the most suitable existing habitat was found on the Lecky Road Cardinia Creek anabranch (locations B). At this location there is potentially permanent water, native aquatic and fringing riparian vegetation and the waterway does not have a resident population of eastern gambusia. For all the other locations examined, aquatic habitat could be rehabilitated and made favourable to the Dwarf Galaxias.





Figure 6 Clyde North PSP Cardinia Creek CMP: Locations examined for Dwarf Galaxias in the Clyde North Precinct.



3.2.5 Habitat requirements

The Dwarf Galaxias occurs in waters which have an array of native aquatic vegetation, typically preferring swampy floodplain environments, but can also be found in creeks and rivers. Some wetlands where the species occurs may partially or completely dry up during summer (Humphries, 1986), and such wetlands rely on seasonal flooding. The natural degree of wetland connectivity to a more permanent waterbody (such as a river or creek) may be vital to their long term survival (particularly during extended dry conditions) and must be considered as part of the habitat requirement critical to survival (Saddlier et al., 2008).

Dwarf Galaxias can be found in two types of habitats, primary habitats which have permanent water, and secondary habitats which have intermittent or ephemeral water regimes. Primary habitats (permanent water sites) are responsible for the long term survival of the species (McGuckin, 2001).

Dwarf Galaxias can establish self sustaining populations in secondary habitats, but these populations can be lost when the habitat dries out. Recolonisation of Dwarf Galaxias into these habitats is generally reliant on the movement of fish from primary habitat.

The Dwarf Galaxias is opportunistic, using floodplains and creeks for range extensions during flood events. Newly inundated environments are advantageous as they can provide food for the growth of young and often, have an absence of predators. Spawning has been noted in seemingly unsustainable habitats like puddles created by vehicle wheel marks, pools in low lying grassed paddocks, sand pits and farm dams. Long term persistence in these environments is largely dependent on permanent water remaining at the location.

Cardinia Creek is primary habitat for the Dwarf Galaxias and the Cardinia Creek floodplain secondary habitat in the Clyde North Precinct.

3.2.6 Populations under threat

With the exception of secure populations in places like Discovery Bay National Park and the Grampians National Park, most populations of Dwarf Galaxias in Victoria are under threat. Many wetland habitats throughout the range of the species have been destroyed or modified as part of agriculture or residential development.

The type of threats applying to particular populations depend largely on land tenure and management (Saddlier et al., 2008). Unfortunately, the majority of populations occur at sites that have little or no formal protection.

The Cardinia Creek floodplain Dwarf Galaxias population is currently given no formal protection.

3.2.7 Threatening processes

There is a number of threatening processes applicable to the Dwarf Galaxias which are identified in the Victorian Flora and Fauna Guarantee Act 1988 (Victorian Government, 1988). The Victoria's Biodiversity Strategy (Department of Natural Resources and Environment, 1997) outlines key environmental considerations necessary for the preservation of the species.



Victorian Flora and Fauna Guarantee Act 1988

Potentially threatening processes listed under Schedule 3 of the FFG Act, 1988 applicable to the Dwarf Galaxias are:

- Alteration to the natural flow regimes of rivers and streams
- Alteration to the natural temperature regimes of rivers and streams
- Degradation of native riparian vegetation along Victorian rivers and streams
- Increase in sediment input into Victorian rivers and streams due to human activities
- Habitat fragmentation as a threatening process for fauna in Victoria
- Input of toxic substances into Victorian rivers and streams
- Prevention of passage of aquatic biota as a result of the presence of in-stream structures

Victorian Biodiversity Strategy

Under the Victorian Biodiversity Strategy the conservation and maintenance of Dwarf Galaxias populations and habitat can be achieved by:

- Maintaining and where necessary restoring ecological processes and biodiversity dependent upon freshwater environments
- Preventing further preventable decline in the viability of any rare species or of any rare ecological community
- Increasing the viability of threatened species and the extent and quality of threatened ecological communities

3.2.8 National Recovery Plan

The National Recovery Plan for the Dwarf Galaxias (Saddlier et al., 2008) summarises appropriate management strategies to avoid threatening processes. These include:

- No direct loss of habitat through wetland drainage on either public or private land
- No physical alteration to Dwarf Galaxias habitat as a consequence of land adjoining Dwarf Galaxias habitat
- No further damage to riparian vegetation
- Damaged or depleted riparian vegetation is protected and (if necessary) supplemented by active revegetation works
- Plans to clear vegetation lying adjacent to Dwarf Galaxias habitat will not impact upon water quality (no increase in sedimentation/pesticides/herbicides etc.)
- Proposals to translocate aquatic species into Dwarf Galaxias habitat are subject to relevant risk management processes according to relevant national and State guidelines



All of the strategies from the National Recovery Plan (listed above) are considered relevant to the Cardinia Creek Clyde North Precinct and have been adapted into this Dwarf Galaxias CMP.

3.3 Conservation Management Plan

3.3.1 Objectives

The principal environmental objectives of the Dwarf Galaxias CMP is to:

- preserve known populations of Dwarf Galaxias in Cardinia Creek and on the Cardinia Creek floodplain
- provide, protect and maintain favourable aquatic habitat
- preserve existing flooding characteristics and aquatic passage
- preserve and improve water quality conditions
- protect and maintain vegetation in and adjacent to aquatic habitat
- provide operator awareness of the Dwarf Galaxias during works programs

3.3.2 Timeframes

The Dwarf Galaxias CMP is be implemented from approval of the CMP, prior to any works commencing in the Clyde North precinct. It must be applied for the entire period works are conducted on the floodplain. It should continue to be implemented after alteration to watercourses/construction of watercourses have been completed. The Dwarf Galaxias CMP will be reviewed at one, three, five and 10 years by a suitably qualified aquatic biologist in conjunction with DSE, Melbourne Water and the City of Casey to determine if any changes to habitat management and/or monitoring is required. A review should also be undertaken for any design changes and if Dwarf Galaxias are found to have colonised the wetlands.

Monitoring should continue annually for 10 years and will not be concluded until at least two periods of floodplain inundation have occurred (with at least one flood equivalent to a 1:10 year event or greater). Sampling should be conducted between August and November each year and preferably immediately after inundation of the floodplain. The end point of the Dwarf Galaxias CMP is a minimum of 10 years, but if the desirable flood event/s have not occurred by this time, it will remain in place until the necessary flood events have occurred and have been monitored and assessed.

It is understood that development of the Clyde North Precinct is likely to be staged over a number of years, so the implementation of the Dwarf Galaxias CMP may be different for each land owner. The common thread for land owners is that it is majority of actions are applicable once a development commences.



Ultimately, the Dwarf Galaxias CMP should continue to be applied until biological assessments show that revegetation programs have been successful and that there is no change in water movement over the floodplain as a result of the proposed development.

3.3.3 Responsibilities

The Dwarf Galaxias CMP will be implemented through the Growth Areas Authority Precinct Structure Plan. The implementation and monitoring of conservation works associated with the CMP will be funded by land owners that develop land adjoining the creek within the PSP. The management strategies outlined in this plan will be implemented once the CMP has been approved and the proposed works have received approval and permit conditions from DSE and the City of Casey. The CMP will operate from this date of DSE approval, throughout construction and then for ten years post-construction. Monitoring will commence from approval of CMP for existing wetlands. However, for created wetlands, the 10 year post construction management/monitoring will commence once wetlands are certified by DSE (application to DSE). Once properties adjacent to the creek have been subdivided and the creek corridor land has been transferred to Melbourne Water, Melbourne Water will manage all areas of the Cardinia Creek corridor to the east of the Main Cardinia Creek Trail (i.e. with a primary function of conservation). City of Casey will manage public open space west of the Main Cardinia Creek Trail (e.g. passive recreational and active open space). Ongoing liaison between the relevant stakeholders will ensure actions outlined in this CMP are implemented.

3.4 Management issues and mitigation measures

3.4.1 Overview of floodplain management considerations

Proposed on-ground works are shown in Appendix 1 and include:

- Cardinia Creek crossing (No. 1)
- proposed sports oval and netball court (No. 2)
- possible car park construction (No. 3)
- protection of wetlands with existing drainage line (No. 4)
- shared path use system (No. 5)
- passive recreation area (No.6)
- possible trail access through school property (No. 7)
- reshaping of excavation area to provide a variable depth wetland with connection to Cardinia Creek during annual flood events (No. 8)

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• existing creek bypass and fish ladder (No. 9)



• adjacent residential development

The Cardinia Creek crossing at Lecky Road (No. 1) and any other creek crossing are subject to separate Conservation Management Plans (CMP's), and as such are not considered in this Dwarf Galaxias CMP.

For the other works proposed, actions that can potentially provide enhancement of Dwarf Galaxias habitat include the protection of existing habitat (No. 4) and the reshaping of a floodplain sandpit (No. 8).

For the creek bypass and fish ladder (No. 9), asset protection with public access would require Melbourne Water approval.

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Environmental degradation can potentially be associated with the construction of the sports oval, a car park, shared paths, adjacent roads and residential developments, the passive recreation area and other trails (Nos. 2, 3, 5, 6, and 7), which could result in new hard surfaces on the floodplain. These proposed works are to incorporate Water Sensitive Urban Design features to reduce their impact on stormwater volumes and water quality inflows to waterways.



3.4.2 Floodplain hydrology

Management issue

Floodplain hydrology needs to remain unchanged by the proposed works. The frequency and duration of floodplain flooding should not be altered by floodplain development. Too much water will provide inappropriate floodplain inundation, too little will not allow necessary connectivity of the Lecky Road Cardinia Creek anabranch with Cardinia Creek.

It is currently expected that the Lecky Road Cardinia Creek anabranch will be inundated every 2-5 years based on streamflow data for the period between 2000 and 2010 (David Reginato, Melbourne Water pers. comm., 2010).

Mitigation

Additional modelling of floodplain hydrology is needed by Melbourne Water to determine whether any of the proposed changes to the floodplain will result in an alteration in frequency or duration of floodplain inundation in the Clyde North Precinct and for the Cardina Creek floodplain downstream.

3.4.3 Protection of existing habitat

Management issue

Cardinia Creek is Dwarf Galaxias habitat and the Lecky Road Cardinia Creek anabranch is also considered habitat for the species (see Figure 6). The aim of the Dwarf Galaxias CMP is to avoid pollution entering Cardinia Creek and floodplain environments.

Cardinia Creek and the riparian fringe should be protected against any disturbance due to works on the floodplain. The Lecky Road Cardinia Creek anabranch (location B) shown in Master Plan - Appendix 1) should receive similar protection, as the area is to be rehabilitated as part of the development.

Mitigation

- Minimise the footprint used for construction activities. No-go zones (Figure 12) both during construction and after completion of the works should be checked and approved by a suitably qualified aquatic ecologist. No go zones are all areas to the east of the main Cardinia creek trail (for construction of pathways in corridor).
- Sedimentation and erosion controls must be implemented during construction in accordance with Victorian Environment Protection Authority (EPA) guidelines including Environmental Guidelines for Major Construction Sites (1996) and Construction Techniques for Sediment Pollution Control (1991).
 - sedimentation control measures must remain in place until the completion of the works, and the surrounds have been effectively stabilised;



- all areas of soils exposed by construction activity must be stabilised with sterilised grasses and, once these grasses have established be landscaped with native vegetation endemic to the local region (no fertilisers should be used).
- Best practice environmental protection measures need to be in accordance with the VicRoads Environment Strategy 2005-2015 (VicRoads, 2005), VicRoads Environmental Management Guidelines (2006) and standard work practices adopted by Melbourne Water (Melbourne Water, 2002).
- Temporary barriers must be erected around the perimeter of construction areas, and around sites of native vegetation adjacent to the construction zone, prior to construction activities commencing and for the duration of construction works. The barriers will prevent access by construction personnel to Cardinia Creek and the Lecky Road Cardinia Creek anabranch.
- Stockpiling of chemical and fuels, along with refuelling of vehicles and machinery, must be undertaken outside of the construction zone, to avoid pollution entering Cardinia Creek.

3.4.4 Floodplain watercourses

Management issue

Existing watercourses on the floodplain should retain natural flow regimes and the man-made watercourse (No. 8) should be modified to improve suitability for the Dwarf Galaxias. New wetlands (locations A, C, D, E, F, H, I, and J) should have be a minimum of 1.0 in depth so that they are suitable for both Dwarf Galaxias and the growling grass frog (*Litoria raniformis*).

Rehabilitation of the Lecky Road Cardinia Creek anabranch (location B) and the sand pit to the south (location G) could improve existing waterway habitat for the Dwarf Galaxias.

Mitigation

Lecky Road Cardinia Creek anabranch

The existing Lecky Road Cardinia Creek anabranch is predominantly shallow water habitat, but it has one pool that may only dry up during extended drought periods (location B1) and a temporary pool which probably periodically dries up (location B2).

No significant modification to the Lecky Road Cardinia Creek anabranch is to be made with the Clyde North Precinct development. The more permanent pool (location) could be revegetated on the western side to provide shade and reduce water temperature. Dwarf Galaxias could potentially naturally recolonise the pool when Cardinia Creek floods. Stocking with Dwarf Galaxias from another nearby Dwarf Galaxias population would require approval from DSE.

Revegetating the remaining parts of the Lecky Road Cardinia Creek anabranch would improve the potential for the habitat to be used by Dwarf Galaxias that may move onto the floodplain during flood events. The habitat is also expected to be suitable for the growling grass frog.



Sandpit

The sandpit near Thompsons Road (No. 8) could be made more useable for Dwarf Galaxias. Planting of fringing native vegetation, reshaping to provide shallow margins, would be advantageous to the potential use of the habitat by Dwarf Galaxias and for the growling grass frog. Dwarf Galaxias could potentially recolonise the reshaped sandpit when Cardinia Creek floods. Stocking with Dwarf Galaxias from another nearby Dwarf Galaxias population would require approval from DSE.

New wetlands

Habitat similar to existing Cardinia Creek floodplain wetlands should be constructed. Newly constructed wetlands (A, C, D, E, F H, I and J) should be similar to the existing wetland on the Lecky Road Cardinia Creek anabranch (location B). The wetlands should have shallow margins and some areas with water depths up to 1.0 m. The deeper water is advantageous to the Dwarf Galaxias, as it provides refuge when other parts of the wetland may dry up, preserving permanent water habitat throughout the year. Newly created wetlands can be constructed in a manner that is advantageous to both the Dwarf Galaxias and also to the growling grass frog. The wetlands can have both shaded areas (which are favoured by the Dwarf Galaxias) and open areas (which are favoured by the growling grass frog).

Local native vegetation should be used for vegetating the fringe of the wetlands. Aquatic vegetation should be similar to that found in other Cardinia Creek floodplain wetlands.

The design and location of new wetlands to be approved though consultation with DSE and Melbourne Water.

3.4.5 Cardinia Creek water quality

Management issue

Maintaining Cardinia Creek water quality should be considered as part of any floodplain development.

Mitigation

- The use of water sensitive urban design elements (Wong et al. 2000) should be made to avoid/minimise alterations to hydrology and water quality. Through appropriate design, pollutants from any constructed or modified wetlands should be prevented from entering Cardinia Creek.
- A water quality monitoring program must be undertaken in Cardinia Creek at a location upstream of the works area and immediately downstream at yearly intervals, and after flooding events (as part of normal fauna monitoring visits (e.g. for fish or frog monitoring). The monitoring program must start prior to the commencement of construction activities and continue until construction activities are completed and must include measurements of turbidity, pH, dissolved oxygen and electrical conductivity. The program can be conducted in conjunction with annual monitoring for the Dwarf Galaxias.


3.4.6 Revegetation of Dwarf Galaxias habitat

Management issue

Riparian zones along the Lecky Road Cardinia Creek anabranch and along the sandpit to the south (location g) should be rehabilitated. The revegetation program should increase shade and reduce water temperature in the existing waterways. These measures will improve waterway condition and the likelihood that the habitat can be utilised by Dwarf Galaxias.

Mitigation

Refer to Section 2.4.4 for detailed revegetation proscriptions for the study area. Planting of fringing and emergent vegetation outlined in Section 2.4.4 will create suitable habitat for Dwarf Galaxias as well as Growling Grass Frog.

Table 6 shows a list of native plants found on the fringe of Cardinia Creek and in floodplain wetlands near the Pakenham Bypass (McGuckin, 2005) and includes species that are desirable for planting in the Clyde North Precinct floodplain wetlands. Refer to Tables 2 and 3 for a full list of plant species suitable for use in revegetation within the Clyde North Precinct.

Plant list		Cardinia Creek fringe Dwar	Floodplain wetlands	Desirable plantings
		p		
Scientific name	Common name			
Alisma plantago-aquatica	water plantain			
Arthropodium spp.	lily	X	X	
Callitriche stagnalis	common starwort	X	X	
Carex gaudichaudiana	fen sedge		X	X
Carex inversa	knob sedge	X		X
Eleocharis acuta	common spike-sedge	X	X	X
Isolepis inundatus	swamp club sedge		X	X
Juncus bufonius	toad rush	X	X	
Juncus spp.	rush		X	
Juncus subsecundus	finger rush		X	X
Melaleuca ericifolia	swamp paperbark	X	X	X

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Table 6 Clyde North PSP Cardinia Creek CMP: Native flora in Cardinia Creek areas where the Dwarf Galaxias has been recorded near the Pakenham Bypass (McGuckin, 2005).



Myriophyllum crispatum	upright water milfoil		Х	Х
Persicaria decipiens	slender knot weed	Х	X	X
Phragmites australis	common reed		X	
Potamogeton tricarinatus	floating pondweed	Х	X	X
Ranunculus glabrifolius	shining buttercup	Х		
Ranunculus inundatus	river buttercup	Х	X	X
Ranunculus lappaceus	Australian buttercup	X	Х	
Rumex brownii	slender dock	X	Х	
Triglochin procerum	water ribbons	X	X	X



3.4.7 Pest species

Management issue

The noxious eastern gambusia can out-compete the Dwarf Galaxias for food and habitat and can stress and kill Dwarf Galaxias when the two species occupy the same environment.

At present the eastern gambusia is found in Cardinia Creek and in the sandpit near Thompsons Road (location g). The species was not found in the Lecky Road Cardinia Creek anabranch (location B), but could potentially establish in this environment when flooding from Cardinia Creek occurs. The current absence of the species may be due to the environment drying out at some stage since the last significant flood event.

Mitigation

As the eastern gambusia has a widespread distribution throughout the Cardinia Creek catchment and can not be effectively controlled on a local scale. Colonisation of the species in floodplain waterways is expected whenever flooding of Cardinia Creek occurs.

No eradication program has yet been devised that could be used to stop the eastern gambusia establishing in the Clyde North Precinct.

3.4.8 Monitoring

Management issue

Ensure that Dwarf Galaxias populations in Cardinia Creek and on the floodplain are both protected and enhanced by the proposed development.

Mitigation

Representative sampling in Cardinia Creek and in watercourses throughout the Clyde North Precinct should be made before, during and post development. As no monitoring of Cardinia Creek was made in the initial investigation, a survey should be made between Lecky Road and Thompsons Road prior to any works commencing on the floodplain. The survey would not only determine whether Dwarf Galaxias are present in the reach of the creek but will determine the other fish species in the area. This monitoring is necessary to provide baseline data for comparison with future surveys during construction and post floodplain development.

Monitoring for Dwarf Galaxias in the waterways of the Clyde North Precinct should be conducted yearly (August to November) and after significant flood events (equivalent of 1:10 year flood or higher). Monitoring should continue for 10 years and should included at least two periods of floodplain inundation (with at least one flood equivalent to a 1:10 year event or greater). The monitoring will have two components, monitoring of Dwarf Galaxias habitat and monitoring of any population/s found in the Clyde North Precinct.

Fish surveys should show that through the implementation of appropriate mitigation measures the Dwarf Galaxias and other fish fauna of Cardinia Creek have not been affected by the Clyde North Precinct development.



During development works, a clear indication needs to made to construction personnel of expected mitigation measures and importance to maintaining ecological values. Direct disturbance like unplanned movement of construction equipment or indirect disturbances like spills from machinery could have a detrimental effect on habitat that can be used by the Dwarf Galaxias. Compliance of mitigation practices during the construction period should be checked by land owner or the responsible agent. Non compliance issues need to be addressed.

Contractors need to have contingency for reporting accidents (disturbance to aquatic habitat) that may impact on waterways. A chain of command between construction personnel, the land owner or the responsible agent and a qualified biologist is needed to report problems and to provide appropriate on-ground responses.

Monitoring following an incident will comprise a survey and appropriate sampling to confirm the extent of the disturbance to aquatic habitat. For spillages, post incident monitoring will be repeated at weekly intervals until the contaminant is no longer considered to be a threat.

Monitoring should be performed by a suitably qualified aquatic biologist. An interpretative report should be prepared for each monitoring exercise and distributed to DSE, DEWHA, and Melbourne Water and other interested parties.

The locations which should be the basis of future monitoring locations in the Clyde North Precinct can only be determined after the baseline survey of Cardinia Creek between Lecky Road and Thompsons Road has been completed. It is, however, expected that field monitoring for the Dwarf Galaxias would be along Cardinia Creek between Lecky Road and Thompsons Road and include the Lecky Road Cardinia Creek anabranch.

Appendix 6 outlines the procedures for population and habitat monitoring for Dwarf Galaxias. Indicative requirements for the annual monitoring of the Dwarf Galaxias are:

• Field component

2 persons x 1.5 days

Travel 2 days x 140 km

Reporting

1 person x 1.5 days

Additional monitoring will be necessary for a minimum of two floods which move onto the floodplain (preferably with one event equal or greater than 1:10 year inundation).

Water quality monitoring can be conducted at the same time as the field study for the Dwarf Galaxias, or Growling Grass Frog without additional field or reporting costs.

3.5 Implementation and mitigation schedule

Priority waters for the preservation of Dwarf Galaxias populations and Dwarf Galaxias habitat can be divided into two types of waters:



- Waters which currently support Dwarf Galaxias populations (Cardinia Creek)
- Waters which have habitat which could potentially support Dwarf Galaxias (Lecky Road Cardinia Creek anabranch, the sandpit near Thompsons Road and newly created wetlands)

Table 7 summarises the primary actions necessary for implementing the Dwarf Galaxias CMP.

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Land owners are the responsible for actions pre-construction unless responsibility is transferred to a public authority. Land owners will remain responsible during construction and for a period of 10 years post-construction unless responsibility has been transferred to a public authority with appropriate funds e.g. Melbourne Water.



Table 7 Clyde North PSP Cardinia Creek CMP: Summary of management issues and mitigation measures for Dwarf Galaxias

Management Issue	Specific Mitigation Measures	Timing	Responsible Agent	Performance measures
Floodplain hydrology	-Conduct modelling to determine frequency, duration and pathway of floodplain inundation	Prior to development	Melbourne Water is undertaking this modelling.	-Understanding floodplain flooding and duration. Developing a contingency plan for such events (for protection of floodplain habitat/s and flooding inundation periods).
Protecting existing Dwarf Galaxias habitat (Cardinia Creek)	-Minimise footprint of development.	Continuous	The land owner is responsible pre construction. Land owner will remain responsible for a period of 10 years post construction unless responsibility is transferred to a public authority eg. Melbourne Water	-No change in Dwarf Galaxias distributions
	-Sediment and erosion controls	As above	As above	
	-Best practice environmental protection	As above	As above	
	-use temporary barriers around construction areas	As above	As above	
	-No stockpiling of chemical and fuel on floodplain	As above	As above	
	-Monitor Dwarf Galaxias in Cardinia Creek and in study area	Once a year for 10 years post construction	As above	
Floodplain watercourse (Lecky Road Cardinia Creek anabranch)	-Provide shade and revegetate along the Lecky Road Cardinia Creek anabranch using native local vegetation	Continuous	As above	-no significant modification to the wetting drying cycle (location B)
Floodplain watercourse (sandpit)	-Reshape watercourse to provide shallow fringes	To be commenced prior to other floodplain development	As above	-future recolonisation and establishment of Dwarf Galaxias after flooding events
	-revegetate fringes	As above	As above	
	-improve water quality	As above	As above	
Floodplain watercourse (new wetlands)	-Create wetland habitat	To be determined	As above	-future temporary colonisation of Dwarf Galaxias after flooding events
	- use native vegetation for vegetating wetlands	To be determined	As above	
Water quality	-Use WSUD elements	Throughout period of floodplain	As above	-no change in water quality characteristics of Cardinia Creek
	-Monitor in-stream water quality in Cardinia Creek	development	As above	



4 Australian Grayling Conservation Management Plan³

Executive Summary

Streamline Research was commissioned by the Growth Areas Authority to prepare a Conservation Management Plan (CMP) for the Australian Grayling (*Prototroctes maraena*) for the Clyde North Precinct. The key risk of development is loss of habitat in Cardinia Creek.

The principal environmental objectives of the Australian Grayling CMP is to:

- provide, protect and maintain favourable aquatic habitat
- preserve existing Cardinia Creek aquatic passage
- preserve and improve water quality conditions in Cardinia Creek
- protect and maintain vegetation in and adjacent to Cardinia Creek
- provide operator awareness of the Australian Grayling during works programs

Cardinia Creek habitat throughout the length of the study area is considered suitable for the Australian grayling. No targeted survey for the Australian Grayling was conducted prior to development of the CMP, however, there is known records of the species in this reach of Cardinia Creek.

For the Australian Grayling the principal management issues are to maintain aquatic habitat and passage in Cardinia Creek, and to maintain water quality and quantity entering the creek. Mitigation measures have been suggested to address these issues.

This Australian Grayling CMP provides background information on the Australian Grayling and actions that can provide for the long term persistence of the Australian Grayling in Cardinia Creek. The Australian Grayling CMP will be implemented through the Growth Areas Authority Precinct Structure Plan.

4.1 Introduction

As part of the urban growth development of the Clyde North Precinct, the Growth Areas Authority is proposing to enhance recreational and environmental usage of the Cardinia Creek floodplain. The nationally threatened fish species, the Australian Grayling (*Prototroctes maraena*) is known to occur in Cardinia Creek and could be indirectly influenced by the development.

This Australian Grayling CMP addresses the development proposed for the floodplain on the western side of Cardinia Creek between Road and Thompsons Road, Clyde North as a requirement of the Strategic Impact Assessment (Department of Sustainability and Environment, 2009). It

³ Section 5 has been prepared by John McGuckin, Streamline Research Pty. Ltd.



provides mitigation measures which can be applied to provide for the long term persistence of the Australian Grayling in Cardinia Creek.

The principal environmental objectives of the Australian Grayling CMP is to:

- provide, protect and maintain favourable aquatic habitat
- preserve existing Cardinia Creek aquatic passage
- preserve and improve water quality conditions in Cardinia Creek
- protect and maintain vegetation in and adjacent to Cardinia Creek
- provide operator awareness of the Australian Grayling during works programs

The key risk of development is loss of habitat in Cardinia Creek.

4.1.1 Study area

The Growth Areas Authority has provided a template of the overall Cardinia Creek Masterplan (Appendix 1). The portion of the plan addressed in this Australian Grayling CMP is applicable only to the Clyde North Precinct (western floodplain side of Cardinia Creek between Lecky Road and Thompsons Road) as shown in Appendix 1.

4.1.2 Waterways in the study area

The main waterway in the Clyde North Precinct is Cardinia Creek. This waterway is known habitat for the Australian grayling. The Australian Grayling is not expected to move onto the Cardinia Creek floodplain, even when the creek is in flood.

There is a northern drainage channel which is hereby referred to as 'the Lecky Road Cardinia Creek anabranch' and a sandpit near Thompsons Road (location g) which do not have suitable habitat or water quality for supporting Australian grayling.

4.2 Australian Grayling Background Information

4.2.1 Status

The Australian Grayling is considered of national significance and is listed as Vulnerable under the EPBC Act. In Victoria, the Australian Grayling is considered a threatened species (DSE, 2007), identified as Vulnerable, and is listed for protection under the FFG Act.

4.2.2 Description and habitat (from Backhouse et al., 2008a)

The Australian Grayling is a small to medium sized-sized, slender, silvery fish with soft rayed fins lacking any spines (Figure 7). It is endemic to south-eastern Australia, including Victoria, Tasmania and New South Wales, and is a migratory species that inhabits estuarine waters and coastal seas as larvae/juveniles, and freshwater rivers and streams as adults.



The Australian Grayling is a diadromous species, migrating between rivers, their estuaries and coastal waters, so relies on free access to a range of freshwater, estuarine and marine habitats for completion of its survival. Australian Grayling spend most of their lives in freshwater, usually in cool, clear waters with a gravel substrate and alternating pool and riffle zones (Bishop & Bell 1978; Berra, 1982), but also occur in turbid water (Jackson & Koehn, 1988). The species can penetrate well inland, and has been reported from over 100 km upstream from the sea (Jackson & Koehn, 1988). Larvae and juveniles inhabit estuaries and coastal seas, and there appears to be a obligatory marine phase (Crook et al. in prep.) although the precise habitat requirements are not known.



Figure 7 Clyde North PSP Cardinia Creek CMP: Australian grayling.

4.2.3 Regional distribution

Extensive surveying of Cardinia Creek to the south of Beaconsfield has been conducted as part of the Pakenham Bypass (for VicRoads) and also for improvement of fish passage (for Melbourne Water) over the past 10 years (Figure 8). The Australian Grayling has only been captured on two occasions, an adult captured near Chasemore Road to the south of the Clyde North Precinct (McGuckin, 2001) and a juvenile found at the base of the Thompsons Road fishway within the precinct (NIWA, 2002).

A much higher incidence of Australian Grayling has been found in the nearby Bunyip and Lang Lang Rivers. Both of these rivers have higher streamflows for attracting the species from Westernport Bay, than Cardinia Creek. It is possible that the few Australian Grayling recorded in Cardinia Creek are vagrants from the Bunyip and Lang Lang River populations.

Barriers to movement, river regulation, poor water quality, siltation, impact of introduced fish, climate change, disease and fishing are considered to be major factors contributing to the loss of Australian Grayling populations (Backhouse et al., 2008a and Backhouse et al., 2008b).



Drought, reduced streamflows and a low frequency of flooding may be partially responsible for few Australian Grayling being attracted into Cardinia Creek from Westernport Bay over the past 10 years. The presence of Australian Grayling in Cardinia Creek near the Clyde North Precinct can not be discounted in the future, particularly if streamflows return to pre-drought levels and high flows coincide with the period of upstream migration of juveniles and adults (note: it is unknown during which months this movement occurs in Cardinia Creek).





Figure 8 Clyde North PSP Cardinia Creek CMP: Australian Grayling records for Cardinia Creek in the past 10 years and the proximity of the Bunyip and Lang Lang Rivers (where populations are also known).



4.2.4 Clyde North Precinct

No targeted survey for the Australian Grayling has been conducted in the Clyde North Precinct as part of this CMP. The species has though previously been found at the base of the Thompsons Road fishway within the study area (NIWA, 2002).

A fish survey of Cardinia Creek through the Clyde North Precinct is suggested, prior to the commencement of any development. The value of the investigation will determine whether the presence of the Australian Grayling and other migratory native fish.

The benefit of a targeted survey for the Australian Grayling would be to ascertain presence/absence of the species and also to determine the current effectiveness of the fishway at Thompsons Road, which has been modified to assist passage of this and other migratory native fish species (NIWA, 2002; NIWA and Streamline Research, 2004).

4.2.5 Populations under threat

The Cardinia Creek Australian Grayling population is currently given no formal protection.

It is likely that some threats are operating in most waters where Australian Grayling occur. Few catchments have escaped vegetation clearing, impoundment or diversion of water, the installation of structures that act as barriers to migration or are free of introduced fish (Backhouse et al., 2008a).

Cardinia Creek, below Beaconsfield the waterway was extensively modified with the draining of the Koo Wee Rup swamp during the late 1800's. Vegetation was cleared and reaches were realigned, straightened and channelised. Impoundment of water in the headwater occurred with the completion of the Cardinia Creek reservoir in 1973. This structure now contributes to partial regulation of streamflow in Cardinia Creek. In-stream damage due to the draining of the Koo Wee Rup swamp culminated in the construction of a retarding basin at Thompsons Road in the late 1970's to prevent an erosion head moving up Cardinia Creek towards Beaconsfield.

The finding of any Australian Grayling in Cardinia Creek is possibly surprising given the history of stream degradation that has occurred in the catchment. In-stream works to improve bank stability and fish passage has been advantageous to the species over the past few decades, however, low streamflows associated with the current drought may have influenced recruitment of Australian Grayling from Westernport Bay. If streamflows return to those that occurred pre-drought it is quite possible that a substantial population of Australian Grayling could be found in Cardinia Creek in the future.

Threatening processes

There is a number of threatening processes applicable to the Australian Grayling which are identified in the Victorian Flora and Fauna Guarantee Act 1988 (Victorian Government, 1988). The Victoria's Biodiversity Strategy (Department of Natural Resources and Environment, 1997) outlines key environmental considerations necessary for the preservation of the species.



Victorian Flora and Fauna Guarantee Act 1988

Potentially threatening processes listed under Schedule 3 of the FFG Act, 1988 applicable to the Australian Grayling are:

- Alteration to the natural flow regimes of rivers and streams
- Alteration to the natural temperature regimes of rivers and streams
- Degradation of native riparian vegetation along Victorian rivers and streams
- Increase in sediment input into Victorian rivers and streams due to human activities
- Habitat fragmentation as a threatening process for fauna in Victoria
- Input of toxic substances into Victorian rivers and streams
- Prevention of passage as a result of the presence of in-stream structures

Victorian Biodiversity Strategy

Under the Victorian Biodiversity Strategy the conservation and maintenance of Australian Grayling populations and habitat can be achieved by:

- Maintaining and where necessary restoring ecological processes and biodiversity dependent upon freshwater environments
- Preventing further preventable decline in the viability of any rare species or of any rare ecological community
- Increasing the viability of threatened species and the extent and quality of threatened ecological communities

4.2.6 Threatening processes due to human activities (from Backhouse et al., 2008a)

- Constructing barriers to fish movement/migration barriers include culverts, weirs, dams, barrages, areas of unsuitable habitat (eg. excessive turbulence, artificially raised water temperatures)
- Reduction in/alteration of river flows (especially winter flows), through abstraction of more water from the system, building new dams/weirs, retention in dams etc.
- Removal/degradation of riparian vegetation/habitat.
- Removal of snags, woody debris, rocks from potential habitat. Where this is unavoidable (eg. for protection of assets such as bridges), alternative suitable habitat should be created as a compensation or offset.
- Events leading to increased siltation or sedimentation such as works on riverbanks and floodplain.



- Release of potential predators/competitors (such as stocking for recreational purposes) in areas where important populations occur or where habitat works are occurring to increase population size and security.
- Pesticide and fertiliser run-off changing nutrient regimes leading to algae blooms, reduction on dissolved oxygen, increasing sedimentation rates etc.

4.2.7 National Recovery Plan

The National Recovery Plan for the Australian Grayling (Backhouse et al., 2008a) is to minimise the probability of extinction of the Australian Grayling in the wild, and to increase the probability of important populations becoming self-sustaining in the long term. The six main objectives are:

- 1. Identify important populations of Australian grayling
- 2. Protect and restore habitat for Australian grayling
- 3. Investigate important life history attributes to acquire targeted information for management
- 4. Investigate and manage threats to populations and habitats
- 5. Increase awareness of Australian Grayling with resource managers and the public
- 6. Manage Recovery Plan implementation

For Cardinia Creek, objectives 2, 3, 4 and 5 are considered relevant to the Clyde North Precinct and mitigation measures to address these issues have been adapted into the Australian Grayling CMP.

4.3 Conservation Management Plan

4.3.1 Objectives

The principal environmental objectives of the Australian Grayling CMP is to:

- preserve known populations of Australian Grayling in Cardinia Creek
- provide, protect and maintain favourable Cardinia Creek habitat
- preserve migratory passage in Cardinia Creek
- preserve and improve water quality conditions in Cardinia Creek
- protect and maintain vegetation in and adjacent to Cardinia Creek
- provide operator awareness of the Australian Grayling during works programs



4.3.2 Timeframes

The Australian Grayling CMP should be implemented from the approval by DSE through the planning scheme amendment process. It must be applied for the entire period works are conducted on the floodplain. It should continue to be implemented after alteration to watercourses and/or construction of watercourses have been completed for a period of 10 years. The CMP will be reviewed at one, three, five and 10 years by a suitably qualified aquatic biologist in conjunction with DSE, Melbourne Water and the City of Casey to determine if any changes to habitat management and/or monitoring is required.

Monitoring should continue annually for 10 years. Sampling should be conducted between August and November each year.

As the Clyde North Precinct development is likely to be staged over a number of years, the implementation of the Australian Grayling CMP may be different for each land owner.

Ultimately, the Australian Grayling CMP should continue to be applied until biological assessments show that there is no population or habitat changes as a result of the Clyde north Precinct development.

4.3.3 Responsibilities

The Australian Grayling CMP will be implemented through the Clyde North Precinct Structure Plan. The implementation and monitoring of conservation works associated with the CMP will be funded by land owners that develop land adjoining the creek within the PSP. The management strategies outlined in this plan will be implemented once the CMP has been approved and the proposed works have received approval and permit conditions from DSE and the City of Casey. The CMP will operate from this date of DSE approval, throughout construction and then for ten years post-construction. Monitoring will commence from approval of CMP for existing wetlands. However, for created wetlands, the 10 year post construction management/monitoring will commence once wetlands are certified by DSE (application to DSE). Once properties adjacent to the creek have been subdivided and the creek corridor land has been transferred to Melbourne Water, Melbourne Water will manage all areas of the Cardinia Creek corridor to the east of the Main Cardinia Creek Trail (i.e. with a primary function of conservation). City of Casey will manage public open space west of the Main Cardinia Creek Trail (e.g. passive recreational and active open space). Ongoing liaison between the relevant stakeholders will ensure actions outlined in this CMP are implemented.

4.4 Management issues and mitigation measures

4.4.1 Overview of floodplain management considerations

Proposed on-ground works are shown in Figure 1 and include:



- Cardinia Creek crossing (No. 1)
- proposed sports oval and netball court (No. 2)
- possible car park construction (No. 3)
- protection of wetlands with existing drainage line (No. 4)
- shared path use system (No. 5)
- passive recreation area (No.6)
- possible trail access through school property (No. 7)
- reshaping of excavation area to provide a variable depth wetland with connection to Cardinia Creek during annual flood events (No. 8)
- existing creek bypass and fish ladder (No. 9)
- adjacent residential development

The Cardinia Creek crossing at Lecky Road (No. 1) and any other creek crossing are subject to separate Environmental Management Plans (EMP's), and as such are not considered in this Australian Grayling CMP.

Environmental degradation can potentially be associated with the construction of the sports oval, a car park, shared paths, the passive recreation area, adjacent residential development, and other trails (Nos. 2, 3, 5, 6, and 7), which could result in new hard surfaces on the floodplain. These proposed works are to incorporate Water Sensitive Urban Design features to reduce their impact on stormwater volumes and water quality inflows to waterways.

For the creek bypass and fish ladder (No. 9), asset protection with public access would require Melbourne Water approval.

Environmental degradation can potentially be associated with all of the on-ground works to be made as part of the Clyde North Precinct, however, non of these actions will affect habitat that is used by the Australian Grayling in Cardinia Creek.

The primary mitigation measures relevant to the Australian Grayling is the protection of existing habitat, maintenance of water quality and quantity and avoidance of any new barriers in Cardinia Creek that could interfere with the migratory movement of the species.

Stormwater water from the development is expected to be drained into Cardinia Creek. Any drainage water that is to enter Cardinia Creek must be of comparable quality to the water within the creek. Slow delivery must occur to avoid sudden rises and falls in water levels in Cardinia Creek. The volume and timing of releases and the release point/s are yet to be determined. Under no circumstance should the streamflows result in changes to the existing seasonal streamflows in Cardinia Creek. A change in streamflow as a result of drainage from the Clyde North Development could adversely affect seasonal migratory movement of the Australian grayling.



4.4.2 Protection of existing habitat

Management issue

Cardinia Creek and the riparian fringe should be protected against any disturbance due to works on the floodplain.

Mitigation

- Minimise the footprint used for construction activities. No-go zones (Figure 12) both during construction and after completion of the works should be checked and approved by a suitably qualified aquatic ecologist.
- No-go zones both during construction and after completion of the works should be checked and approved by a suitably qualified aquatic ecologist. No go zones are 100 m to each side of Cardinia Creek. Ideally access should be prevented or restricted in the long term. Fencing may be necessary to exclude people and pets.
- Sedimentation and erosion controls must be implemented during construction in accordance with Victorian Environment Protection Authority (EPA) guidelines including Environmental Guidelines for Major Construction Sites (1996) and Construction Techniques for Sediment Pollution Control (1991).
 - sedimentation control measures must remain in place until the completion of the works, and the surrounds have been effectively stabilised;
 - all areas of soils exposed by construction activity must be stabilised with sterilised grasses and, once these grasses have established be landscaped with native vegetation endemic to the local region (no fertilisers should be used).
- Best practice environmental protection measures need to be in accordance with the VicRoads Environment Strategy 2005-2015 (VicRoads, 2005), VicRoads Environmental Management Guidelines (2006) and standard work practices adopted by Melbourne Water (Melbourne Water, 2002).
- Temporary barriers must be erected around the perimeter of construction areas, and around sites of native vegetation adjacent to the construction zone, prior to construction activities commencing and for the duration of construction works. The barriers will prevent access by construction personnel to Cardinia Creek.
- Stockpiling of chemical and fuels, along with refuelling of vehicles and machinery, must be undertaken outside of the construction zone, to avoid pollution entering Cardinia Creek.
- Consideration needs to be made to potentially store drainage water from the development and to ensure that acceptable water quality Cardinia Creek does not adversely altered the existing water quality within the creek. Quantity, timing and point/s of release will need to be determined prior to any commencement of construction work.



4.4.3 Water quality and quantity

Management issue

Maintaining Cardinia Creek water quality and quantity should be considered as part of any floodplain development.

Mitigation

All crossings of Cardina Creek need to be conducted with minimal change to native vegetation and floodplain drainage. Any crossings of Cardinia Creek are subject to separate Environmental Management Plans (EMP's), and as such are not considered in the Australian Grayling CMP.

- There should be no net loss/gain of the existing water regime or in the timing of existing floodplain drainage.Stormwater water from the development is expected to be drained into Cardinia Creek. Any drainage water that is to enter Cardinia Creek must be of comparable quality to the water within the creek. Slow delivery must occur to avoid sudden rises and falls in water levels in Cardinia Creek. The volume and timing of releases and the release point/s are yet to be determined. Under no circumstance should the streamflows result in changes to the existing seasonal streamflows in Cardinia Creek. A change in streamflow as a result of drainage from the Clyde North Development could adversely affect seasonal migratory movement of the Australian grayling.
- The use of water sensitive urban design (WSUD) elements (Wong et al. 2000) should be made to avoid/minimise alterations to hydrology and water quality. Through appropriate design, pollutants from any constructed or modified wetlands should be prevented from entering Cardinia Creek.

4.4.4 Monitoring

Management issue

Ensure that Australian Grayling populations in Cardinia Creek remain unchanged by the proposed development.

Mitigation

Representative sampling in Cardinia Creek should be made before, during and post development. As no monitoring of Cardinia Creek was made in the initial investigation, a survey should be made between Lecky Road and Thompsons Road. The survey will not only determine whether Australian Grayling are present in the reach of the creek but will determine the other fish species in the area. This monitoring is necessary to provide baseline data for comparison with future surveys during construction and post floodplain development.

A water quality monitoring program must be undertaken in Cardinia Creek at a location upstream of the works area and immediately downstream at yearly intervals, and after flooding events. The monitoring program must start prior to the commencement of construction activities and continue



until construction activities are completed and must include measurements of turbidity, pH, dissolved oxygen and electrical conductivity. The program can be conducted in conjunction with annual monitoring for the Australian Grayling.

Fish surveys should indicate that through the implementation of appropriate mitigation measures the Australian Graylingand other fish fauna of Cardinia Creek have not been affected by the Clyde North Precinct development.

During development works, a clear indication needs to be made to construction personnel of expected mitigation measures and importance to maintaining ecological values. Direct disturbance like unplanned movement of construction equipment or indirect disturbances like spills from machinery could have a detrimental effect on Cardinia Creek habitat that can be used by the Australian grayling. Compliance of mitigation practices during the construction period should be checked by the land owner or the responsible agent. Non compliance issues need to be addressed.

Contractors need to have contingency for reporting accidents (disturbance to aquatic habitat) that may impact on waterways. A chain of command between construction personnel, the land owner or the responsible agent and a qualified biologist is needed to report problems and to provide appropriate on-ground responses.

Monitoring following an incident will comprise a survey and appropriate sampling to confirm the extent of the disturbance to aquatic habitat. For spillages, post incident monitoring will be repeated at weekly intervals until the contaminant is no longer considered to be a threat.

Monitoring should be performed by a suitably qualified aquatic biologist. An interpretative report should be prepared for each monitoring exercise and distributed to DSE, Department of Environment, Water, Heritage and the Arts (DEWHA), and Melbourne Water and other interested parties.

Appendix 6 outlines the protocols for population and habitat monitoring for Australian Grayling. Indicative requirements for the annual Australian Graylingmonitoring are:

- Field component
 - 2 persons x 1.5 days

Travel 2 days x 140 km

- Reporting
 - 1 person x 1.5 days

4.5 Implementation and mitigation schedule

Cardinia Creek is the only priority water for the preservation of Australian Grayling populations and Australian Grayling habitat in the Clyde North precinct. It should be noted that floodplain development could, however, indirectly change the suitability of Cardinia Creek for the Australian grayling. Mitigation measures need to be made to ensure this does not occur.

Table 8 summarises the actions necessary for implementing the Australian Grayling CMP.

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Table 8Clyde North PSP Cardinia Creek CMP: Summary of management issues and mitigation measures for Australian
Grayling.

Management Issue	Specific Mitigation Measures	Timing	Responsible agent	Performance measures
Protecting existing Australian Grayling habitat (Cardinia Creek)	-Minimise footprint of development.	Continuous	The land owner is responsible pre construction.	-No change in Australian Grayling distributions
	-Retain 100 m buffer of native riparian vegetation	As above	Land owner will remain responsible for a period of 10 years post construction unless responsibility is transferred to a public authority e.g. Melbourne Water	
	-no net loss/gain of existing water regime or in the timing of existing floodplain drainage	As above	As above	
	-Sediment and erosion controls	As above	As above	
	-Best practice environmental protection	As above	As above	
	-use temporary barriers around construction areas- No Go Zones	As above	As above	
	-No stockpiling of chemical and fuel on floodplain	As above	As above	
	-Monitor Australian Grayling in Cardinia Creek and in study area	Once a year	As above	
Maintain water quality and quantity (Cardinia Creek)	-Use WSUD elements	Throughout period of floodplain development	Land owner will remain responsible for a period of 10 years post construction unless responsibility is transferred to a responsible agent eg Melbourne Water	-no change in water quality characteristics of Cardinia Creek
	-Monitor instream water quality and quantity to Cardinia Creek	As above	As above	-no change in water quantity in Cardinia Creek



5 Threatened Species - Summary of Management Requirements and Implementation Schedule for Development

The recommended management actions and key issues aimed to protect and enhance threatened fauna habitat in the study area are tabulated below (Table 9). The implementation of these actions in conjunction with other relevant stakeholders will help maintain existing habitat values and increase the availability of potential breeding habitat and habitat diversity. The performance measures or habitat management thresholds outline management goals to reach. Adaptive management outlines actions that will be required if certain habitat management 'thresholds' are reached in relation to threatened fauna. These thresholds are predominantly based on significant impact thresholds developed as part of the EPBC Act Policy Statement 3.14 for Growling Grass Frogs (DEWHA 2009). Many of these thresholds have been reviewed by Geoffrey W. Heard (PhD student studying Growling Grass Frogs in Merri Creek corridor from La Trobe University, Heard 2009). Suggestions and comments from Mr. Heard have been incorporated into Table 9.

Table 9 includes:

- Habitat element;
- Location where applicable;
- The management action;
- Frequency and timing of the action;
- Duration of the action;
- Performance measure;
- Adaptive management;
- Responsible agent; and
- Funding Source.



Table 9 Clyde North PSP Cardinia Creek CMP: Management Actions and Performance Measures for protection and enhancement of threatened fauna species habitat in the study area

The following habitat management actions to be implemented and performance measures are applicable to maintaining habitat suitability for Dwarf Galaxias and Australian Grayling and enhancing habitat for the potential colonisation of Growling Grass Frogs.

Legend: GAA - Growth Areas Authority; DSE - Department of Sustainability and Environment; MW - Melbourne Water; PV - Parks Victoria

Location	M	anagement measures to be implemented	Timing/ Frequency	Duration/ Timeframe	Per	formance Measures	Ad	laptive management	Responsible Agent	Funding Source
Pre-construe	ction	and Construction: Habitat Protection and Enhancement								
Cardinia Creek and existing wetlands	•	Protect creek line and existing wetlands values through fencing and sediment control measures. Sediment control fences should have intermittent gaps (one metre) approximately every 30 m to 50 m to allow for any movement of frogs.	Pre-construction /construction period.	For the duration of the construction period.	•	No removal or degradation of terrestrial habitats or existing wetland area within the core habitat area for Growling Grass Frog and Dwarf Galaxias (e.g. within 30 m of wetlands or Cardinia Creek). No increase in sediment loads which reduce water quality below acceptable State Environment Protection Policy Guidelines (SEPP guidelines) and/or reduces habitat suitability for frogs (e.g. high turbidity).	•	Maintenance of fencing. Implement sediment and pollution controls.	Land owner unless transferred to a public authority (eg. Melbourne Water)	Funded by land owners. Funding mechanism yet to be determined.
	•	Model floodplain flooding. Model frequency and duration of floodplain inundation.	Pre-construction period.	Twice during 10 year period (once after commencement of development and second time after all development has occurred).	•	No change in current flooding regime	•	Test modelled data with on ground investigation (monitoring of floodplain inundation heights and persistence)	Melbourne Water	Funded by land owners. Funding mechanism yet to be determined.
	•	Designate creek line and existing wetlands as 'NO-GO ZONES' during construction.	Pre-construction /construction period.	For the duration of the construction period.	•	No machinery access into core area of Growling Grass Frog or Dwarf Galaxias habitat.	•	Maintain fencing and signage illustrating No- Go Zones.	Land owner unless transferred to a public authority (eg. Melbourne Water)	Funded by land owners. Funding mechanism yet to be determined.
	•	During construction all No-Go Zones should be fenced, with a distance of at least 30 m from a waterbody. Fencing must exclude humans and machinery from entering the site but also allow the movement of frogs. No Go Zones should be practical to allow suitable access points to construction area in consultation with DSE.	Pre-construction /construction period.	For the duration of the construction period.	•	No removal or degradation of terrestrial habitats or existing wetland area within the core habitat area for Growling Grass Frog (e.g. within 30 m of wetlands or between wetlands and Cardinia Creek).	•	Maintain fencing delineating No-Go Zone.	Land owner unless transferred to a public authority (eg. Melbourne Water)	Funded by land owners. Funding mechanism yet to be determined.
	•	Existing wetland B has been selected as the recipient site for any Growling Grass Frogs found during the salvage operation. As such, all enhancement plantings associated with this wetland will be completed before all other construction works in the study area. Wetland B now consists of two small shallow waterbodies that are separated by a $5 - 10$ m strip of exotic grasses. Once enhancement plantings on wetland B are completed mitigation measures as outlined above must be implemented for this wetland to ensure protection throughout the entire construction period. If wetland B is not available, an alternative site for salvaged frogs will be selected to the satisfaction of DSE.	Pre-construction / construction period.	Wetland B enhancement plantings to occur before other construction works. Wetland B to be protected during construction of other works.	•	Protection of wetland B throughout construction period.	•	Maintain fencing, sediment controls and signage illustrating No- Go Zones.	Land owner unless transferred to a public authority (eg. Melbourne Water)	Funded by land owners. Funding mechanism yet to be determined.
	•	Minimise vegetation removal. This does not apply to weed control works.	Construction period	For the duration of construction and post- construction period, as required.	•	No removal of vegetation outside construction footprint (excludes weed control works). Minimal soil erosion and establishment of weeds at works sites.	•	Implement fencing and signage on areas to be retained. Immediately rehabilitate after vegetation removal works.	Land owner unless transferred to a public authority (eg. Melbourne Water)	Funded by land owners. Funding mechanism yet to be determined.
	•	The created wetlands will be filled through flood events from Cardinia Creek and surface runoff. Pumping of water from Cardinia Creek into the wetlands will not be undertaken. Appropriately treated stormwater may flow into created wetlands from future residential development. See Section 2.4.2 for water quality requirements and specifications.					•	Wetland plantings will be undertaken once a flood event has occurred. Potential for planting failure if wetland dries out.	Land owner unless transferred to a public authority (eg. Melbourne Water)	Funded by land owners. Funding mechanism yet to be determined.
	•	Undertake enhancement plantings in retained wetlands. Enhancement plantings will aim to increase the structural diversity of habitat and include three zones (e.g. shallow marsh, shallow inundation and permanent water).	Construction and post- construction period.	As required, for the duration of the 10 year post- construction period of the CMP.	•	Alteration of aquatic vegetation such that it drops below 60% cover (where aquatic vegetation cover is calculated as the sum of the cover of emergent, submergent and floating macrophytes, divided by 3, see Heard 2009). This figure of 60% cover was modelled on the Merri Creek catchment and may be applicable to other areas.	•	Monitor and undertake replacement planting as required.	Land owner unless transferred to a public authority (eg. Melbourne Water)	Land owners. Cash or works as agreed by Melbourne Water



Location N	Management measures to be implemented	Timing/ Frequency	Duration/ Timeframe	Performance Measures	Adaptive management	Responsible Agent	Funding Source
•	Provide refuge/shelter sites.	Construction and post- construction period.	During construction period and as required for the duration of the 10 year post- construction period of the CMP.	Rocks, logs other cover is removed or modified.	 Monitor and undertake shelter augmentation as required. 	Land owner unless transferred to a public authority (eg. Melbourne Water)	Land owners. Cash or works as agreed by Melbourne Water
•	Plantings along Cardinia Creek will maintain a mosaic of open and closed canopy.	Construction and post construction period.	During construction period and as required for the duration of the 10 year post- construction period of the CMP.	Maintenance of open and closed habitat along Cardinia Creek.	Monitor and undertake habitat manipulation as required.	Land owner unless transferred to a public authority (eg. Melbourne Water)	Land owners. Cash or works as agreed by Melbourne Water
	Undertake fox control as part of community wide program Given that the wetlands will be filled through flooding events from Cardinia Creek, control of Eastern Gambusia is unlikely to be achieved.	Construction and post- construction period.	During construction period and as required for the duration of the 10 year post- construction period of the CMP.	Absence of predatory fish.	 Design wetland to reduce habitat suitability for exotic fish - dense submergment plantings and riparian plantings on the north and western side of the water body. If appropriate, engage a fish control expert. If appropriate, prepare and implement fish control management plan in consultation with DSE, MW, Council, and a suitably qualified zoologist. Monitor through yearly fish surveys 	Land owner unless transferred to a public authority (eg. Melbourne Water). In consultation with: • Fish Consultant • DSE • Qualified zoologist • Council/PV	Funded by land owners. Funding mechanism yet to be determined.
•	Staged weed removal and replacement with indigenous species.	Construction and post- construction period.	During construction period and as required post- construction for the duration of the CMP. Weeds should be removed in autumn with revegetation undertaken in early winter.	Reduction in weed cover.	Immediately rehabilitate after weed removal.	Land owner unless transferred to a public authority (eg. Melbourne Water)	Land owners. Cash or works as agreed by Melbourne Water
•	The use of herbicides in and adjacent to water-bodies will be avoided where practicable. Application methods resulting in low levels of off-target damage (e.g. cut/paint, and drill/fill) will be favoured over spray application.	Construction and post- construction period.	During construction period and as required for the duration of the 10 year post- construction period of the CMP.	No degradation to wetland environs from use of herbicides.	Undertake mechanical/ hand removal where possible.	Land owner unless transferred to a public authority (eg. Melbourne Water)	Land owners. Cash or works as agreed by Melbourne Water
Construction p	eriod: Habitat Creation – Wetland Design and Management:						
Created wetlands	 Wetlands will be clustered within 300 – 500 m of each other to allow movement and dispersal between areas of habitat. 	Construction period.		Colonisation and movement of Growling Grass Frog between wetlands.	 Maintain connectivity through habitat manipulation including appropriate revegetation and management (e.g. slashing) may be necessary to maintain suitable open habitat. 	Land owner unless transferred to a public authority (eg. Melbourne Water)	Land owners. Cash or works as agreed by Melbourne Water
•	Depth will vary across each wetland, with permanent and ephemeral water areas. Water depth will be a maximum of 1 m.	Construction period.				Land owner unless transferred to a public authority (eg. Melbourne Water)	Land owners. Cash or works as agreed by Melbourne Water
•	Wetlands gradients slopes will grade from 1 in 8; 1 in 5; to 1 in 3.	Construction period.		•	All created wetlands will be designed according to recommended gradients	Land owner unless transferred to a public authority (eg. Melbourne Water)	Land owners. Cash or works as agreed by Melbourne Water
•	Implement revegetation as outlined in revegetation management plan.	Construction period.		Maintain high habitat values for Growling Grass Frog.	 Habitat manipulation including appropriate revegetation and management (e.g. slashing) may be necessary to maintain 	Land owner unless transferred to a public authority (eg. Melbourne Water)	Land owners. Cash or works as agreed by Melbourne Water



Location	Management measures to be implemented	Timing/ Frequency	Duration/ Timeframe	Performance Measures	Adaptive management	Responsible Agent	Funding Source
					suitable open habitat.		
	• Planting regimes will incorporate at least three vegetation zones (e.g. shallow marsh, shallow inundation and permanent water). Plantings will aim to provide structural diversity of habitat and include emergent, submergent, floating and fringing aquatic vegetation.	Construction and post- construction period.	Throughout construction and for the duration of the 10 year post-construction period of the CMP. Assess suitability of vegetation every three-six months in the first two years.	• Alteration of aquatic vegetation such that it drops below 60% cover (where aquatic vegetation cover is calculated as the sum of the cover of emergent, submergent and floating macrophytes, divided by 3, see Heard 2009). This figure of 60% cover was modelled on the Merri Creek catchment and may be applicable to other areas.	• Monitor and undertake enhancement plantings as required.	Land owner unless transferred to a public authority (eg. Melbourne Water)	Land owners. Cash or works as agreed by Melbourne Water
	• Maintain current grassy vegetation to retain open areas. If possible, open grassy areas with sedges, tussock-grasses, rocks and occasional low lying shrubs for shelter which allow frogs to forage adjoining the wetlands and allow east-west movement between the creek and wetlands.	Construction and post- construction period.	Assess twice yearly for the duration of the 10 year post- construction period of the CMP– then review.	• Alteration to buffer and corridor habitat that is not compatible with Growling Grass Frog habitat e.g. change from more open grassy vegetation to closed dense or overgrown habitat.	 Habitat manipulation including appropriate revegetation and management (e.g. slashing) may be necessary to maintain suitable open habitat. 	Land owner unless transferred to a public authority (eg. Melbourne Water)	Land owners. Cash or works as agreed by Melbourne Water
	• Provide rocks, logs and fringing vegetation (e.g. rushes and sedges) for shelter and refuge sites.	Construction and post- construction period.	Assess twice yearly for the duration of the 10 year post- construction period of the CMP – then review.	 Rocks, logs other cover is removed or modified. 	• Monitor and augment with refuge sites as required.	Land owner unless transferred to a public authority (eg. Melbourne Water)	Land owners. Cash or works as agreed by Melbourne Water
	• The wetlands will be created off the main channel. Wetlands will be designed to exclude Eastern Gambusia through plantings. Draining of wetlands is unlikely to be successful in excluding the Eastern Gambusia in the long-term, given that the wetlands will be filled through flood events from Cardinia Creek.	Construction and post- construction period.	Duration of the 10 year post-construction period of the CMP.	Absence or low numbers of predatory fish.	 Design wetland to reduce habitat suitability for exotic fish - dense submergment plantings and riparian plantings on the north and western side of the water body. If appropriate, engage a fish control expert. If appropriate, prepare and implement fish control management plan in consultation with DSE, MW, Council, and a suitably qualified zoologist. 	Land owner unless transferred to a public authority (eg. Melbourne Water)	Land owners. Cash or works as agreed by Melbourne Water
	 The created wetlands will be filled through flood events from Cardinia Creek and surface runoff. Pumping of water into the wetlands will not be undertaken. Ideally water levels in wetlands should be between 0.5 m and 1 m in vegetation zone 3 (see Wetland design)). Vegetation can be planted to minimise evaporation of water –Planting vegetation on the north side may provide some shading for the waterbody but also allow basking sites for Growling Grass Frog on the opposite side. Ideally wetlands should not completely dry out over the summer period. 	Construction and post- construction period.		 Any alteration to wetland hydrological regime which leads to wetlands drying-out completely. 	 Monitor water levels to optimise potential breeding habitat for frogs. 	Land owner unless transferred to a public authority (eg. Melbourne Water)	Land owners. Cash or works as agreed by Melbourne Water
	 Establish quantitative guidelines for water quality according to SEPP Guidelines. 	Construction and post- construction period.		• No increase in sediment loads, salinity or an algal bloom which reduces water quality below acceptable State Environment Protection Policy Guidelines (SEPP guidelines) and/or reduces habitat suitability for frogs (e.g. high turbidity).	 Undertake further monitoring of water quality. Implement sediment and pollutant controls. 	Land owner unless transferred to a public authority (eg. Melbourne Water)	Land owners. Cash or works as agreed by Melbourne Water
	Install sediment control fencing and install sediment and gross pollutant traps during pre- construction.	Pre-construction and construction period.	Implement pre-construction and monitor throughout the construction period.	 No increase in sediment and/or pollutant loads which reduce water quality below acceptable State Environment Protection Policy Guidelines (SEPP guidelines) and/or reduces habitat suitability for frogs (e.g. high turbidity). 	 Maintain sediment control fencing. Implement further sediment controls as required. 	Land owner unless transferred to a public authority (eg. Melbourne Water)	Land owners. Cash or works as agreed by Melbourne Water
	Design wetlands to minimise turbidity.	Pre-construction and construction period.	Throughout pre-construction and construction and for the duration of the 10 year post- construction period of the CMP – then review.	 No increase in turbidity that reduces habitat suitability for frogs. Water quality should be maintained at levels acceptable under the State Environment Protection Policy Guidelines (SEPP guidelines). 	 Undertake further monitoring of water quality. Implement water quality control measures. 	Land owner unless transferred to a public authority (eg. Melbourne Water)	Land owners. Cash or works as agreed by Melbourne Water
	• Apply for certification from DSE – wetlands to be adequately designed in line with CMP. Once wetlands are certified the 10 year post construction management/monitoring will commence.	Construction period.	As required	• Wetlands meets standards as outlined by the CMP.	•	Land owner unless transferred to a public authority (eg.	Land owners. Cash or works as agreed by Melbourne Water



Location	Ma	anagement measures to be implemented	Timing/ Frequency	Duration/ Timeframe	Per	formance Measures	Ada	aptive management	Responsible Agent	Funding Source
									Melbourne Water)	
Buffers										
Applies to existing and retained wetland habitat	•	Implement buffers around each wetland to minimise impacts as per DSE requirements. The following buffer width will be provided between the wetlands and the main Cardinia Creek trail: 50 m for wetland A; 60 m for wetland D, G and H; 70 m for Wetland C and E; and 80 m for Wetland B and F.	Pre-construction, construction and post- construction period.	Pre-construction and for the duration of the 10 year post- construction period of the CMP.	•	Exclusion of human and dog access to buffer habitat. Alteration to buffer habitat from degradation due to recreational usage.	•	Exclude human and dog access through post and wire fencing if necessary.	Land owner unless transferred to a public authority (eg. Melbourne Water)	Land owners. Cash or works as agreed by Melbourne Water
	•	Within buffer zones, exclude all development and manage vegetation to ensure compatibility with terrestrial frog habitat.	Construction and post- construction period.	Throughout the construction period and for the duration of the 10 year post- construction period of the CMP.	•	Alteration to buffer habitat that is not compatible with Growling Grass Frog habitat e.g. change from more open grassy vegetation to closed dense or overgrown habitat.	•	Habitat manipulation including appropriate revegetation and management (e.g. slashing) may be necessary to maintain suitable open habitat.	Land owner unless transferred to a public authority (eg. Melbourne Water)	Land owners. Cash or works as agreed by Melbourne Water
Habitat corri	idor	S		m1 1					· · · ·	
This applies to the creek corridor and east –west connectivity between created/existing wetlands and Cardinia Creek.	•	Maintain connectivity along Cardinia Creek by minimising vegetation removal, planting appropriate terrestrial vegetation and implementing sensitive design options (e.g. clear span bridge and raised boardwalks).	Pre-construction, construction and post- construction period.	Throughout pre-construction and construction and for the duration of the 10 year post- construction period of the CMP – then review.	•	Potential movement of frogs through the creek systems is compromised/habitat link is severed.	•	Maintenance of sensitive design options for the proposed road bridge and any future pedestrian creek crossings. Maintain drift fences to guide frogs under the bridge. Habitat manipulation including appropriate revegetation and management (e.g. slashing) may be necessary to maintain open habitat.	Land owner unless transferred to a public authority (eg. Melbourne Water)	Land owners. Cash or works as agreed by Melbourne Water
	•	Maintain east-west connectivity by creating multiple habitat corridors of 30 – 50 m width. Corridors will be comprised of sedges, tussock-grasses, rocks/logs and only occasional low-lying shrubs for shelter.	Pre-construction, construction and post- construction period.	Throughout pre-construction and construction and for the duration of the 10 year post- construction period of the CMP – then review.	•	Potential movement of frogs between potential breeding habitat of the wetlands and the creek system is compromised/habitat link is severed.	•	Habitat manipulation including appropriate revegetation and management (e.g. slashing) may be necessary to maintain onen habitat	Land owner unless transferred to a public authority (eg. Melbourne Water)	Land owners. Cash or works as agreed by Melbourne Water
	•	All pathways will be located outside habitat corridors and the area of core habitat. (with the exception of future pathways that cross the creek)	Construction period.	Throughout construction and for the duration of the 10 year post-construction period of the CMP – then review.	•	No fragmentation of core habitat immediately between the wetlands and creek. Maintenance of connectivity for frog movement through sensitive design options such as raised boardwalks in those areas crossing or within 30 m of a waterbodies.			City of Casey	Funding mechanism yet to be determined.
Revegetation										
Cardinia Creek, existing and created wetlands and post construction rehabilitation areas.	•	Implement the revegetation management plan.	Pre-construction, construction and post- construction.	Throughout pre-construction and construction and for the duration of the 10 year post- construction period of the CMP – then review.	•	Revegetation in existing and created wetlands and along the creek corridor has established (see measures above).	•	Undertake weed removal and revegetation replacement as required.	Land owner unless transferred to a public authority (eg. Melbourne Water)	Land owners. Cash or works as agreed by Melbourne Water
	٠	Engage a wetland rehabilitation specialist to implement wetland design and revegetation	Pre-construction, construction and post- construction.		•	Alteration of aquatic vegetation such that it drops below 60% cover (where aquatic vegetation cover is calculated as the sum of the cover of emergent, submergent and floating macrophytes, divided by 3, see Heard 2009). This figure of 60% cover was modelled on the Merri Creek catchment and may be applicable to other areas.	•	Undertake monitoring and enhancement plantings as required.	Land owner unless transferred to a public authority (eg. Melbourne Water)	Land owners. Cash or works as agreed by Melbourne Water
	•	Retain open grassy areas in terrestrial habitats and habitat corridors.	Pre-construction, construction and post- construction period.	Throughout pre-construction and construction and for the duration of the 10 year post- construction period of the	•	Potential movement of frogs between and along the creek system is compromised/habitat link is severed	•	Habitat manipulation including appropriate revegetation and management (e.g.	Land owner unless transferred to a public authority (eg. Melbourne Water)	Land owners. Cash or works as agreed by Melbourne Water



Location	Management measures to be implement	ed	Timing/ Frequency	Duration/ Timeframe	Performance Measures	Adaptive management	Responsible Agent	Funding Source
				CMP – then review.		slashing) may be necessary to maintain open habitat.	1	
	• Maintenance of revegetation.		Post–construction.	Undertake every three months for the first year post-construction	• Revegetation in existing and created wetlands and along the creek corridor has established (see measures above). Survival rate of >80 % of plantings	 Undertake weed removal and revegetation replacement as required. 	Land owner unless transferred to a public authority (eg. Melbourne Water)	Land owners. Cash or works as agreed by Melbourne Water
	Dense vegetation plantings are not re disrupt movement or create a barrier.	commended under the proposed future bridge as this may The road crossing is subject to a separate CMP.	Construction and post- construction period.		 Potential movement of frogs along the creek system is compromised/habitat link is severed. 	 Undertake weed removal. Habitat manipulatior including slashing m be necessary to maintain open habita 	Vic Roads ay t.	Funding mechanism yet to be determined.
Weed Contro	1							
Cardinia Creek corridor (within and outside the study area).	Liaise and coordinate with other land of catchment approach.	managers. Weed control would be best undertaken as a whole	Construction and post- construction.	Throughout construction and for the duration of the 10 year post-construction period of the CMP – then review.	Coordination of weed removal works throughout the catchment.	 Liaise with relevant stakeholders to discu target weed species a appropriate techniqu for control. 	Land owner unless transferred to a public nd authority (eg. s Melbourne Water)	Land owners. Cash or works as agreed by Melbourne Water
	Implement weed management plan.		Pre-construction, construction and post- construction period.	Throughout pre-construction and construction and for the duration of the 10 year post- construction period of the CMP – then review.	• An overall reduction in the area covered by invasive weeds.	Engage weed control contractor to implement weed management plan	Land owner unless transferred to a public authority (eg. Melbourne Water)	Land owners. Cash or works as agreed by Melbourne Water
	• The use of herbicides in and adjacent Application methods resulting in low be favoured over spray application.	to water-bodies will be avoided where practicable. levels of off-target damage (e.g. cut/paint, and drill/fill) will	Construction and post- construction period.	Throughout construction and for the duration of the 10 year post-construction period of the CMP – then review.	 No significant off-target damage from herbicide usage. 	 Utilise mechanical control techniques ne water-bodies where practical. 	Land owner unless ar transferred to a public authority (eg. Melbourne Water)	Land owners. Cash or works as agreed by Melbourne Water
Feral Anima	Control							
Cardinia Creek corridor (within and outside the study area).	Unlikely to control Eastern Gambusia wetlands through flooding events fro	a given the prevalence in the catchment and the filling of m Cardinia Creek.	Post construction	For the duration of the 10	Absence of exotic fish.	 Design wetland to reduce habitat suitability for exotic fish - dense submergment planting on the north and western side of the water body. If necessary: Engage a fish contro expert. Prepare and implement fish control management plan in consultation with DS MW, Council, and a suitably qualified zoologist. Monitor through yea fish surveys 	Land owner unless transferred to a public authority (eg. Melbourne Water) gs s	Land owners. Cash or works as agreed by Melbourne Water
	If practical, coordinate a community with relevant authorities.	wide effort to control foxes and discuss control techniques	Post-construction	For the duration of the 10 year post-construction period of the CMP – then review.	Initiation of a catchment wide fox control program.	 Liaise with relevant stakeholders to discu need for control and the most cost effectiv and appropriate techniques. 	 Council DSE MW PV Surrounding private landowners 	Funding mechanism yet to be determined.
	Remove all food waste.		Construction and post- construction period.	Throughout construction and for the duration of the 10 year post-construction period of the CMP – then review.	Absence of food waste.	 Educate construction workers to remove a waste to discourage feral animals. Engage contractors to regularly remove foo wastes from site. 	Land owner unless transferred to a public authority (eg. Melbourne Water) d	Funded by land owners. Funding mechanism yet to be determined.



Location	Management measures to be implemented	Timing/ Frequency	Duration/ Timeframe	Performance Measures	Adaptive management	Responsible Agent	Funding Source
	• Use signage for education of detrimental effects of releasing introduced fish into waterways or impacts of foxes (see Section 2.4.6).	Post-construction period.	For the duration of the 10 year post-construction period of the CMP – then review.	• Appropriate signage is erected around wetlands prohibiting the introduction of fish.	Maintain and replace signage as required.	Land owner unless transferred to a public authority (eg. Melbourne Water)	Land owners. Cash or works as agreed by Melbourne Water
User related	issues						
Cardinia Creek corridor (study area)	• All recreational facilities, and most pathways will be located outside the area of core habitat.	Construction and post- construction.	Throughout construction and for the duration of the 10 year post-construction period of the CMP – then review.	Any alteration to core habitat due to recreational usage.	•	City of Casey	Funding mechanism yet to be determined.
	Provide clear delineation of trails to encourage path use.	Construction and post- construction period.	Throughout construction and for the duration of the 10 year post-construction period of the CMP – then review.	Pedestrian traffic is isolated to designated pathways only.	Revegetate and/or fencing may help to designate areas.	City of Casey	Funding mechanism yet to be determined.
	• Where pathways cross the creek or are located near a wetland, sensitive design options will be implemented (e.g. raised boardwalks).	Construction period.	Throughout construction and for the duration of the 10 year post-construction period of the CMP – then review.	• Trampling by foot traffic in sensitive areas is minimised by creation of appropriate pathways.	 Maintain clear pathways. Provide signage to illustrate No-Go Zones for visitors. 	City of Casey	Funding mechanism yet to be determined.
	Prohibit dogs from accessing waterbodies where possible.	Post-construction period.	For the duration of the 10 year post-construction period of the CMP – then review.	• Exclusion of dogs in sensitive habitats.	 Provision of post and wire fencing to exclude dogs. Provide signage to illustrate restrictions for pets – No-Go Zones 	City of Casey	Funding mechanism yet to be determined.
	Prohibit riding of trail bikes.	Post-construction period.	For the duration of the 10 year post-construction period of the CMP – then review.	Absence of trail bikes.	 Provide signage to illustrate access restrictions. Regular monitoring and enforcement 	City of Casey	Funding mechanism yet to be determined.
	• Prohibit riding of horses except on designated tracks as per draft Master Plan.		For the duration of the 10 year post-construction period of the CMP – then review.	Horse traffic is isolated to designated pathways only.	 Provide signage to illustrate access restrictions. Regular monitoring and enforcement 	City of Casey	Funding mechanism yet to be determined.
	• Prohibit the removal of fallen timber and other plant material.	Construction and post- construction period.	Throughout construction and for the duration of the 10 year post-construction period of the CMP – then review.	• No removal of woody debris and other vegetation.	 Provide signage to illustrate restrictions of collecting materials. Regular monitoring and enforcement. 	Land owner unless transferred to a public authority (eg. Melbourne Water)	Land owners. Cash or works as agreed by Melbourne Water
	• Prohibit the introduction of exotic fish into the creeks or wetlands (see above).	Construction and post- construction period.	Throughout construction and for the duration of the 10 year post-construction period of the CMP – then review.	Absence of exotic fish.	 Provide signage to illustrate prohibition of stocking. Regular monitoring and enforcement. 	Land owner unless transferred to a public authority (eg. Melbourne Water)	Land owners. Cash or works as agreed by Melbourne Water
	• Enforce a strict 'No dumping policy' for rubbish or litter.	Construction and post- construction period.	Throughout construction and for the duration of the 10 year post-construction period of the CMP – then review.	Absence of dumped rubbish.	 Provide signage to illustrate prohibition of rubbish dumping. Regular monitoring and enforcement. 	Land owner unless transferred to a public authority (eg. Melbourne Water). In consultation with • Council	Land owners. Cash or works as agreed by Melbourne Water
	• Provide interpretive signage in areas of interest.	Post-construction period.	For the duration of the 10 year post-construction period of the CMP – then review.	 Provision of signage outlining environmental values, potential impacts from recreational use and appropriate behaviours. 	 Engage contractor to maintain and replace signage as required. 	Land owner unless transferred to a public authority (eg. Melbourne Water)	Land owners. Cash or works as agreed by Melbourne Water
	Permanent post and wire fencing will be installed following the construction period to delineate areas at the interface of recreation and conservation zones e.g. sports oval	Post-construction period.	For the duration of the 10 year post-construction period of the CMP – then review.	Protection of core habitat from degradation caused by human and dog disturbance.	Maintain and replace fencing as required.	Land owner unless transferred to a public authority (eg. Melbourne Water)	Land owners. Cash or works as agreed by Melbourne Water
	Temporarily fence (with appropriate signage) revegetation zones.	Pre-construction, construction and post- construction period.	Fence revegetation zones until plants are established.	Protection of newly revegetated sites from human and dog access.	Maintain and replace fencing as required.	Land owner unless transferred to a public authority (eg. Melbourne Water)	Land owners. Cash or works as agreed by Melbourne Water
	• No lighting will be installed within 30 m of the creek or created/existing wetlands. All lighting outside this area should be directed away from the waterbodies.	Construction and post- construction period.	For the duration of the 10 year post-construction period of the CMP – then	Absence of visual lighting disturbance.	Monitor light spillage and replace lighting as necessary.	City of Casey	Funding mechanism yet to be determined.



Location	Ma	anagement measures to be implemented	Timing/ Frequency	Duration/ Timeframe	Per	formance Measures	Ad	aptive management	Responsible Agent	Funding Source
				review.						
Roads, path	ways	s, future creek crossings and fencing								
Development areas.	•	Undertake enhancement plantings in wetland B (before all other construction activities) to establish as recipient site for any translocated Growling Grass Frogs found during salvage operations. Implement protective measures (e.g. fencing, signage) throughout construction period.	Pre-construction and construction period.	For the duration of construction activities.	•	Maintenance of high habitat values for Growling Grass Frog. Protection of wetland B throughout construction period.	•	Maintenance of fencing. Implement sediment and pollution controls.	Land owner unless transferred to a public authority (eg. Melbourne Water)	Funded by land owners. Funding mechanism yet to be determined.
	•	Undertake pre-construction/ construction Growling Grass Frog salvage as outlined in Appendix 4.	Pre-construction and construction period.	For the duration of construction activities.	•	Translocation of any frogs present within the constructions zones to wetland B. Protection of those frogs throughout the construction period through maintenance of fencing, and No-Go Zone signage.	•	Maintenance of fencing. Implement sediment and pollution controls.	Land owner unless transferred to a public authority (eg. Melbourne Water)	Funded by land owners. Funding mechanism yet to be determined.
	•	Minimise and stage any vegetation removal. Removal of vegetation to be followed by site rehabilitation measures to stabilise the banks and reinstate Growling Grass Frog habitat.	Construction and post- construction period.	Throughout construction and as required, during the 10 year post-construction period of the CMP – then review.	•	Potential movement of frogs through the creek systems is compromised/habitat link is severed. Maintenance of high habitat values for Growling Grass Frog.	•	Revegetate immediately.	Land owner unless transferred to a public authority (eg. Melbourne Water)	Funded by land owners. Funding mechanism yet to be determined.
	•	Maintain connectivity both along Cardinia Creek and east-west connectivity (see habitat corridors above.	Pre-construction, construction and post- construction period.	Throughout pre- construction, construction and as required, during the 10 year post-construction period of the CMP – then review.	•	Potential movement of frogs between and along the creek system is compromised/habitat link is severed.	•	Habitat manipulation including appropriate revegetation and management (e.g. slashing) may be necessary to maintain open habitat.	Land owner unless transferred to a public authority (eg. Melbourne Water)	Land owners. Cash or works as agreed by Melbourne Water.
	•	The proposed road crossings are subject to a separate CMP. Preliminary recommendations are to implement a large clear span bridge that maximises opportunity for fauna movement under the bridge. Any frogs utilising this area should be discouraged from crossing the road through the use of drift fencing, directing movement under the bridge.	Construction and post- construction period.	Throughout construction and for the 10 year post- construction period of the CMP – then review.	•	Potential movement of frogs along the creek system is compromised/habitat link is severed.	•	Implement drift fencing. Ensure vegetation under the bridge is open to encourage frog movement.	Vic Roads	Funding mechanism yet to be determined.
	•	Heavy vehicles and machinery will not access the floodplain or low flow zone (i.e. No-Go Zone). Only hand held equipment will be used in these areas.	Construction period.	For the duration of construction activities	•	Exclusion of machinery from No-Go Zones.	•	Implement appropriate fencing and signage to illustrate access restrictions.	Land owner unless transferred to a public authority (eg. Melbourne Water)	Funded by land owners. Funding mechanism yet to be determined.
	•	Future creek crossing or where pedestrian paths are located within 30 m of a waterbody, sensitive design options such as a raised boardwalk will be implemented.	Construction period.	For the duration of the construction period.	•	Potential movement of frogs along the creek system is compromised/habitat link is severed. Protection of sensitive vegetation communities from trampling by foot traffic.			City of Casey	Funding mechanism yet to be determined.
	•	Utilise existing pathways where possible and minimise fragmentation by keeping pathway alignments outside areas of the core habitat area.	Construction period.	Throughout construction and for the 10 year post- construction period of the CMP – then review.					City of Casey	Funding mechanism yet to be determined.
	•	Implement 'Best Practice' procedures to minimise construction impacts (sedimentation and pollution) on the creek and existing wetlands.	Pre-construction, construction and post- construction period.	For the duration of the construction period.	• Env (SE suit	No increase in sediment loads which uce water quality below acceptable State vironment Protection Policy Guidelines EPP guidelines) and/or reduces habitat tability for frogs (e.g. high turbidity).	•	Maintenance of fencing. Implement sediment and pollution controls.	Land owner unless transferred to a public authority (eg. Melbourne Water)	Funded by land owners. Funding mechanism yet to be determined.
	•	Undertake soil stabilisation of disturbed areas.	Construction and post- construction period.	For the duration of construction and as required post-construction.	• area	Minimisation of soil erosion in works as.	•	Rehabilitate immediately.	Land owner unless transferred to a public authority (eg. Melbourne Water)	Funded by land owners. Funding mechanism yet to be determined.
	•	The need for weed control within the construction zone and at machinery wash down sites is to be determined during the revegetation monitoring and undertaken as required.	Construction period.	For the duration of construction and as required post-construction.	•	Reduction in weed cover.	•	Monitor regularly and implement control as required.	Land owner unless transferred to a public authority (eg. Melbourne Water)	Funded by land owners. Funding mechanism yet to be determined.
	•	A permit to remove native vegetation would be required from the relevant local councils.	Pre-construction period.						Land owner unless transferred to a public authority (eg. Melbourne Water)	Funded by land owners. Funding mechanism yet to be determined.
Salvage and	Relo	ocation							· · · ·	
All development areas	•	Existing wetland B has been selected as the recipient site for any Growling Grass Frogs found during the salvage operation. As such, all enhancement plantings associated with this wetland will be completed before all other construction works in the study area. Wetland B now consists of two	Pre-construction / construction period.	One week prior to and throughout the entire period	•	Protection of wetland B throughout construction period.	•	Maintain fencing, sediment controls and	Land owner unless transferred to a public authority (eg	Funded by land owners. Funding mechanism yet to be



Location	Management measures to be implemented	Timing/ Frequency	Duration/ Timeframe	Performance Measures	Adaptive management	Responsible Agent	Funding Source
	small shallow waterbodies that are separated by a $5 - 10$ m strip of exotic grasses. Once enhancement plantings on wetland B are completed mitigation measures as outlined above must be implemented for this wetland to ensure protection throughout the entire construction period.				Go Zones.	Melbourne Water)	determined.
	Implement the salvage and translocation plan before any works occur throughout the remainder of the study area	Pre-construction / construction period.	One week prior to and throughout the entire period of construction.	Removal and translocation of any Growling Grass Frogs from construction zone.	 Qualified zoologist to implement salvage and translocation plan. Salvage to occur prior to and during construction works. Zoologist to be present during all construction activities within or adjacent to existing waterbodies. Staff induction to educate on Growling Grass Frog. 	Land owner unless transferred to a public authority (eg. Melbourne Water). Engage qualified zoologist. In consultation with DSE.	Funded by land owners. Funding mechanism yet to be determined.
Monitoring		De et e en etmostien	A	Y 11 21 1 11 22 1 1		T	Landauman Cash an
	• Conduct annual water quality monitoring of all wethands. Parameters to be tested in the field include salinity, dissolved oxygen, turbidity and suspended solids and temperature. Laboratory testing will not be required for these standard water quality measurements.	period.	Annual monitoring will commence from approval of CMP for existing wetlands. Annually throughout the 10 year post-construction period of the CMP once wetlands are certified by DSE (application to DSE). Consultation with DSE will be required to review monitoring/management post 10 year period. Monitor through yearly fish surveys	• Increase in sediment loads, satinity of algal blooms which reduces water quality below acceptable State Environment Protection Policy Guidelines (SEPP guidelines) and/or reduces habitat suitability for frogs (e.g. high turbidity).	 Undertake further monitoring of water quality. Implement sediment and pollutant controls. 	Land owner unless transferred to a public authority (eg. Melbourne Water)	Land owners. Cash or works as agreed by Melbourne Water
	Monitor revegetation.	Post-construction period.	Every three months for the first year after planting. Yearly ongoing.	• Establishment and maintenance of revegetation.	 Implement weed control and replacement plantings as required. 	Land owner unless transferred to a public authority (eg. Melbourne Water)	Land owners. Cash or works as agreed by Melbourne Water
	Implement an annual weed-monitoring program.	Post-construction period.	Annual weed monitoring to occur throughout the 10 year post-construction period of the CMP – then review. Contractor also to undertake ongoing informal monitoring.	• Elimination and/or control of target species as outlined in Table 4	Ongoing informal monitoring should be undertaken in combination with weed control works.	Land owner unless transferred to a public authority (eg. Melbourne Water)	Land owners. Cash or works as agreed by Melbourne Water
	 Population monitoring. Monitor created and existing wetlands for colonisation of Growling Grass Frog (See Appendix 5). This will be done annually over a total of two nights during the breeding season. Monitor success of translocated frogs (with PIT tags) – see Appendix. Monitor Dwarf Galaxias populations as per prescribed schedule. 		Monitoring will commence from approval of CMP for existing wetlands. For created wetlands, the 10 year post construction management/monitoring will commence once wetlands are certified by DSE (application to DSE). Consultation with DSE will be required to review monitoring/management post 10 year period.	•	•	Land owner unless transferred to a public authority (eg. Melbourne Water). Engage a qualified zoologist	Land owners. Cash or works as agreed by Melbourne Water
	 Habitat components - Monitor core Growling Grass Frog habitat along Cardinia Creek, the wetlands and habitat corridor. Monitor Dwarf Galaxias habitat as per prescribed schedule. 	Post construction period.	Monitoring will commence from approval of CMP for existing wetlands. For created wetlands, the 10 year post construction management/monitoring will commence once wetlands are certified by DSE (application to DSE). Consultation with DSE will be required to review monitoring/management post 10 year period.	 Maintenance of high habitat values for Growling Grass Frog. Colonisation of the waterbodies by this species. 	 Habitat manipulation including appropriate revegetation and management (e.g. slashing) may be necessary to maintain open habitat. 	Land owner unless transferred to a public authority (eg. Melbourne Water). Engage a qualified zoologist	Land owners. Cash or works as agreed by Melbourne Water

The CMP does not cover the proposed road bridge or any future pedestrian creek crossings. A separate CMP is required for crossing (design and location of creek crossings will be in consultation with DSE). Preliminary recommendations include: implementation of no-go zones and sediment control, minimise vegetation removal and maintain connectivity under bridge with relatively open habitat and use of drift



Figure 9 Clyde North PSP - Cardinia Creek CMP: Management actions to be implemented in the study area

Grass Frog.





Figure 10 Clyde North PSP Cardinia Creek CMP: Vegetation communities and proposed revegetation within the study area.











Figure 12 Clyde North PSP Cardinia Creek CMP: No-Go Zones during construction periods (e.g. construction within: corridor; road/bridge crossing; and residential development). Approximate dimensions of the conservation area are also shown.



5.1 Development Sequencing Schedule

To conserve potential Growling Grass Frog, Dwarf Galaxias and Australian Grayling habitat in the Cardinia Creek study area, a number of key sequential steps area required. Table 7 outlines the development sequencing schedule for pre-construction, construction and post-construction protocols and monitoring in the study area.

Table 10 Clyde North PSP Cardinia Creek CMP: Development sequencing schedule.						
Development Schedule	2010	2011	2012	2013	2014	201
Pre-construction period for Cardinia Creek Corridor (works associated with the CMP)						
Undertaken a survey of Cardinia Creek between Lecky Road and Thompsons Road to determine critical habitat zones where the Dwarf Galaxias and/or Australian Grayling may exist in this section of creek.	\rightarrow					
Undertake all enhancement plantings in wetland B to establish as recipient site for translocated frogs.	\rightarrow					
Fence-off all construction zones (e.g. pathway) and implement sediment controls around works areas (e.g. at least 30 m from all existing wetlands/dams (e.g. B and H) – No-Go Zones.	\rightarrow					
Erect No-Go signs along all areas to be retained along Cardinia Creek including, existing wetlands.	\rightarrow					
Obtain approvals and permits for salvage/translocation and vegetation removal.	\rightarrow					
Implement salvage and translocation of any frogs immediately prior to construction works in or adjacent to waterbodies (wetlands or creek). Animals salvaged would be translocated to a waterbody in close proximity to the study area but away from all construction works. A location would be selected in consultation with DSE and other relevant experts/authorities.		\rightarrow				
Implement revegetation and weed management plan.		\rightarrow	\rightarrow	\rightarrow	\rightarrow	\rightarrow
Key construction staff to participate in an on-site environmental induction by a qualified zoologist and botanist.		\rightarrow	\rightarrow	\rightarrow		
Construction period for Cardinia Creek Corridor (works associated with the CMP)						
Sediment and erosion controls implemented in accordance with Victorian Environmental protection Authority (EPA) guidelines, including Environmental Guidelines for Major Construction Sites (1996) and Construction Techniques for Sediment Pollution Control (1991).		\rightarrow	\rightarrow			
All major infrastructure and facility construction to occur prior to creating dedicated Growling Grass Frog wetlands to minimise potential impacts from sedimentation and pollution on created habitats.		\rightarrow	\rightarrow			
All areas of soil exposed by construction activity must be stabilised with sterilised grasses and, once these grasses have established be landscaped with native vegetation as per the prescribed plan.			\rightarrow			
Implement wetland development as per revegetation management plan and wetland design. Contractor will have previous experience creating dedicated Growling Grass Frog habitat.			\rightarrow	\rightarrow		
Construct all dedicated Growling Grass Frog wetlands (e.g. wetlands A, B, C and F), in accordance with the CMP, implementing habitat requirements for design, hydrology, planting, water quality, refuge, etc			\rightarrow	\rightarrow		
Stage weed removal and revegetation works.			\rightarrow	\rightarrow	\rightarrow	\rightarrow
Provide temporary fencing for revegetation zones or created wetlands.			\rightarrow	\rightarrow	\rightarrow	

2015	2016	2017	2018	2019	2020
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Development Schedule	2010	2011	2012	2013	2014	20
Design and implement buffers and dedicated habitat corridors in accordance with the CMP. This would create movement opportunities along the creek and also between the creek and the wetlands to maintain east-west connectivity.				\rightarrow	\rightarrow	
Implement revegetation regime in remaining areas along the Cardinia Creek corridor to reinstate pre-European EVC's.				\rightarrow	\rightarrow	
Provide interpretive signage for visitors to outline threatened fauna ecology, wetland values, appropriate behaviours and potential impacts to Cardinia Creek and off-line wetland environs.					\rightarrow	
Undertake regular monitoring of water quality and hydrology in all wetlands, as outlined by established monitoring protocols.			\rightarrow	\rightarrow	\rightarrow	\rightarrow
Undertake pest animal control as required within the study area and if possible as a whole of catchment approach.			\rightarrow	\rightarrow	\rightarrow	\rightarrow
Design wetland to reduce habitat suitability for exotic fish - dense submergment plantings and riparian plantings on the north and western side of the water body.			\rightarrow	\rightarrow	\rightarrow	\rightarrow
Undertake regular weed monitoring and control throughout the entire study area as required.			\rightarrow	\rightarrow	\rightarrow	\rightarrow
Implement monitoring protocols for Growling Grass Frog and their existing/created wetland and corridor habitat.				\rightarrow	\rightarrow	\rightarrow
Implement monitoring protocols for Dwarf Galaxias and Australian Grayling and their existing/created wetland and corridor habitat.				\rightarrow	\rightarrow	\rightarrow
A qualified Zoologist will undertake a review of the CMP at 1, 3, 5 and 10 years post-construction. A review should also be undertaken should any changes to design occur or if threatened fauna species are found to have colonised the site.		\rightarrow		\rightarrow		\rightarrow
Pre-construction period for Residential Development adjacent to the Cardinia Creek Corridor						
Fence-off and implement sediment controls along appropriate sections of the Cardinia Creek corridor. (i.e. development is likely to be staged along the corridor, fence off areas opposite residential development) Designate entire creek corridor as No-Go Zone during residential development.				\rightarrow	\rightarrow	\rightarrow
Erect No-Go signs along Cardinia corridor.				\rightarrow		
Obtain approvals and permits for salvage/translocation and vegetation removal within the remaining precinct area.				\rightarrow		
Implement salvage and translocation of any frogs immediately prior to construction works in or adjacent to all waterbodies in the precinct where potential Growling Grass Frog habitat exists. Animals salvaged outside the corridor would be translocated to wetland B or a location to be selected in consultation with DSE and other relevant experts/authorities.				\rightarrow		
Pre-construction period for road/bridge crossing						
Fence-off all construction zones and implement sediment controls around works area – No-Go Zones.				\rightarrow		
Erect No-Go signs along all areas to be retained along Cardinia Creek including, low flow zone and floodplain.				\rightarrow		
Obtain approvals and permits for salvage/translocation and vegetation removal.				\rightarrow		
Implement salvage and translocation of any frogs immediately prior to construction works in the creek or riparian vegetation. Animals salvaged would be translocated to a waterbody in close proximity to the study area but away from all construction works. A location would be selected in consultation with DSE and other relevant experts/authorities.				\rightarrow		
Key construction staff to participate in an on-site environmental induction by a qualified zoologist and botanist.				\rightarrow	\rightarrow	
Construction period for road/bridge crossing						
Implement drift fencing immediately after bridge construction to guide frogs under the bridge instead of crossing the road.			\rightarrow			

015	2016	2017	2018	2019	2020

\rightarrow	\rightarrow	\rightarrow	\rightarrow	\rightarrow	\rightarrow
\rightarrow	\rightarrow	\rightarrow	\rightarrow	\rightarrow	\rightarrow
\rightarrow	\rightarrow	\rightarrow	\rightarrow	\rightarrow	\rightarrow
\rightarrow	\rightarrow	\rightarrow	\rightarrow	\rightarrow	\rightarrow
\rightarrow	\rightarrow	\rightarrow	\rightarrow	\rightarrow	\rightarrow
\rightarrow	\rightarrow	\rightarrow	\rightarrow	\rightarrow	\rightarrow
\rightarrow					\rightarrow

Development Schedule

Rehabilitate immediately through staged weed removal and revegetation works.

-

Final

 \rightarrow



2015	2016	2017	2018	2019	2020

 \rightarrow \rightarrow


5.2 Funding

The following information on funding works associated with the CMP has been provided by the GAA.

"Each land owner is obligated to contribute towards the implementation of the works outlined in this CMP prior to statement of compliance.

The plan in Figure 13 shows a desktop assessment of known and potential habitat in the Clyde North Precinct Structure Plan of the three threatened species covered by this CMP. The plan demonstrates that the majority of the PSP area contains known or potential habitat for one or more of the three species. On this basis it is considered appropriate that the cost of implementing and maintaining the CMP works (design, construction, maintenance and where required the cost of land acquisition) be distributed between all property owners. The cost of these works and land is to be apportioned by the total developable area of each individual land parcel as a percentage of the total developable area of the precinct. This cost is then equitably applied as required to each land owner.

Melbourne Water has agreed to implement and maintain the CMP works once land is transferred and funds provided by land owners. Each land owner is to make a financial contribution to the implementation and maintenance of the CMP by entering into an agreement with Melbourne Water and DSE (under Section 173 of the *Planning and Environment Act 1987* or other appropriate mechanism as agreed with Melbourne Water and DSE).

The CMP also requires monitoring of the works for a 10 year period. Given known or potential habitat for the Growling Grass Frog is found throughout the PSP area, the Growling Grass Frog monitoring costs will be distributed evenly between all land owners. Similarly, the cost of the land required for Growling Grass Frog foraging associated with the proposed wetlands will also be distributed evenly between all land owners. Given known or potential habitat of the two fish species (Dwarf Galaxias and Australian Grayling) are found only in properties with frontage to Cardinia Creek, the monitoring costs for these two species will be distributed evenly between these land owners. Melbourne Water has agreed to undertake the monitoring once land is transferred and funds provided by land owners. Each land owner will make their financial contribution towards the monitoring by entering into an agreement with Melbourne Water and DSE (under Section 173 of the *Planning and Environment Act 1987* or other appropriate mechanism as agreed with Melbourne Water and DSE)."

The cost of works and the cost of land for Growling Grass Frog associated with the implementation of the CMP is contained in Appendix 8 and have been distributed on a property by property basis as described above. (See Appendix 9: breakdown of the CMP cost per property)."





Figure 13 Clyde North PSP Cardinia Creek CMP: Potential habitat for Growling Grass Frog, Dwarf Galaxias and Australian Grayling within the greater Clyde North PSP area. Figure modified from Ecology Australian (2010).

Field assessed: CMP study area. Identification of suitable habitat and/or known records for threatened fauna species

Lecky Road Cardinia Creek anabranch and entire floodplain to the south is identified as supporting suitable habitat for Dwarf Galaxias when inundated. The floodplain also provides suitable dispersal, movement, foraging and overwintering habitat for Growling Grass

Wetland B (identified during field assessment) supports suitable breeding habitat for Growling Grass Frog and Dwarf Galaxias.

Cardinia Creek - The entire reach within the study area provides known habitat for Australian Grayling.

The creek supports potential habitat for Dwarf Galaxias.

The entire corridor provides suitable dispersal, movement, shelter and foraging habitat for Growling Grass Frog.

Cardinia Creek provides the boundary between the City of Casey (west of the creek) and the Cardinia Shire (east of the creek).

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Appendix 1 Cardinia Creek Draft Master Plan



Appendix 2 Survey Methodology and Results

Methodology

Database and Information Review

Databases and information pertaining to the study area were reviewed, including the following:

- Historical and current distribution of the Growling Grass Frog (i.e. records from the Atlas of Victorian Wildlife database, DSE 2007a) within 5 km of the study area;
- Results of surveys undertaken by Ecology Australia and other consultants which have not as yet been included into the AVW;
- Waterways and wetland layer (e.g. creeks, tributaries, drains and large wetlands);
- Ecological Vegetation Class mapping (DSE 2009);
- Aerial photography;
- Topographical (1:25,000) maps;
- Relevant ecological reports from the area e.g. Practical Ecology 2009

Field Survey

The field survey was divided into two parts:

- Diurnal survey and habitat assessment; and
- Nocturnal survey.

Site Selection

Aerial photographs were initially assessed for potential survey sites within the study area. Sites assessed were limited to areas easily accessible and ability to assess within the limited timeframe. Three sites along Cardinia Creek and two off-line wetlands were selected for habitat assessment and nocturnal surveys. Site visit were undertaken on 16 November and 10 December 2009 (see Table 11 and 12 and Figure 1). Our sites, labelled 2 and 3 in Figure 1 are equivalent to existing wetlands B in Figure 5. Wetlands are referred to by their letter codes in the text.

Table 11Cardinia Creek Growling Grass Frog CMP: List of sites assessed for
potential Growling Grass Frog surveys along Cardinia Creek study
area, 16 November and 10 December 2009.

Site	Description	Type of	UTM Co-ordinate
No.		Water body	
	Cardinia Creek c.300 m from the eastern end of	Creek	
	Grices Road. Northern boundary of the study		
1	area.		357604 5784105



Clyde North PSP Cardinia Creek: Threatened Fauna Conservation Management Plan

Site	Description	Type of	UTM Co-ordinate
No.		Water body	
	Off-line Wetland/Dam, fenced off from	Wetland/Dam	
	adjacent grazed paddock c.100 m from		
	Cardinia Creek at the northern end of the study		
2	area		357852 5783902
	Off-line Wetland/Dam, fenced off from	Wetland/Dam	
	adjacent grazed paddock c.100 m from		
	Cardinia Creek at the northern end of the study		
3	area		357852 5783902
	Cardinia Creek c.140 m south of the northern	Creek	
4	boundary of the study area.		357949 5783903
5	Cardinia Creek c.370 m east of Smiths Lane.	Creek	358262 5782822

Diurnal survey and habitat assessment

Sites were selected within the study area along Cardinia Creek for diurnal survey and habitat assessment. Diurnal surveys were undertaken on the 16 November and 10 December 2009. All frog species recorded during the diurnal survey were recorded along with a broad estimate of their numbers (e.g. 1-5; 5-10; 10-20; 20+). Any tadpoles observed in the water column were also recorded.

The following attributes were recorded during the habitat assessment:

- Location of site (AMG);
- Key attributes of habitat including:
 - Percentage cover of emergent, submergent, floating and fringing vegetation and terrestrial vegetation composition.
 - o Percentage cover of terrestrial refuge sites (e.g. logs, rocks and other debris).
- Basic water chemistry (electrical conductivity, pH, temperature and total dissolved solids);
- Basic hydrology (e.g. permanent, semi-permanent, ephemeral);
- Landscape context, habitat in surrounding areas;
- Assessment of potential impacts of development and identification of opportunities to protect and enhance habitat and habitat links; and
- Identification of other threatening processes in the study area, such as the presence of predators (e.g. Eastern Gambusia, foxes, cats and dogs).

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Nocturnal surveys



A targeted nocturnal survey was conducted on 10 December 2009 at selected sites within the study area along Cardinia Creek. The following techniques were implemented during the nocturnal survey:

- The survey was commenced after sunset;
- Climatic conditions were be recorded at the commencement of the survey including relative humidity, temperature, wind direction, speed, cloud cover, moon phase and occurrence of rain in the previous 24-48 hours;
- Once surveyors arrive at a site, five minutes was spent listening for calling males frogs;
- If no frogs are calling, call play-back was used to illicit a response;
- Following the aural surveys, a systematic search of the water body perimeter, aquatic vegetation and an area of 10 m from the waters edge were searched for Growling Grass Frogs using spotlights. A 30 watt 12 volt hand-held spotlight was used;
- Other areas searched included under rocks, boulders, artificial cover and the base of grass tussocks; and
- The number, location, sex and size of frogs were recorded. Tadpoles and metamorphs were also recorded.

Survey Results

Frog species recorded

No Growling Grass Frogs were recorded within the study area. Four common frog species were recorded during the diurnal and nocturnal field surveys: Southern Brown Tree Frog (*Litoria ewingi*), Whistling Tree Frog (*Litoria verreauxi*), Spotted Marsh Frog (*Limnodynastes tasmaniensis*) and Striped Marsh Frog (*Limnodynastes peronii*).

Habitat assessment

A description of the general habitat availability in the study area is provided in Section 2 above. Habitat assessments were undertaken within selected sites only in the study area. A brief description of these sites is outlined below in Table 12. Weather data collected during the assessment is summarised in Table 13.



 Table 12
 Cardinia Creek Growling Grass Frog CMP: Habitat descriptions for selected sites assessed along Cardinia Creek (December 2009).

Selected sites	Habitat	Growling Grass Frog
1 (Figure 1)	Cardinia Creek.	Low LRO
	Track over Cardinia Creek adjacent to site.	Likely to provide
	Dense terrestrial riparian vegetation. The canopy is dominated by Tea-tree (<i>Melaleuca</i> spp.) and understorey heavily invaded by weeds (e.g. Blackberry and Tradescantia)	dispersal habitat only
	Narrow channel with fast to moderate flows.	
	Much of the in-stream habitat and banks are shaded from over-hanging vegetation.	
	Some emergent vegetation.	
2 (see	Wetland	Moderate to High
Figure 1) – (Equivalent	Bare open banks for basking and foraging.	LRO
to northern	Structural diversity including, emergent, submergent, floating and fringing aquatic vegetation.	This area supports potential breeding
waterbody	Grassy fringing vegetation may provide suitable over-wintering habitat	foraging and over-
with	Close proximity to Cardinia Creek.	wintering habitat.
existing wetland B – Figure 10)	Apparent absence of predatory fish provides potential breeding habitat.	
3 (see Figure 1) –	Wetland	Moderate to High LRO



Selected sites	Habitat	Growling Grass Frog	
(Equivalent	Bare open bank for basking and foraging.	This area supports	
to existing wetland B)	Structural diversity including, emergent, submergent, floating and fringing aquatic vegetation.	potential breeding, foraging and over-	
((etalle D)	Grassy fringing vegetation may provide suitable over-wintering habitat	wintering habitat.	
	Close proximity to Cardinia Creek.		
	Apparent absence of predatory fish provides potential breeding habitat.		
4	Cardinia Creek	Low LRO	
	Dense terrestrial riparian vegetation with a understorey completely dominated by Blackberry.	Likely to provide	
	Deep incised banks and pool.	dispersal habitat only	
	Absence of in-stream aquatic vegetation.		
	In-stream habitat and banks are shaded from over-hanging vegetation.		
	Fast to moderate flows and appear to have deep incised pools in places.		
5	Cardinia Creek	Moderate LRO.	
	More open riparian vegetation with bare ground and rocky banks.		
	Slow flowing water and wide creek channel.		
	Dense aquatic vegetation (e.g. Typha spp.) in wide channel downstream of drop structure.		

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122



Table 13 Cardinia Creek Growling Grass Frog CMP: Weather data collected during diurnal and nocturnal surveys (November and December 2009)

BOM – Bureau of Meteorology

Site #	Date	Air Temp (Min and Max from BOM)	Water Temp	Humidity (from BOM - 9am Cranbourne)	Cloud Cover (0-8)	Rain (0- 3) in study area	Rain mm/day (from BOM - Cranbourne)	Moonlight (0-4)	Wind (0-3)	Wind Direction
1	16/11/2009	15°C	No data	84%	6	1	0 mm	0	1	SW
2	10/12/2009	Min 11.5°C, Max 23.6°C	17.4°C	78%	8	2	0 mm	0	1	NW
3	10/12/2009	Min 11.5°C, Max 23.6°C	19.7°C	78%	8	2	0 mm	0	1	NW
4	10/12/2009	Min 11.5°C, Max 23.6°C	19.6°C	78%	8	0	0 mm	0	1	NW
4	10/12/2009	Min 11.5°C, Max 23.6°C	No data	78%	8	0	0 mm	0	1	NW



Appendix 3 Examples of drift fencing (wildlife fencing) and wetland creation/habitat augmentation, used previously for the Growling Grass Frog or closely-related Green and Golden Bell Frog, for Cardinia Creek CMP.



Drift-fencing used in Sydney for the closely-related Green and Golden Bell Frog (*Litoria aurea*); used to keep frogs off the road and direct them into culvert entrances (March 2006)



Similar drift-fencing example from Craigieburn Bypass, Melbourne (August 2005).

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Fencing will need to extend out from the proposed bridge crossing on either side of the creek and be continuous along the Cardinia Creek corridor, it can be lower (e.g. 1-1.5 m tall), and will need to be a solid structure (see below) or mesh (see above), so frogs can not get onto the road surface

Figure 6.13 A culvert with wildlife guide fencing and raised ledges (Sunshine Coast Motorway, south-east Queensland)

Figure 6.13 are reproduced from the Queensland Department of Main Roads (2000).



Example of artificial wetland created for the Growling Grass Frog at Botanica Park in Bundoora prior to vegetation in 2002 (Source: reproduced with permission from Aaron Organ, Ecology Partners).

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Example of artificial wetland created for the Growling Grass Frog at Botanica Park in Bundoora prior to vegetation in 2002 (Source: reproduced with permission from Aaron Organ, Ecology Partners).



Example of artificial wetland created for the Growling Grass Frog at Botanica Park in Bundoora post-vegetation in 2003 (Source: Christina Renowden, Ecology Australia).





Example of artificial wetlands created for the closely-related Green and Golden Bell Frog in Sydney, near Homebush Bay, NSW. Note rocks, 'openness' of vegetation and black mesh 'drift fencing' (in foreground) to keep frogs off the road. (Source: Christina Renowden, Ecology Australia, March 2006).

Commercially available options for wildlife fencing (drift-fencing)

Hy-Tex (UK) Limited, PO Box 97 Aldington, ASHFORD, Kent TN25 7EATel: +44 (0)1233 720097 Fax: +44 (0)1233 720098 sales@hy-tex.co.uk Hy-Tex (UK) Limited Committed to Quality Value & Service

Wildlife Fence

The tough and durable recycled plastic fence acts as a barrier to amphibians approaching hazardous areas and guides them towards safe passage.

The curved shape of the interlocking fence panels prevent amphibians climbing over from the protected side, whilst allowing any animals on the dangerous side to climb over and drop to safety. The arched shape also shelters the amphibians from the danger of predators and strong sunlight.

Landscaped backfill conceals the protecting fence from public view to create a discreet barrier whilst also subtly defining a safe area from future development.





Example of a 'Wildlife Fence' used overseas



Wildlife Fence

The unique "one way" plastic fence allows guidance of amphibians and creatures over a wide band into the tunnel.

Amphibian guidance fencing to enable animals to safely follow their migratory routes.

- Minimizes danger to animals and drivers where migratory routes cross roads
- Fencing has an concave profile to prevent access to the road but allows and to guide animals to the tunnel
- Profile fits snuggly to the tunnel entrance to avoid spaces where animals may fit through.



Wildlife Fence

Description	Part No	Length		Width		Height		Weight
		inches	mm	inches	тт	inches	тт	lbs
Fence	00520	39.37"	1000	20.5"	520	15.7"	400	18.0
Post	00521	-	-	-	-	33.5"	850	2.6
Nail	00522	-	-	-	-	8.7"	220	0.2

-

http://www.acousa.com/wildlife/fence.htm



Appendix 4 Relocation Protocols for the Growling Grass Frog along Cardinia Creek between Thompsons and Grices Road

Salvage protocols

As the recipient site for Growling Grass Frog, all enhancement plantings on wetland B must be completed before any further salvage and construction works can be implemented. Once enhancement works are completed, protection measures around the wetland should be installed e.g. fencing, sediment controls, signage illustrating No-Go Zone areas.

Pre-construction salvage of Growling Grass Frog during either the active and inactive period (see below) should be undertaken within all construction zones associated with construction: in the creek corridor for all infrastructure (e.g. future bridge crossing of Cardinia Creek, pathways within 30 m of a waterbody); all major excavation (if required) in existing wetlands; vegetation removal for created wetlands within 30 m of an existing waterbody; major vegetation removal works (if required) before revegetation around wetlands; and for removal and/or disturbance impacts of native vegetation where potential Growling Grass Frog habitat is present within wetlands/dams/drainage lines within the greater Clyde North precinct area.

Works areas for created wetlands (e.g. E, F, I) and pathways/facilities greater than 30 m from an existing wetland or creek can be salvaged during construction. Soil excavated from construction areas within these areas will be examined for Growling Grass Frogs. Two qualified zoologists will work in tandem with the excavator, to clear and sort through soil (and vegetation). One zoologist will monitor the excavation site. The second zoologist will sort through soil and vegetation in each bucket of the excavator.

Searches for the Growling Grass Frog during the active period (September to April)

- Searches will be undertaken within at least three days preceding commencement of construction activities.
- At least two night-time spotlighting surveys will be undertaken and each survey will involve two people searching for at least one hour. Night-time surveys (where possible) will be undertaken on nights of optimal weather for detecting the species (i.e. little or no wind, temperatures greater than 15°C, and relatively high humidity).
- A standard diurnal search will be undertaken in the habitat where construction activities will be taking place. Daytime searches will include investigation of potential shelter and basking sites and searching within dense vegetation, at the base of grass tussocks, on reed beds, under rocks and other surface debris. It is estimated that 30 person minutes would be required to search a 50 m x 5 m strip along the Creek (survey time may vary according to waterbody size and complexity).
- Footwear will be washed in disinfectant at the commencement and end of each survey to prevent the introduction and/or spread of diseases.



- Frog handling procedures, including wearing gloves, disinfecting footwear and using plastic bags for frog handling, will be followed as outlined above.
- If deemed appropriate (see 'Monitoring of relocated Growling Grass Frogs' section below), tagging or marking of frogs would occur at this stage prior to release.
- Captured frogs will be released as soon as possible (within 24 hours) within existing wetland (**B**) in dense vegetation or under woody debris at the edge of the water body.

Searches for the Growling Grass Frog during the inactive period (May to August)

- Searches will be undertaken within at least three days preceding commencement of construction activities.
- A diurnal search will be undertaken along areas to be disturbed along Cardinia Creek and any areas adjacent to existing wetland habitats. Daytime searches will include investigation of potential shelter sites and searching within dense vegetation, at the base of grass tussocks, within reed beds, under rocks and other surface debris. It is estimated that 60 person minutes would be required to search a 50 m x 5m strip along the Creek (survey time may vary according to waterbody size and complexity).
- Footwear will be washed in disinfectant at the commencement and end of each survey to prevent the introduction and/or spread of diseases.
- Frog handling procedures, including wearing gloves, disinfecting footwear, using plastic bags for frog handling, will be followed as outlined above.
- If deemed appropriate (see 'Monitoring of relocated Growling Grass Frogs' section below), tagging or marking of frogs would occur at this stage prior to release.
- Captured frogs will be released as soon as possible (within 24 hours) within existing wetland **B** in dense vegetation or under woody debris at the edge of the water body.
- Additional searches during construction

During works over Cardinia Creek (e.g. proposed bridge construction or future pedestrian crossings), pathways within 30 m of the creek or existing wetlands, and/or any major excavation works to existing wetlands, additional diurnal searches during construction may be deemed necessary if frogs are not found during diurnal/nocturnal searches prior to construction.

- Vegetation (e.g. creek and wetland riparian zone and surrounding fringing vegetation) removed during construction activities will be examined for Growling Grass Frogs.
- Soil excavated from construction areas within the riparian zone will be examined for Growling Grass Frogs. Two qualified zoologists will work in tandem with the excavator, to clear and sort through soil (and vegetation). One zoologist will



monitor the excavation site. The second zoologist will sort through soil and vegetation in each bucket of the excavator.

- Captured frogs will be handled and released according to protocols given above.
- If deemed appropriate (see 'Monitoring of relocated Growling Grass Frogs' section below), tagging or marking of frogs would occur at this stage prior to release.

Relocation protocols

- If Growling Grass Frogs are found during the salvage operations, works will immediately stop, with the works referred to the Federal Environment Minister for approval under the EPBC Act.
- An appropriate wildlife permit, 'Management Authorisation' and appropriate ethics approval from DSE is required before relocation of Growling Grass Frogs can be undertaken. These permits and documentation would be required under the *Victorian Wildlife Act 1975*.
- The relocation operation must be undertaken by qualified zoologists, or someone who has knowledge and experience in handling and transporting frogs.
- The relocation operation should take place <u>prior to</u> and as close as possible (i.e. within a few days) to any disturbance event along Cardinia Creek or adjacent to any existing wetland.
 - A long intervening period between the relocation of frogs and the construction works may result in frogs moving back into the area.
- Different survey techniques may be required to find and subsequently re-locate the frogs (prior to construction), depending on the time of year:
 - If the relocation operation is to be undertaken during the period when frogs are more active (between September and April) spotlighting surveys will be required. If relocation occurs during the inactive period (between May and August), surveys will need to be undertaken during the day where frogs are searched for within vegetation, under rocks and other debris (see below).
- If frogs are not found prior to excavation, but are considered to be present, additional diurnal searches for frogs may also need to be undertaken <u>during</u> excavation works. This would include works within Cardinia Creek, its riparian vegetation and any major excavation works to existing wetlands. This is to search for frogs within the soil, vegetation and other ground debris during excavation works (see below).
- All relocation activities must be undertaken in accordance with the hygiene protocol for disease in frogs developed by the New South Wales Parks and Wildlife Service (NSW NPWS 2001), to help prevent the spread of the lethal chytrid fungus



(*Batrachochytrium dendrobatidis*). Relocation activities must also make reference to the '*Threat Abatement Plan: Infection of amphibians with chytrid fungus resulting in chytridiomycosis*' (Commonwealth of Australia 2006).

- Footwear will be washed in disinfectant at the commencement and end of each survey to prevent the introduction and/or spread of diseases.
- Frogs will be captured by hand; latex surgical gloves will be worn at all times when frogs are being handled; gloves will be disposed of and new gloves used for the next capture after each frog is handled.
- Captured frogs will be transported individually in plastic bags.
- If deemed appropriate (see 'Monitoring of relocated Growling Grass Frogs' section below), tagging or marking of frogs would occur at this stage prior to release.
- Captured frogs will be released as soon as possible (within 24 hours) within existing wetland (**B**) in dense vegetation or under rocks or woody debris at the edge of the water body.
- Sick/injured/visibly distressed frogs will be taken to the Amphibian Research Centre at Werribee for analysis.

Monitoring of relocated Growling Grass Frogs

- Ideally monitoring of frogs relocated into wetland **B** should be undertaken to determine the success of the relocation operation (also see Monitoring in Section 2.4.10 and Appendix 5 below).
- This can be achieved by marking frogs prior to release by subcutaneous injection of a passive integrated transponder (PIT).
 - PIT tagging is a cost-effective option which, has been undertaken during monitoring of the closely-related Green and Golden Bell Frog at Homebush Bay (NSW); and more recently for the Growling Grass Frog in the Koo Wee Rup-Pakenham area (Hamer and Organ 2006a), and in the Merri Creek corridor (Geoff Heard, pers. comm).
- Marking of frogs must be undertaken by personnel who have experience with these monitoring techniques.
- Prior to marking frogs, a DSE 'Management Authorisation' would be required under the Victorian *Wildlife Act 1975*; marking of frogs would need to be in accordance with DSE ethics approval.
- Landowner will be responsible engaging an appropriately qualified zoologist to monitor the success of translocated Growling Grass Frog. Monitoring of translocated frogs should occur one month after translocation (if during the active



season) and then surveyed (two nights) during the active season each year concurrent with the colonisation monitoring. Translocated frogs should be monitored for at least 2 years after relocation.



Appendix 5 Monitoring procedures for the Growling Grass Frog

Population monitoring procedures

In line with a recent detectability analysis in the Merri Creek corridor (Heard et al. 2006), and in accordance with protocols established with DSE and DEWHA during the Policy Statement workshop for the Growling Grass Frog in 2008, monitoring of created and existing wetlands would be conducted by a qualified zoologist(s) to determine whether Growling Grass Frogs have colonised the waterbodies and/or to determine the success of frog relocation into wetland **B** (e.g. frogs with PIT tags). Melbourne Water will be responsible engaging an appropriately qualified zoologist to monitor frogs. Monitoring would be undertaken within all wetlands and along Cardinia Creek during the breeding season (e.g. October – February). Each waterbody will be surveyed (two nights) during the active season each year from the date of approval of the CMP, throughout construction, and then for ten years post-construction. Monitoring of created wetlands will occur once established (timing and frequency as above). Monitoring of translocated frogs should occur one month after translocation (if during the active season) and then concurrent with the colonisation monitoring for a period of at least 2 years after relocation. This would include:

- Two nocturnal surveys (two nights) during the main activity period of the frog, between October and February;
- Two surveyors with a total of 60 person minutes spent at each site/water body (survey time may vary according to waterbody size and complexity);
- Survey will proceed in the following order:
 - Call recognition to see if any male frogs are calling (including call playback);
 - Undertake a visual inspection of the waterbody and vegetation with a spotlight and with the aid of binoculars; and
 - Search the perimeter of the waterbody or edge of the creek for frogs, scanning vegetation on the banks and within the water body;
- Records will include:
 - o The AMG location, time and activity of each frog encountered/heard;
 - The microhabitat (e.g. sitting on floating pond weed in middle of wetland);
 - Where possible, identify the age class of individuals (e.g. snout to groin length = < 30 mm metamorph; 30-50 mm sub-adult; and >50 mm adult); and
 - The microchip number of captured PIT tagged animals (if appropriate) and indicative condition.
- Creek sections to be surveyed can be divided into transects of 50 m in length; and



- Measures to reduce the possible spread of infectious pathogens (e.g. 'chytrid' fungus) between the survey sites will be implemented in accordance with standards described by the New South Wales Parks and Wildlife Service (NPWS 2001).
- The methods, results and discussion, as well as recommendations for changes in management regimes will be presented in a report following the completion of the surveys.

Habitat monitoring procedures

The following is an example of a proforma field sheet that could be used to monitor habitat elements for Growling Grass Frog.

GGF Habitat Assessment						
Location:		AMG:				
Site Ref No:		Time of Day:				
Personnel Present: Date:						
Type of Waterbody:		Pond Dam Swamp Creek Drain Ditch Wetland				
Flow:		Still Slow Rapid				
Substrate type:						
Dimensions (dam/wetland	d):	Length (m) X Width (m)				
I ength of stream (m):						
Stream Width (m):						
Stream Depth (m):						
Permanence (0 - 3):		0 - sporadic: 1 - enhemeral: 2 - semi-permanent: 3 - permanent				
		0 = sporadic, 1 = epinemeral, 2 = semi-permanent, 3 = permanent				
Vegetation Cover (%)						
Emergent:	Туре:					
	% cover					
Outersent						
Submergent:	Type: %					
	cover					
Floating:	Type:					
r loating.	%					
	cover					
Fringing	Type:					
	%					
	cover					
Dominant Plant species:						

Clyde North PSP Cardinia Creek: Threatened Fauna Conservation Management Plan

-



Substrate (%)

Bare rock

Bare ground/soil

Rock rubble

Logs/Fallen Timber

Artificial

General description of vegetation/habitat structure and quality:

Evidence of grazing/disturbance/trampling:

Water quality (poor, moderate, high)

Fish species present:

Frog species present:

General description:



Appendix 6 Monitoring Procedures for Dwarf Galaxias and Australian Grayling

Population and habitat monitoring procedures

Melbourne Water will be responsible in engaging an appropriately qualified aquatic biologist to monitor Dwarf Galaxias and the Australian grayling. Monitoring would be undertaken within all wetlands and along Cardinia Creek for Dwarf Galaxias and in Cardinia Creek for the Australian grayling.

For the Dwarf Galaxias, monitoring will involve the use of a dip net to survey the waterbodies on the Cardinia Creek floodplain and along the fringe of Cardinia Creek.

For the Australian grayling, immediately below and inclusive of the fishway at Thompsons Road will be electrofished. Fyke nets will be set at three locations in Cardinia Creek, one between Chasemore Road and Thompsons Road, a location approximately 100 m downstream of the Thompsons Road fishway and at a location upstream of the retarding basin.

Each waterbody will be surveyed once (nets set overnight) during October/November each year from the date of approval of the CMP, throughout construction, and then for ten years post-construction.

Monitoring of created wetlands will occur for the Dwarf Galaxias once the waterways have been established and floodplain inundation has occurred (which could potentially allow for Dwarf Galaxias to move into the wetlands). The created wetlands will be included into the yearly monitoring of Dwarf Galaxias in the Clyde North Precinct.

An aquatic biologist and assistant will be required for the fish field survey work. Accommodation overnight will be made at Beaconsfield, to maximise the efficiency of the survey work and to minimise travel costs.

At each of the survey location, a GPS will be used to record the position and the waterway photographed (it is suggested that photo points be established). If the waterway is dry this will be recorded. If no fish are captured this will also be recorded. If fish are present, each species will be identified. The length of the largest and smallest specimens will be measured and weighed (with the exception of the Dwarf Galaxias). For Dwarf Galaxias, presence of adult, juvenile and young will be recorded. No lengths or weights will be made (to avoid any damage to any individuals). An evaluation of the habitat (and potential for supporting the targeted species) will be conducted during each field survey.

Reporting will summarise the methods used in the fish survey, the results of the surveys, discussion of current conditions and fish distributions. Recommendations will be made if improvements can be made in management regimes.



Appendix 7 Plates



Potential Dwarf Galaxias and Growling Grass Frog habitat (Wetland B)



Wetland B Potential Dwarf Galaxias and Growling Grass Frog habitat





Australian Grayling habitat in Cardinia Creek. Potential dispersal/movement corridor for Growling Grass Frog.



Potential Dwarf Galaxias and Australian Grayling habitat within Cardinia Creek. Photo shows shaded banks from overhanging riparian vegetation and flow of water over existing creek crossing. Riparian vegetation may be used as dispersal, foraging or shelter habitat by Growling Grass Frog.



Appendix 8 Cost estimate for works associated with the implementation of the Clyde North Precinct Structure Plan CMP

Prepared by					
29 June 2010					
Conservati	on Management Plan related costs				
ltem	Description	Unit	Qty	Est Rate	Est Total
1.0	Design costs				
1.1	Design development, construction documentation, tendering and contract administration (7% of construction cost)	item			\$182,222.11
1.7	Sign design & layout		4	\$2,200.00	\$8,800.00
	Design subtotal				\$191,022.11
2.0	Construction costs				
2.1	Preliminaries & Site Establishment	item			
a)	Temporary construction phase fencing; up to 600m * 2 (if public access is possible)	m		10	\$12,000.00
b)	Construction site amenities - 2 x portables amenity block	ea	2	5000	\$10,000.00
C)	Site set out for ponds (surveyor)				\$3,200.00
2.2	Trimming, grading & site clearance	m2			\$109,600.00
2.3	Proposed Core EVC revegetation area (143,500m2)				



a)	Direct planting of groundcover/grasses 20% of area @ 2-3 tube stock per m2	no.	\$3.85	\$276,237.50
b)	Direct Planting of indigenous shrubs @ 1 per 3m2	no.	\$11	\$526,163.00
C)	Direct planting of indigenous trees @ 1 per 25m2	no.	\$11	\$63,140.00
2.4	Significant EVC Vegetation (20,900m2) (See Comment)			
	NB: This EVC area is within the riparian zone and a portion Water funds that already provide for some revegetation on development is not remodelling the creek, this work will pro department or, if necessary, as a joint project with the deve Melbourne Water contribution.	n of these pla waterways (obably be und eloper. Costs	Inting requirements may busually within narrower ripudertaken by Melbourne Wurdertaken be confirmed de	be covered by Melbourne barian corridor). As the later River Health epending on possible
a)	Weed eradication	m2	2.85	\$59,565.00
b)	Direct planting of indigenous groundcover/grasses 1 per 5m2	no.	3.85	\$16,093.00
C)	Direct planting of indigenous shrubs 1 per 3m2	NO.	11.00	\$76,637.00
2.5	Existing wetland Pond B			
a)	Enhancement wetland planting @ 6/m2	m2	\$23.10	\$11,434.50
2.6	Existing wetland Pond G			
a)	Enhancement wetland planting @ 6/m2	m2	\$23.10	\$50,831.55
2.7	New wetland Pond A			
a)	Pond excavation - cut and fill	m3	\$45.00	\$21,600.00
b)	Supply and Install of jute matting around perimeter of wetland ponds (1m below and 1m above level of water)	m2		\$1,442.00
C)	Wetland planting @ 6/m2	m2	\$23.10	\$10,706.85



2.8	New wetland Pond C			
a)	Pond excavation - cut and fill	m3	\$45.00	\$82,980.00
b)	Supply and Install of jute matting around perimeter of wetland ponds (1m below and 1m above level of water)	m2		\$3,360.00
C)	Wetland planting @ 6/m2	m2	\$23.10	\$24,948.00
2.9	New wetland Pond D			
a)	Pond excavation - cut and fill	m3	\$45.00	\$15,300.00
b)	Supply and Install of jute matting around perimeter of wetland ponds (1m below and 1m above level of water)	m2		\$938.00
C)	Wetland planting @ 6/m2	m2	\$23.10	\$6,964.65
2.10	New wetland Pond E			
a)	Pond excavation - cut and fill	m3	\$45.00	\$14,400.00
b)	Supply and Install of jute matting around perimeter of wetland ponds (1m below and 1m above level of water)	m2		\$882.00
C)	Wetland planting @ 6/m2	m2	\$23.10	\$6,548.85
0.11	Nowwetland Dand E			
2.11				
a)	Pond excavation - cut and fill	m3	\$45.00	\$35,100.00
b)	Supply and Install of jute matting around perimeter of wetland ponds (1m below and 1m above level of water)	m2		\$1,736.00
с)	Wetland planting @ 6/m2	m2	\$23.10	\$12,889.80
2.12	New wetland Pond H			



a)	Pond excavation - cut and fill	m3		\$45.00	\$72,000.00
b)	Supply and Install of jute matting around perimeter of wetland ponds (1m below and 1m above level of water)	m2			\$2,604.00
C)	Wetland planting @ 6/m2	m2		\$23.10	\$19,334.70
2 13	New wetland Pond I				
a)	Pond excavation - cut and fill	m3		\$45.00	\$10.800.00
b)	Supply and Install of jute matting around perimeter of wetland ponds (1m below and 1m above level of water)	m2			\$938.00
C)	Wetland planting @ 6/m2	m2		\$23.10	\$6,964.65
2.14	New wetland Pond J				
a)	Pond excavation - cut and fill	m3		\$45.00	\$16,200.00
b)	Supply and Install of jute matting around perimeter of wetland ponds (1m below and 1m above level of water)	m2			\$1,204.00
C)	Wetland planting @ 6/m2	m2		\$23.10	\$8,939.70
2.15	Rock and log placement				
a)	Rock placement	M3	40	\$145.00	\$5,800.00
b)	Log placement	item	4		\$8,000.00
2.16	Interpretive Signage				
a)	Supply and install interpretive signage to educate public about threatened fauna species	no	4		\$10,000.00



	As built survey of ponds for inclusion to asset register				\$15,000.00
	Construction subtotal				\$1,632,482.75
3.0	Maintenance costs (10 years)				
3.1	Initial maintenance for 2 years. Includes 5% allowance for plant stock replacement, weed control, watering for establishment (water from site), mowing and general tidy for 24 months (1 visit per fortnight, 2 people)	month			\$120,000.00
3.1 a	Plant replacement - 5% of total	%	5		\$52,734.69
3.2	Maintenance for years 3-10	month			\$192,000.00
	Maintenance subtotal				\$364,734.69
4.0	Monitoring costs (10 years)				
4.1	Growling Grass Frog				
a)	Targeted survey and habitat monitoring	surveys	12	\$3,520.00	\$42,240.00
b)	Reporting	days	12	\$800	\$9,600.00
C)	Travel expenses	travel days	12	\$288	\$3,456.00
d)	Quarterly water quality sampling visit, for 2 years after ponds established - as specified in CMP page 29	days	0	\$900	\$0.00
e)	Travel for water qual monitoring	travel days	8	\$288.00	\$2,304.00
-



4.2	Dwarf Galaxias								
i)	Baseline survey & determination of future survey locations	days	3	\$900.00	2,700.00				
ii)	Travel expenses for baseline survey	travel days	2	\$288.00	576.00				
iii)	Baseline survey report	days	1.5	\$900.00	1,350.00				
a)	Targeted survey and habitat monitoring	days	42		\$37,800.00				
b)	Reporting	days	21		\$18,900.00				
C)	Travel expenses	kms	2240	\$1.50	\$3,360.00				
d)	accommodation	visits	14	\$760.00					
4.3	Australian Grayling								
	Streamline Consulting recommend in CMP that reporting for Grayling can occur concurrently with Dwarf Galaxias at no extra cost - therefore additional costs for second species monitoring can be removed. (Confirmed - J. McGukin 11/06/10)								
a)	Targeted survey and habitat monitoring	days			0				
b)	Reporting	days			0				
C)	Travel expenses	km			0				
	Monitoring subtotal				\$122,286.00				
4.4	MW Contract/fund administration fee of \$3 k per year	%	12	\$3,000	\$36.000				
		, .		+-,000					
	TOTAL				\$ 2,346,525.55				
	Contingency (20%)				\$469,305.11				

-



	GRAND TOTAL				\$2,815,830.66				
Final per-he	Final per-hectare rates are o be determined after GAA provide total developable hectares for precinct. Contribution								
rates will be adjusted to NPV and indexed to CPI. These rates are a preliminary estimate only, and will be reviewed									
and adjusted by Melbourne Water on a regular basis, in accordance with actual costs of delivery or changes in									
expected costs of delivery, in line with Melbourne Water's DSS pricing process (Provided by Melbourne Water, June									
2011)	2011)								
Notes									
	Tubestock planting to include jute matting or jute mat squares to								
1	suppress weed growth and retain soil moisture (Trees and Shrubs only)								
	[Melbourne Water Comment] - this does not appear to be								
	included in the provided cost								
Exclusions									
1	Works to Hillcrest College section of creek corridor								



Appendix 9 Breakdown of CMP costs per property

CMP Cost Breakdown (by property assuming equal apportionment of works, design, construction, contract administration, maintenance& monitoring GGF).

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**Monitoring for DG and AG equally shared by those properties with direct creek frontage.

Property (Land Budget Ref.)	Gross Develop able Area (GDA)	% of Precinct (of properties with Potential Habitat calculated by Gross Developable Area)	Apportioned cost (by % GDA) of works (design, construction, signage, contract admin)	Apportioned cost (by % GDA) on-going maintenance	Apportioned cost (by % GDA) on-going monitoring GGF	Apportioned cost (by 1/3 creek frontage) on- going monitoring DG and AG	Aggregated Total Cost	Aggregated total cost + 20% contingency	Apportioned cost of land for GGF foraging areas associated with proposed wetlands (Area = 0.6175 hectares @ \$1,100,000/ hectare)	Total cost by property
4	32.55	6.71%	\$124,766.83	\$24,472.53	\$3,864.78		\$53,104.13	\$183,724.96	\$45,575.50	\$229,300.46
7	19.59	4.04%	\$75,090.08	\$14,728.63	\$2,325.99		\$92,144.70	\$110,573.64	\$27,429.31	\$138,002.95
9	20.04	4.13%	\$76,814.97	\$15,066.96	\$2,379.42		\$94,261.35	\$113,113.62	\$28,059.39	\$141,173.00
10	21.35	4.40%	\$81,836.31	\$16,051.88	\$2,534.96		\$100,423.14	\$120,507.77	\$29,893.61	\$150,401.38
11	40.8	8.41%	\$156,389.76	\$30,675.25	\$4,844.33		\$191,909.33	\$230,291.19	\$57,126.90	\$287,418.09
12	29.91	6.17%	\$114,647.49	\$22,487.66	\$3,551.32	\$21,562.00	\$162,248.47	\$194,698.17	\$41,879.06	\$236,577.22
13	35.4	7.30%	\$135,691.11	\$26,615.29	\$4,203.17	\$21,562.00	\$188,071.56	\$225,685.88	\$49,565.98	\$275,251.86
17	29.91	6.17%	\$114,647.49	\$22,487.66	\$3,551.32	\$21,562.00	\$162,248.47	\$194,698.17	\$ 41,879.06	\$236,577.22
18	48.3	9.96%	\$185,137.87	\$36,314.08	\$5,734.83		\$227,186.78	\$272,624.13	\$67,628.16	\$340,252.30
19	109.21	22.51%	\$418,610.91	\$82,108.91	\$12,966.89		\$513,686.71	\$616,424.05	\$152,912.46	\$769,336.51
20	21.15	4.36%	\$ 81,069.69	\$15,901.51	\$2,511.21		\$99,482.41	\$119,378.89	\$29,613.57	\$148,992.47
21	10.77	2.22%	\$ 41,282.30	\$8,097.36	\$1,278.76		\$50,658.42	\$60,790.10	\$15,079.82	\$75,869.92
22	10.48	2.16%	\$40,170.70	\$7,879.33	\$1,244.33		\$49,294.36	\$59,153.23	\$14,673.77	\$73,827.00
23	8.42	1.74%	\$32,274.55	\$6,330.53	\$999.74		\$39,604.82	\$47,525.78	\$11,789.42	\$59,315.20
25	7.71	1.59%	\$29,553.06	\$5,796.72	\$915.44		\$36,265.22	\$ 43,518.26	\$ 10,795.30	\$54,313.57
26	39.53	8.15%	\$ 151,521.74	\$29,720.40	\$4,693.54		\$185,935.68	\$ 223,122.82	\$ 55,348.68	\$278,471.50
Total	485.12	100.00%	\$1,859,504.86	\$ 364,734.69	\$57,600.00	\$64,686.00	\$2,346,525.55	\$2,815,830.66	\$679,250.00	\$3,495,080.66



Appendix 10: Statutory Mechanism / requirement for land to be transferred to Melbourne Water (including the buffer requirement for existing wetlands: Clyde North PSP).

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10 September 2010

Doc No: D/10/7756

Mr Michael Kirsch Panel Chair Planning Panels Victoria 8 Nicholson Street EAST MELBOURNE VIC 3002

Dear Mr Kirsch

Re: Response to request for further information: Cardinia Creek Conservation Management Plan (CMP) Casey Planning Scheme Amendment C129

I refer to the directions of Panel dated 2 July 2010.

Specifically, Direction 3 requested further advice in relation to Cardinia Creek CMP. We have subsequently sought comment from both Melbourne Water and the Department of Sustainability and Environment (DSE) with regard to the matters raised. We provide the following response below.

Statutory Mechanism/ requirement for land to be transferred to Melbourne Water

Melbourne Water has provided advice in respect of the issues raised by Panel (*see attachment Letter dated 4 August 2010*). Melbourne Water have stipulated within their advice that:

"Setback or reserve widths are therefore determined in accordance with, and are designed to fulfil the requirements of the Water Act and the P&E Act by protecting and preserving the local floodplain, waterway functions, and any significant values including biodiversity, geomorphic or cultural features. Reserve widths are therefore necessarily set on a case by case basis."

Further, Melbourne Water has sought to provide greater rigour in terms of defining the land that would be required for the waterway reserve. The reserve that is required is broadly similar to the area that was identified in the exhibited documents:

"However, rather than following a consistent 100 metre setback from the bank closest to the waterway, Melbourne Water's required reserve area responds to topography and other local features; and therefore varies in width throughout its length."

Melbourne Water has provided a revised plan that demonstrates the extent of the waterway reserve. The GAA has then translated this reserve width across to all revised structure plan maps that have been circulated with this letter. This includes the Cardinia Creek Masterplan.

The justification of the waterway reserve is adequately addressed in Section 2 of the Melbourne Water letter. It should be noted that the justification for the reserve is based upon what is required for the waterway reserve not what has been required by the CMP or EPBC Act requirements.

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With regard to the transfer mechanism required for the waterway reserve, Melbourne Water has specified the general method utilised to achieve this outcome in Section 3 of their letter. GAA support the methods outlined in this section and the revisions suggested to the UGZ Schedule to formalise these matters. Section 4 of the Melbourne Water letter discusses the issues of equity. The GAA note that if Melbourne Water was forced to acquire the land required for the waterway reserve along the Cardinia Creek, then the cost associated with this acquisition would be borne by the landowners within the associated Drainage Scheme. In the case of the Cardinia Creek the three properties fronting the Cardinia Creek are the only properties within the Clyde North precinct that are subject to this drainage scheme.¹ Hence these landowners would effectively cross compensate one another for the land required for the waterway reserve. The GAA considers that such a course of action is inefficient and ultimately provides little benefit.

The equity of requiring land beyond the 1:100 flood line

In responding to this specific request we do not directly consider the 1:100 flood line, but instead the Melbourne Water waterway reserve as defined by Melbourne Water (and referred to above). As has been discussed, the requisite waterway reserve is the better tool for determining that:

- Adequate flood water conveyance is provided for, and new development is protected from inundation;
- Development maintains the pre-development flows at the boundary and does not exacerbate any flood risks downstream or elsewhere in the catchment;
- The health and function of the waterway is protected;
- Water quality is enhanced or restored through water quality treatment systems; and
- Access for maintenance and works is provided.

It is acknowledged that specific areas beyond the Melbourne Water waterway reserve are required for the purposes of ecology and conservation. In this sense we have sought the views of DSE to determine the appropriate extent of these areas and refer to their letter of 19 August 2010 as attached.

It is useful to differentiate between those existing ecological features present along the Cardinia Creek corridor requiring protection and those areas that will be required once remedial works (funded by the CMP) have occurred.

Wetland B and Wetland F are extant. The CMP has qualified that the existing wetlands require an 80 metre buffer to provide sufficient terrestrial habitat for the Growling Grass Frog. The GAA on advice from DSE and the ecological consultant considers that this area is therefore encumbered by this existing ecological requirement and function. These areas of encumbrance are demonstrated on the attached plan.

Given the ecological encumbrance associated with these areas it is the GAAs opinion that compensation should not be provided in respect of these existing ecological encumbrances. The manner and means in which the land owner responds to these environmental encumbrances must be in accordance with the CMP.

The proposed wetlands will also require buffers as discussed by DSE in their letter (page 2) and recommended by the environmental consultant in the CMP. The areas required for buffers for the future wetlands are identified on the attached plan. It is acknowledged that these areas extend

¹ There are other landowners extraneous to the precinct to the east, north and south that would conceivably form part of a broader Cardinia Creek drainage scheme.



beyond the Melbourne Water waterway reserve and essentially affect unencumbered land². The GAA believes that these areas should be costed within the CMP for acquisition and transferred to the management authority for the conservation area, in this instance Melbourne Water. The cost of acquisition of the land would be credited to the respective property owner and would thereby reduce the financial obligations required of the land owner by the CMP. This would have the effect of increasing the total cost associated with the implementation of the CMP (ie. by the cost of land acquired). The area of land in question aggregates to 6175 square metres. This has been subsequently costed into the revised CMP costs table.³

The above outcome is considered an equitable outcome and reflects the underlying value of the land. It is considered that simplest mechanism would be that the land would be vested at subdivision (to either the Crown or Casey City council) as a contribution in-lieu of cash as is required by the CMP. Thereafter it would be managed by Melbourne Water as is the adjacent land.

As discussed given the refinements to the Melbourne Water waterway reserve and the confirmation of the required buffers by the CMP the Cardinia Creek Masterplan has minor changes to reflect this outcome. Please find this attached.

I trust this information provides sufficient response to the matters raised under Direction 3 of Panel.

Yours faithfully

Tim Peggie STRUCTURE PLANNING MANAGER

² The areas of land have been identified as having potential Growling Grass Frog habitat within the CMP. However, it should be noted that the majority of the remainder of the precinct is similarly identified as such. The location of the proposed wetlands has directly required these areas to provide foraging habitat for potential Growling Grass Frogs.

³ DSE has advised that the land required for Growling Grass Frog foraging does not necessarily have to be transferred from private ownership. The key issue is that it is managed appropriately in line with the requirements of the CMP. GAA advise that it supports transfer of land given that there is a mechanism to ensure equity and a management authority (ie. Melbourne Water) that is willing to administer the area.



04 August 2010

Mr Tim Peggie Structure Planning Manager Growth Areas Authority Level 29, 35 Collins Street MELBOURNE VIC 3000

Dear Tim

RE: CASEY PLANNING SCHEME AMENDMENT C129 – FURTHER INFORMATION FOR PANEL OUR REFERENCE: 172477

This letter provides information to the Growth Areas Authority (GAA) to facilitate its response to the directions of the Panel on Casey Amendment C129, issued on 2 July 2010. The Panel's direction requested that the GAA provide it with further information regarding:

- The statutory mechanism/requirement for land to be transferred to Melbourne Water (under the UGZ schedule and under the provisions of the EPBC Act.)
- The equity of requiring land beyond the 1:100 flood line (arguably unencumbered land) to be transferred to the CMP area without compensation

Before setting out the statutory mechanism for transfer of drainage and waterway reserves to Melbourne Water it is relevant to further explain what the Melbourne Water requirement for land is in this case and the rationale for the requirement.

1. Melbourne Water requirement for a waterway reserve

Melbourne Water has drainage, floodplain and waterway management functions under Part 10 of the *Water Act 1989 (Vic) (Water Act)*, and is a referral authority under section 55 of the *Planning and Environment Act 1987 (Vic)* (P&E Act). The following discussion of reserves and setbacks along waterways relates to Melbourne Water's obligations and powers as a floodplain, drainage and waterways manager for the Port Phillip and Westernport Region, and development conditions that are imposed in this capacity.

It should be noted that Melbourne Water's requirement for a drainage and waterway setback or reserve along Cardinia Creek under the Water Act is separate from requirements for land reserves required by the Victorian Department of Sustainability and Environment or the Commonwealth Department of Environment, Water, Heritage and the Arts for the purposes of biodiversity conservation under other legislation such as the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

Melbourne Water routinely requires setbacks or reserves along waterways, drainage courses and in floodplains in Greenfield development areas in order to



fulfil its obligations as waterway, drainage and floodplain manager for the Port Phillip and Western Port region to ensure that:

- Adequate flood water conveyance is provided for, and new development is protected from inundation;
- Development maintains the pre-development flows at the boundary and does not exacerbate any flood risks downstream or elsewhere in the catchment;
- The health and function of the waterway is protected
- Water quality is enhanced or restored through water quality treatment systems; and
- Access for maintenance and works is provided.

While often there is sufficient space for passive recreational activities and some infrastructure to be co-located within the reserves, this is always considered on a case by case basis to ensure the reserve continues to meet its primary objectives set out above.

Setback or reserve widths are therefore determined in accordance with, and are designed to fulfil the requirements of the Water Act and the P&E Act by protecting and preserving the local floodplain, waterway functions, and any significant values including biodiversity, geomorphic or cultural features. Reserve widths are therefore necessarily set on a case by case basis.

2. Cardinia Creek Reserve:

A review of drainage and waterway requirements in the Clyde North area was undertaken by Mr Neil Craigie during the development of the Precinct Structure Plan (PSP). Mr Craigie's report: *Clyde North Precinct Structure Plan Surface Water Management Aspects*, recommended a setback of "100 metres or more measured from the edge of the creek bank" in order to meet established industry surface water management and ecologically sustainable development principles.

To achieve the waterway management objectives outlined in section 1, Melbourne Water requires a setback or reserve area along the length of Cardinia Creek. The reserve area required by Melbourne Water is broadly similar to that recommended by Mr Craigie. However, rather than following a consistent 100 metre setback from the bank closest to the waterway, Melbourne Water's required reserve area responds to topography and other local features; and therefore varies in width throughout its length.

The setback or reserve area required by Melbourne Water is shown in appendix 1.

South of Hillcrest Christian College, the floodplain extends significantly further than 100 metres from the top of the creek bank. The floodplain is bounded by a drop structure and levee bank designed to direct flood flows through the waterway while controlling erosion. In this reach of the creek, Melbourne Water's reserve follows the edge of the natural floodplain from the southern boundary of Hillcrest College to the north end of the levee bank. It then follows the external side of the levee bank, allowing a 20 metre gap to preserve space for future works requirements, maintenance access, and landscaping.

At the southern end of the levee bank, the reserve maintains a minimum distance of 50 metres from a constructed low-flow waterway channel. This constitutes a greater setback than 100 metres from the top of the natural waterway bank, as the waterway consists of a dual channel at this location. Melbourne Water considers that it is appropriate to consider a greater setback at this location to protect the constructed low-flow channel, which is located some distance from what might be considered the top of the original creek bank. The low-flow channel is associated with the drop structure, directing everyday waterway flows around it, and through a fish ladder that preserves access to the upstream waterway for a number of EPBC listed threatened species. Maintaining a minimum of 50 metres of vegetated, undeveloped land is critical to preserve the health of this highly significant section of the waterway and adequate functioning of the fish ladder.

North of Hillcrest College, Melbourne Water's required reserve extends approximately 20 - 25 metres from the top of the upper bank or 'break of slope' adjacent to the Grices Road Anabranch. This 'upper bank' reflects an old channel once followed by Cardinia Creek, and is located between 50 and 100 metres from the current creek channel. Aligning the waterway reserve with the top of this upper bank provides an adequate setback from the Creek, and more consistent protection for the anabranch, a feature of environmental significance, containing existing growling grass frog habitat (shown at 'wetland b' on Plan 13 if the PSP; *Cardinia Creek Masterplan*). It results in a setback of comparable area to Mr Craigie's recommended 100 metres setback from the top of creek bank, though in some places slightly wider, and in others slightly narrower. It also provides a smoother reserve edge that may be more practical to implement

It should be noted that Melbourne Water's waterway management reserve includes a component of land that is not subject to flooding, but is otherwise required for the environmental and waterway management reasons outlined above.

3. Mechanism for transfer of land to Melbourne Water:

The Panel direction refers to the UGZ Schedule and the EPBC Act mechanisms for transfer of land. We cannot comment on mechanisms under the EPBC Act. However we set out below the usual process for transfer of land to Melbourne Water pursuant to the Water Act and also note a suggested change to the UGZ Schedule to reflect the Water Act requirement.

When landowners in Greenfield areas propose to subdivide land adjacent to a waterway, Melbourne Water generally enters into an agreement with the landowner at an early stage in the development process to provide developer works and drainage services. Two key parts of this agreement are requirements to:

- create an easement or a waterway reserve over the waterway setback areas; and
- transfer to Melbourne Water any other land which is required for flood storage (such as retarding basins) or upon which other drainage works are constructed. This is then shown on the plan of subdivision.

When landowners in the Clyde North PSP area subdivide land, Melbourne Water intends to enter into agreements with them for the creation of waterway reserves or easements and for the transfer of any flood storage land (ie retarding basins).

If appropriate agreements cannot be reached, a reserve determined by Melbourne Water will be required as a condition of approval of the plan of subdivision under Section 136 of the Water Act. However, Melbourne Water rarely needs to rely on this power.

Section 136 of the Water Act empowers Melbourne Water to require the creation of easements or reserves along waterways, or both, for drainage and waterway

management purposes, when a proposal for subdivision of land is referred to it under Section 55 of the P&E Act.

Similarly, if an agreement could not be reached on the transfer of land required for flood storage or drainage works, then Melbourne Water would resort to using its powers of acquisition under section 130 of the Water Act, using the process set out in the *Land Acquisition and Compensation Act 1986* (Vic) (LACA). Again, Melbourne Water rarely needs to resort to this process.

The UGZ Schedule is currently silent on any application requirements for, or conditions required upon, subdivision of land arising from the waterway reserves. While not strictly necessary given Melbourne Water has the powers set out above to require these reserves or to acquire other land as needed, Melbourne Water suggests that the following bullet points be inserted into the Schedule where indicated:

- At 3.0 Application Requirements:
 - \circ $\,$ For subdivision of any land adjacent to the waterways, a plan showing:
 - waterway management easements or reserves generally in accordance with *PSP Plan 13 Cardinia Creek Masterplan* to the satisfaction of Melbourne Water.
 - all land to be set aside for drainage works to the satisfaction of Melbourne Water.
- At 4.0 Conditions and requirements for permits:
 - For permit for subdivision of land adjacent to the waterways, a condition requiring:
 - that waterway management easements or reserves shown on the plan of subdivision are vested in Melbourne Water.
 - the plan of subdivision to show all land to be set aside for drainage works.

4. "Equity" Considerations and Compensation:

As set out above, Melbourne Water has a statutory power to require waterway management and drainage easements or reserves to be created for the use of the Authority whenever a plan of subdivision is referred to Melbourne Water under the P&E Act.

Such easements and reserves are regularly required by Melbourne Water to enable it to fulfil its statutory functions of managing waterways, floodplains and drainage systems. No compensation is paid for such easements and reserves.

Acceptance of the requirement over many years by developers is because it is consistent with the general principles of land valuation, namely that compensation is not payable, or is effectively a zero value, for un-developable or encumbered land.

Land adjacent to waterways is not developable where it is prone to flooding, is required for flood conveyance or where it contributes to the ongoing health and function of the waterway. Compensation is therefore not paid to owners where part of a property is required as an easement or reserve to preserve waterway functions or to provide for flood conveyance.

Where otherwise developable land is required for drainage or water quality treatment infrastructure that will also serve other development, Melbourne Water

does provide for compensation through a Development Services Scheme (DSS). Landowners contributing to a DSS pay a rate per-hectare that covers the costs of implementing the scheme, including the acquisition of developable land. Therefore the cost of acquiring land for drainage purposes is shared by all landowners within a catchment.

The principles guiding Melbourne Water's DSSs have been developed in consultation with peak land development bodies, and are included in appendix 2. The principles include that, where land is flood prone or otherwise encumbered, compensation is not paid or is effectively zero for that part of the land.

The Cardinia Creek Corridor area is not yet included in a DSS. While much of Clyde North will be serviced by the established *Ti Tree Creek DSS*, the Cardinia Creek area falls into a different sub-catchment and will be separately served by the forthcoming *Lower Cardinia Creek DSS*. The *Lower Cardinia Creek DSS* area is shown in appendix 3. Any area of land that is considered developable, and is required to provide drainage services to other properties within the catchment, would be acquired by Melbourne Water with funding from the forthcoming DSS. The cost of acquiring the land would therefore be spread among developing property owners within that catchment that pay money into the DSS on a perhectare basis.

As noted above, where a dispute arises and developers do not agree to enter into the Developer Works Agreements, Melbourne Water has power to acquire the necessary land using its powers under section 130 of the Water Act and the LACA process.

While a series of Growling Grass Frog ponds are proposed to be constructed within the Melbourne Water waterway reserve (as shown on PSP *Plan 13 Cardinia Creek Masterplan*), it should be noted that the reserve is required in the first instance for waterway management purposes. Locating offset biodiversity infrastructure within the encumbered area presents an opportunity to use the reserve efficiently, and potentially enhance its environmental value. The proposed Growling Grass Frog Ponds however, do not create the requirement for a waterway reserve, nor do they affect its extent. However, clearly a benefit is provided to those land owners that are otherwise required to provide habitat offsets for the frog pursuant to permit and legislative obligations.

Should a greater land area than Melbourne Water's required setback be transferred into public ownership for biodiversity or other purposes, any compensation or acquisition process for that land should be determined and completed by other public authorities pursuant to any relevant powers vested in those authorities under their governing legislation.

If you have any queries regarding this matter, please contact me on (03) 9235 1530 or Deborah.riley@melbournewater.com.au.

Yours sincerely

DEBORAH RILEY TOWN PLANNER, WATERWAYS



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Map at A3 Scale 1:5,000

Appendix 1: Cardinia Creek Clyde North Waterway Reserve

Appendix 1. oardinia oreek orgae North Waterway					Scale 1:5,000		\mathbf{A}
	MWC Reserve	100 M offset from Cree!		Whilst all due skill and attention has been used Melbourne Water Corporation shall not be liable in anyway for loss of any kind including damages, costs,	4/8/2010		MGA55
	1 in 100 year flood		50 m offset from Creek	Shain for be liable in anyway lon loss of any kind including darhages, costs, interest, loss of profits or special loss or damage, arising from any error, inaccuracy, incompleteness or other defect in this information. By receiving and accepting this information the recipient acknowledges that Melbourne Water Corporation makes no representations as to the accuracy or completeness of this information and ought carry out its own investigation if appropriate.	Victoria The Place To Be	Melb Wate	ourne r

Appendix 2: Principles of Development Services Schemes

The general principles for Development Services Schemes, from *Principles for Provision of Waterway and Drainage Services for Urban Growth*

- (a) Schemes are based on drainage catchment boundaries.
- (b) Schemes are established when greenfield catchments involving several or many landowners are to be developed.
- (c) Schemes are established to ensure the orderly provision of drainage infrastructure within catchments.
- (d) The drainage infrastructure required within a catchment due to development, is funded from contributions received from landowners as they develop their properties.
- (e) Schemes are not designed with a profit margin for Melbourne Water. In theory schemes are cost neutral to Melbourne Water, however in practice Melbourne Water often makes a financial contribution in respect of existing development.
- (f) Scheme infrastructure services all developable properties within the catchment.
- (g) Schemes often include water quality treatment works and natural treatment of waterways.
- (h) Schemes provide the drainage infrastructure required due to the upstream catchment and convey this flow across the development and down to the scheme outlet. The drainage works required to drain areas within a development is the responsibility of the developer and does not form part of the drainage scheme.
- (i) Contributions are received from landowners within the catchment when they develop their properties.
- (j) Land developers within a scheme contribute at the same rate irrespective as to their location within the catchment. However, adjustment is made to the contribution rate in respect of the land use type (zoning) as this affects the runoff characteristics. Industrial/commercial zoned properties contribute at 1.50 times the residential rate. To make allowance for the time value of money a net present value model is used for this calculation.
- (k) The Drainage Scheme Plan shows the functional design of all drainage scheme works within the catchment as well as the contributing properties.
- (I) The scheme works are constructed (usually by the developer) as development occurs within the catchment
- (m) Melbourne Water maintains all assets where the drainage catchment is larger than 60 ha, with Council maintaining all assets where the catchment is less than 60 ha.
- (n) Schemes are flexible in that they allow the developer to vary the drainage works from that shown on the Drainage Scheme Plan to suit the development. Sometimes the form of the drainage works is also changed from that proposed by the Scheme, however the drainage works must

always perform the same function and achieve the same objectives as the original scheme works.

- (o) Drainage Schemes are reviewed periodically to take account of the works constructed since the last review and the contributions received. Because the life of a scheme can be 20 years plus, the review also considers the changes in standards, construction costs and the development patterns within the catchment.
- (p) Once a contribution has been received for a development property, that property has fulfilled its financial obligations to the scheme. Melbourne Water does not seek additional contributions if a review recommends an increase in the drainage scheme rate, nor is a refund given if the scheme rate is reduced.

These principles were developed in the early 1990s by a working group convened by Melbourne Water comprising: the Urban Development Institute of Australia, Housing Institute Australia, Association of Land Development Engineers and the Municipal Association of Victoria.



Melbourne Water

16/9/2010 MGA55





Department of Sustainability and Environment

30 Prospect Street Box Hill, Victoria 3128 Telephone: (03) 9296 4400 ABN 90 719 052 204

19 August 2010

Tim Peggie Growth Areas Authority Level 29, 25 Collins Street Melbourne Vic

Dear Mr Peggie,

The Department of Sustainability and Environment (DSE) provides the following information to assist the Growth Areas Authority in their response to the Casey C129 Further Directions 2 July 2010 from Planning Panels Victoria.

DSE provides a summary of the requirements of land beyond the 1:100 year flood line for protection of threatened species in Clyde North Precinct as presented in the *Clyde North PSP Cardinia Creek: Threatened Fauna Conservation Management Plan, Ecology Australia and Streamline Research, 28/07/2010* (Clyde North CMP). The Clyde North CMP fulfils the requirements of Melbourne's Strategic Assessment for three species listed under the Commonwealth *Environmental Protection and Biodiversity Conservation Act 1999.*

In relation to the Cardinia Creek Corridor, the land containing Wetland B, its terrestrial buffer (80m), and the Grices Road Anabranch are existing suitable habitat for the Growling Grass Frog that is required to be protected by DSE and the Commonwealth. A proportion of this buffer for Wetland B extends beyond the 1 in 100 year flood line. The creation of additional wetlands in the Cardinia Creek Corridor is required to create habitat as a response to the loss of habitat in the rest of the precinct allowing for urban development. Terrestrial buffers have also been provided as defined in the Clyde North CMP. A proportion of these buffers extends beyond the 1 in 100 year floodline. This area outside the 1 in 100 year flood line, that provides for the terrestrial buffers as described above, is considered necessary to maintain a population of Growling Grass Frog should they colonise the study area and as such should be managed for both its recreational and conservation values.

These areas are required to be protected and enhanced for threatened species. This can be achieved on either private or public land. The Clyde North CMP outlines that that the land owners will be responsible for undertaking works unless transferred to a public authority by agreement (eg. Melbourne Water) (Clyde North CMP pg 21).

Justification for the Cardinia Creek Corridor.

An agreement under the Strategic Assessment provision of the *Environment Protection and Biodiversity Conservation Act* (Section 146(1) Agreement, Part 10 Strategic Assessment (EPBC Act)) was made between the Commonwealth of Australia and the State of Victoria on 16th June 2009. This agreement outlines that the State will undertake a Strategic Assessment to assess requirements under the EPBC Act.

Melbourne's Strategic Assessment has received approval from the Federal Government for controlled actions to occur for the types of activities that can take place under the Program for all precincts within the Urban Growth Boundary. Where in accordance with the approvals of the Strategic Assessment, such activities will need no further Federal assessment.

The Clyde North precinct contains habitat for three species listed under the EPBC Act including Growling

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Grass Frog, Dwarf Galaxias, and Australian Grayling. The approvals include a prescription for Growling Grass Frog that requires

"A Growling Grass Frog Conservation Management Plan (CMP) must be prepared for precincts containing suitable habitat for Growing Grass Frog. The CMP must be prepared prior to exhibition of the PSP....The CMP must be to the satisfaction of DSE."

The prescription and Commonwealth Guidelines for Growling Grass Frog identify that it is essential to protect suitable habitat for the species and movement corridors for the species even where there is not an exact record of the species.

Suitable habitat for Growling Grass Frog has been identified throughout the Clyde North precinct by Practical Ecology (Figure 13 Clyde North CMP 28/07/2010 pg 109). The Clyde North CMP also identifies the habitat along Cardinia Creek as core habitat and important for the species. The species is assumed to be present in the Cardinia Creek Corridor or at least individuals may use the creek corridor for dispersal, movement, foraging and or shelter (Clyde North CMP 28/07/2010 pg 10). The Cardinia Creek corridor has also been identified as a high priority corridor for Growling Grass Frog dispersal in the draft Sub-regional Strategy for Growling Grass Frog that is currently being prepared by DSE and must be followed under Melbourne's Strategic Assessment.

The Clyde North CMP requires:

- Protection of existing suitable habitat in accordance with Melbourne's Strategic Assessment. This includes:
 - Protection of Wetland B as it is suitable habitat for Growling Grass Frog and Dwarf Galaxias. A terrestrial buffer of existing habitat of 80m is also required to be protected for Growling Grass Frog for foraging and sheltering around the wetland (Clyde North CMP 28/07/2010 page 30).
 - Protection of the Cardinia Creek and Grices Road Anabranch and surrounding terrestrial habitat as an important movement corridor for the species, and terrestrial habitat ie grassy areas surrounding creek line and water bodies.
- Creation of additional wetlands and terrestrial habitat to offset the loss of Growling Grass Frog habitat in the precinct. This includes the creation of wetlands A, C, D, E, F, H, I, and J as per the Cardinia Creek Masterplan. These wetlands are to be buffered for terrestrial habitat by:
 - o 50m for Wetland A,
 - o 60m for Wetlands D,G,H,
 - o 70m for Wetlands C and E, and
 - o 80m for Wetland F (Clyde North CMP 28/07/2010 page 30).
- Enhancement of areas of suitable habitat for Growling Grass Frog and Dwarf Galaxias including Wetlands B, G and Grices Road Anabranch,

Rationale for terrestrial habitat buffers around wetlands.

A terrestrial buffer adjacent to Cardinia Creek has been identified that is consistent with the impact threshold for Growling Grass Frogs. A terrestrial buffer is required as the species is mobile and uses terrestrial habitat (including farm paddocks) for foraging or resting. The impact threshold for habitat degradation in temperate regions is identified in the Significant Impact Guidelines as up to 200m from



a water body (EPBC Act Policy Statement 3.14 Feb 2009). A 'buffer' is an environmental management tool used to protect the environmental values of the waterbody (Steedman and France 2000; Biosis Research 2003; DSE 2004). It is important to maintain a suitable buffer width around Cardinia Creek and the wetlands (core area of Growling Grass Frog habitat) to protect from over use by residents, edge effects and deterioration of habitat.

To maintain the long-term viability of Growling Grass Frog habitat, the DEWHA Growling Grass Frog Workshop (March 2008) suggested a width of 200 m around waterways where populations are present (DEWHA 2009). The value is based on movement data (radio tracking) between water bodies and foraging sites (Nick Clemann, Arthur Rylah Institute, pers comm., Peter Robertson Wildlife Profiles, pers comm.).

A width of 200 m obviously requires large reservations of land and is unlikely to be available or practical around the area of habitat within the Cardinia Creek corridor. In the case of Clyde North Precinct, DSE have suggested a minimum 'buffer' width of 30 m around each of the wetlands to buffer wetland from impacts, noting that the wetlands are within a larger terrestrial system that provides for additional terrestrial habitat. The larger terrestrial system is identified with terrestrial buffers for each wetland in the Clyde North CMP, as described in paragraph 6.

All wetlands are within the 1 in 100 year flood line from the creek. Therefore, if Growling Grass Frog colonise the study area, land outside the 1 in 100 year flood line from the creek will almost certainly be utilised for foraging and/or sheltering and overwinter aestivation (hibernation).

It is understood that this information is accepted by the Growth Areas Authority. For further information please contact Clare White, DSE, Senior Biodiversity Officer (Ph: (03) 9296 4636).

Regards,

Mark Winfield Group Manager, Biodiversity Statewide Services Department of Sustainability and Environment





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