Draft Report v4

Preliminary Documentation: Residential Development at 200 Ballan Road, Moorabool, Victoria (EPBC 2023/09498).

Prepared for

Tango Projects

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Ecology and Heritage Partners acknowledge the Traditional Owners of the country we live and work on, and we pay our respect to Elders past, present and emerging.

GLOSSARY

Acronym	Description
CMA	Catchment Management Authority
CMP	Conservation Management Plan
CHMP	Cultural Heritage Management Plan
DCCEEW	Commonwealth Department of Climate Change, Energy, the Environment and Water
DCP	Development Contributions Plan
DEECA	Victorian Department of Energy, Environment and Climate Action
DELWP	(former) Victorian Department of Environment, Land, Water and Planning
DSEWPaC	(former) Commonwealth Department of Sustainability, Environment, Water, Populations and Communities.
ESD	Ecologically Sustainable Development
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999*
EVC	Ecological Vegetation Class
FFG Act	*Flora and Fauna Guarantee Act 1988*
GGF	Growling Grass Frog *Litoria raniformis major*
VGED	Victorian Grassland Earless Dragon *Tympanocryptis pinguicolla*
MNES	Matters of National Environmental Significance
NVPP	Native Vegetation Precinct Plan
OMP	Offset Management Plan
PMST	Protected Matters Search Tool (DCCEEW)
RAP	Registered Aboriginal Party
VBA	Victorian Biodiversity Atlas (DEECA)
WTOAC	Wadawurrung Traditional Owners Aboriginal Corporation

SUMMARY

Ecology and Heritage Partners Pty Ltd were commissioned by Tango Projects to prepare the Preliminary Documentation for the proposed development of between 330 and 350 residential lots at 200 Ballan Road, Moorabool, Victoria (EPBC 2023/09498).

On 20 October 2023, it was determined by a delegate for the Department under Section 75 of the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) that the proposed action is considered a controlled action, and that the development of the study area will likely have a significant impact on 'Listed threatened species and communities (Section 18 and Section 18A)'. It has also been determined that the proposed action will be assessed by Preliminary Documentation.

Specifically, the Matter of National Environmental Significance (MNES) that the Commonwealth Department of Climate Change, Energy, the Environment and Water (DCCEEW) has requested additional information for concerns the EPBC Act-listed Growling Grass Frog *Litoria raniformis major*, Blue-winged Parrot *Neophema chrysostoma*, and Victorian Grassland Earless Dragon *Tympanocryptis pinguicolla*.

The size of the study area is an approximately 30-hectare parcel of land located at 200 Geelong-Ballan Road, Moorabool and has been acquired for the subdivision and development of the land for residential purposes. The study area is bordered by Warners Road to the north, Evans Road to the east, and Geelong-Ballan Road to the south-west. Cowies Creek traverses the study area in the north-east corner of the property. The study area is currently used for agriculture and farming, with a residence and outbuildings on site. No dams or ponds are present in the study area. The study area gently slopes in the direction of Cowies Creek, with a depression also running in a north-south direction from Cowies Creek towards the existing residence.

Growling Grass Frog habitat in the study area was initially assessed and targeted surveys undertaken during a site assessment undertaken on 17 January 2020 as part of the Existing Ecological Conditions assessment for the Western Geelong Growth Area (WGGA) (Ecology and Heritage Partners 2021). The WGGA is part of the Geelong Strategic Assessment (Greater Geelong City Council 2025a, 2025b). An additional habitat and water quality assessment was undertaken on 7 November 2022 (Ecology and Heritage Partners 2023). Further targeted surveys for Growling Grass Frog were undertaken on 7 and 29 February and 6 March 2024 as well as habitat assessments for Victorian Grassland Earless Dragon *Tympanocryptis pinguicolla*, Blue-winged Parrot *Neophema chrysostoma* and any other MNES.

Growling Grass Frog was not recorded in the study area during initial targeted surveys in 2020. Two Growling Grass Frog specimens were recorded within the study area during targeted surveys in 2024. Based on the findings of detailed survey and habitat assessments, the study area supports low-quality Growling Grass Frog foraging habitat, currently provides a dispersal corridor for a local Growling Grass Frog population and is unlikely to provide breeding habitat for the species. Areas adjacent to the creekline are dominated by open paddocks subject to historical cropping, containing pasture/introduced grasses, and which do not provide habitat for the species.

Potential direct impacts associated with the proposed residential development include changes in the hydrology of Cowies Creek, the deterioration of water quality, noise and lighting impacts. Potential indirect impacts associated with the proposed residential development include the introduction and spread of chytrid fungus, human access, and the spread of weeds and pests. The prevention and/ or management of these impacts is outlined in the Growling Grass Frog Conservation Management Plan (Appendix 1). Potential impacts relate to 2.6 hectares of Growling Grass Frog habitat and up to four individuals recorded within the study area.

A range of mitigation measures will be implemented by the construction contractor to manage and potential direct and indirect impacts to Growling Grass Frog and adjacent matters of NES. Measures to mitigate impacts upon terrestrial and aquatic values present include a range of mitigation measures including the use of exclusion fencing, sediment fencing, noise and light containment, hygiene protocols, among other measures proposed in the Growling Grass Frog Conservation Management Plan (Appendix 1) and the forthcoming Construction and Environmental Management Plan.

Habitat enhancement works are proposed as part of the mitigation measures for the species within the study area. The improvement of retained habitat will provide improved foraging and potentially breeding habitat for the species and improve habitat connectivity and frog dispersal along the broader Cowies Creek corridor. Habitat enhancement measures are further outlined below and are further outlined in the Growling Grass Frog Conservation Management Plan (Appendix 1). Greater aquatic vegetation cover, inclusive of emergent, submergent and floating aquatic vegetation, provision of rock mattresses, and pest control measures will be provided to ensure continued Growling Grass Frog occupancy and persistence at the site.

Management of the habitat corridor will be undertaken over the life of the Growling Grass Frog Conservation Management Plan, followed by potential arrangements with relevant organisations (for example, Greater Geelong City Council, DEECA) to manage the sites thereafter. This will be determined during further discussions with the relevant authorities. Ongoing population and habitat monitoring will be conducted in accordance with the detailed Growling Grass Frog Conservation Management Plan to assess any impacts associated with proposed residential development and to ensure habitat conditions within the study area remain suitable for the species.

In relation to stormwater impacts, stormwater associated with the proposed development will ultimately flow into Cowies Creek following water treatment via the stormwater wetland within the study area. This is not expected to directly or indirectly significantly impact the hydrology of Cowies Creek as there is not anticipated to be any long-term change in maximum flow rates along the creekline following completion of the proposed action (Rain Consulting 2024).

The proposed development area does not intersect with Growling Grass Frog habitat, with a further 50-metre buffer proposed from the outer edge of aquatic habitat for the species along Cowies Creek, restricting any proposed construction areas to beyond this 50-metre buffer. Any direct or indirect impacts to Growling Grass Frog are not anticipated to be significant. The proposed residential development will not impact any other species or ecological community listed under the EPBC Act.

CONTENTS

1 INTRODUCTION

1.1 Project Background

Ecology and Heritage Partners Pty Ltd were commissioned by Tango Projects to prepare the Preliminary Documentation for the proposed development of between 330 and 350 residential lots at 200 Ballan Road, Moorabool, Victoria (EPBC 2023/09498) (Figure 1).

On 20 October 2023, it was determined by a delegate for the Department under Section 75 of the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) that the proposed action is considered a controlled action, and that the development of the study area will likely have a significant impact on 'Listed threatened species and communities (Section 18 & Section 18A)'. It has also been determined that the proposed action will be assessed by Preliminary Documentation.

Owing to the known presence of a population of the nationally significant Growling Grass Frog *Litoria raniformis major* along the Cowies Creek corridor which traverses the study area, a referral (EPBC 2023/09498) was submitted to the Commonwealth Minister of Climate Change, Energy, the Environment and Water (DCCEEW) under the EPBC Act, to determine potential impacts to Matters of National Environmental Significance (MNES). This referral was deemed a 'Controlled Action' by DCCEEW on 20 October 2023 based on likely impacts to listed threatened species and communities protected under the EPBC Act.

In October 2022, Ecology and Heritage Partners was engaged by Pro-urban to undertake a Growling Grass Frog Habitat Assessment within the study area and prepare a Conservation Management Plan for the site. The purpose of this assessments was to determine the extent and type of Growling Grass Frog habitat present within the study area, and to propose mitigation measures associated with the proposed action and conservation measures for potential Growling Grass Frog habitat to ensure the proposed activity did not have a significant impact on the Growling Grass Frog population and associated habitats.

In January 2024, Ecology and Heritage Partners was commissioned by Tango Projects to prepare a Preliminary Documentation, including targeted surveys for Growling Grass Frog as well as habitat surveys for Blue-winged Parrot *Neophema chrysostoma*, Victorian Grassland Earless Dragon *Tympanocryptis pinguicolla* and any MNES.

A residential development plan was prepared as part of a proposed planning permit application for the proposed residential development, and this plan includes the provision of dedicated Growling Grass Frog habitat corridor. Existing Growling Grass Frog habitat within the Cowies Creek corridor is proposed to be enhanced via the provision of rock mattresses and/or loose rock as basking and overwintering habitat, planting of suitable vegetation, and weed and feral animal control.

Ecology and Heritage Partners has prepared a Growling Grass Frog Conservation Management Plan for the proposed development which includes detail on how any potential impacts to the species will be mitigated, and measures to ensure that the resident population at the site remains viable in the future. The proposed residential development will not impact any other species or ecological community listed under the EPBC Act.

The following information includes that outlined in the EPBC Act referral, as well as additional information requested by DCCEEW regarding impacts of the action and the strategies proposed to avoid, mitigate and/or offset those impacts. The contents page of this report provides a reference table detailing where each of the requirements of the Preliminary Documentation request is addressed.

2 DESCRIPTION OF THE ACTION

The Preliminary Documentation must provide a detailed description of the proposed action, including:

a) The location, boundaries and size (in hectares) of the proposed action area and the proposed disturbance footprint (if different);

b) A description of all components of the action, including the anticipated timing and duration (including start and completion dates) of each component of the project;

c) A description of the operational requirements of the action including any anticipated maintenance works;

d) An indicative layout plan for the proposed action, including the location and type of land use, key infrastructure, stormwater infrastructure and the number and location of dwellings, houses and associated infrastructure;

e) The referral documentation currently mentions that the proposed action will include houses, local streets and amenity connections, a local activity centre and mixed-use areas. The preliminary documentation should confirm or amend these with the mapping identifying the layout and location within the proposed action area.

2.1 Response

2.1.1 Location, boundaries and size of the proposed action

The size of the study area is an approximately 30-hectare parcel of land located at 200 Ballan Road (1/TP240293) and has been acquired for the subdivision and development of the land for residential purposes. The study area is bordered by Warners Road to the north, Evans Road to the east, and Geelong-Ballan Road to the south-west. Cowies Creek traverses the study area in the north-east corner of the property.

The study area is currently used for agriculture and farming, with a residence and outbuildings on site. No dams or ponds are present in the study area. The study area gently slopes in the direction of Cowies Creek, with a depression also running in a north-south direction from Cowies Creek towards the existing residence.

Patches of Creekline Grassy Woodland (EVC 68) were recorded within the study area during existing conditions surveys in 2020 (Ecology and Heritage Partners 2021). According to the Department of Energy, Environment and Climate Action (DEECA) NatureKit Map (DEECA 2024c), the study area is located in Victorian Volcanic Plain. It is situated within the jurisdiction of the Corangamite Catchment Management Authority (CMA) and the Greater Geelong City Council municipality.

The study area is subject to the Creamery Road Precinct Structure Plan, which is currently undergoing preparation along with a Growling Grass Frog Conservation Management Plan for the broader Cowies Creek habitat corridor (Greater Geelong City Council 2025a, 2025b).

The study area is located within the Greater Geelong and is subject to an Urban Growth Zone – Schedule 2 (UGZ2). No overlays are currently present on the property.

Size and disturbance footprint of the proposed action

The study area is proposed to be subject to future residential development. The residential development is proposed to be undertaken over one phase and is proposed to include between 330 and 350 residential lots. The overall disturbance footprint in the study area is 18.29 hectares.

This plan includes the enhancement of existing habitat for Growling Grass Frog, including the provision of rock mattresses and/or loose rock as basking and overwintering habitat, planting of suitable vegetation, and weed and feral animal control. Habitat enhancement measures are proposed to ensure ongoing and improved dispersal opportunities for the species between areas of suitable breeding habitat along Cowies Creek. As part of this design, areas containing some characteristics of the species habitat (i.e. exposed rock, ephemeral ponds) will be enhanced where possible.

There are no direct impacts to Growling Grass Frog or other MNES proposed as part of residential development works.

Potential indirect impacts to Growling Grass Frog include noise and lighting and other construction impacts (i.e. spread of chemicals/sediment/disease/weeds via machinery and equipment) to Growling Grass Frog habitat in adjacent habitat. Potential indirect impacts for these species are proposed to be mitigated through the application of a 50-metre construction and residential development buffer from the outer edge of aquatic habitat for the species along Cowies Creek. Further, potential impacts include but are not limited to erosion, sedimentation, plant disease, and pest plant spread, with specific mitigation measures proposed for all potential impacts. Mitigation measures include appropriate storage of materials, use of water-sensitive urban design principles, frequent washdown of vehicles during construction among a range of other measures highlighted below (Section 6.1).

Overall, the following disturbance scenario would occur due to the proposed action:

- Disturbance footprint: 18.29 hectares;
- Area of avoidance: 2.6 hectares;
- Construction impacts to Growling Grass Frog habitat: 0 hectares.

Please see included spatial files for details.

At this stage the project action is proposed to be undertaken under one phase and is not part of a staged development or related to other actions or proposals in the region.

2.1.2 Description of areas adjacent to the study area

Cowies Creek runs through the north-east portion of the study area and provides high-quality potential breeding habitat for Growling Grass Frog along several sections of the creekline downstream.

Growling Grass Frog has previously been recorded within the Cowies Creek in 2020, with a count of 50 individuals observed (Ecology and Heritage Partners 2021). The results of the targeted surveys identified a population of the nationally listed Growling Grass Frog that occurred throughout Cowies Creek within the Western Geelong Growth Area (WGGA). Individuals were detected downstream of the study area within and adjacent to open pools along the Cowies Creek that support a high percentage cover of floating, submerged and fringing emergent vegetation, and comparatively higher water quality (Ecology and Heritage Partners 2021).

Five Growling Grass Frogs were recorded along Cowies Creek with a further 45 individuals recorded along the Creek approximately 500 metres east of the study area and approximately 1-2 kilometres east of the study area, respectively (Ecology and Heritage Partners 2021; Figure 5). Additionally, a large number of records (cluster of occupied sites) of the species was recorded in 2009/10 further east along Cowies Creek, outside of the WGGA (Biosis 2023) (Figure 5).

2.1.3 A description of all components and stages of the action

The study area is proposed for development of a residential estate. The development is proposed to be undertaken over one phase and include between 330 and 350 residential lots along several local access streets (A Different City 2024). A stormwater treatment facility is also proposed in the north of the study area to ensure stormwater runoff is treated before discharging into Cowies Creek. There is no proposed construction commencement date at this time given the timeline for PSP approval is not yet known.

The project action is not part of a staged development or related to other actions or proposals in the region.

Ongoing maintenance for the residential development would be typical to that of a residential area for City of Greater Geelong, and would extend to maintenance of roads, reserves, retarding basin, and all other public areas. All roads in the current development plan are earmarked to be council owned roads, with no private or strata managed roads proposed.

3 SPECIES AND COMMUNITIES GENERAL INFORMATION

The Preliminary Documentation must provide a general description of the environment affected by, and surrounding, the proposed action, in both the short and long term. Specific matters this section must address include, but are not limited to:

a) Provide a summary of the habitat assessment for listed threatened species and communities in the proposed action area and the project area that includes a summary of patches of buffer zones and species habitat, as described in Appendix C;

b) Identify and describe known historical records of the listed threatened species and ecological communities in the broader region. Records should be supported by an appropriate source (i.e., Commonwealth and State databases, published research, publicly available survey reports, etc.), the year of the record and a description of the habitat in which the record was identified;

c) Provide detailed mapping of suitable habitat within, adjacent to and downstream of the proposed action and project area for all listed threatened species and communities, which:

   - is specific to the habitat assessment undertaken for each listed threatened species and ecological community;
   - includes an overlay of the project disturbance footprint and the proposed action layout (from 1.4);
   - includes known records of individuals derived from the desktop analysis (from 2.1.1 and 2.1.2) and any additional field surveys; and,
   - is provided separately as attachments in PDF and Shapefile(s) (Appendix C).

d) Results of targeted surveys to confirm the presence, status and extent of listed threatened species and communities within the proposed action and project area, undertaken in accordance with the guidance outlined in the Species Profile and Threats Database, if applicable;

e) Include an assessment of the adequacy of any surveys undertaken (including survey effort and timing). In particular, the extent to which these surveys were appropriate for the listed species or community and undertaken in accordance with relevant departmental survey guidelines.

3.1 Response

3.1.1 Habitat Assessments

Growling Grass Frog habitat in the study area was initially assessed and targeted surveys undertaken in accordance with the *Significant impact guidelines for the vulnerable growling grass frog* (DEWHA 2009) during a site assessment undertaken on 17 January 2020 as part of the Existing Ecological Conditions assessment for the WGGA (Ecology and Heritage Partners 2021). The purpose of this assessment was to inform the Creamery Road Precinct Structure Plan to determine any MNES implications, and to determine the likely presence of significant flora and fauna species and/or ecological communities. An additional habitat and water quality assessment was undertaken on 7 November 2022 (Ecology and Heritage Partners 2023). Further targeted surveys for Growling Grass Frog were undertaken on 7 and 29 February and 6 March 2024 as well as habitat assessments for Victorian Grassland Earless Dragon *Tympanocryptis pinguicolla*, Blue-winged Parrot

Neophema chrysostoma and any other MNES in accordance with the relevant DCCEEW Species Profile and Threats Databases and approved conservation advice for each species (DCCEEW 2024a; 2023a; 2023b).

Growling Grass Frog habitat

Habitat assessment results showed poor water quality, with fringing vegetation largely comprising exotic grasses and some native sedges. Approximately 10-30% emergent vegetation was present, while over 80% fringing vegetation was recorded.

An additional detailed habitat assessment was undertaken on 2 November 2022 (Ecology and Heritage Partners 2023). During the site assessment, the quality and extent of suitable habitat described in the *Approved Conservation Advice* (DCCEEW 2024a) was documented, with the following habitat variables assessed:

- Quality of vegetation and presence of weeds;
- Aquatic vegetation cover (% cover of emergent, submergent and floating aquatic plants);
- Hydroperiod, water depth and water flow;
- Availability of refuge sites (e.g. rocks, logs)
- Proximity to other suitable habitat in the surrounds;
- Evidence of introduced predators; and
- Evidence of litter and/ or disturbance.

The study area supports low-quality Growling Grass Frog habitat due to the lack of key habitat features for the species described in the *Approved Conservation Advice* (DCCEEW 2024a), including floating and emergent vegetation, and structural fringing habitat such as rushes and grasses forming large tussocks (Plate 1-4). Fringing vegetation is present throughout Growling Grass Frog habitat in the study area and is typically in the form of *Juncas spp.* and exotic pasture grasses such as Toowoomba Canary-grass. There is minimal basking habitat (i.e. exposed rock) while this section of the creek does not contain floating or submerged vegetation (e.g. Floating Pondweed such as Sago Pondweed *Potamogeton pectinatus* which is an important habitat component required for calling males and a high predictor of site occupancy of the species; DCCEEW 2024a). There is also low-moderate percentage cover (<20%) of emergent vegetation.

During the habitat assessments, attributes of the land traversed on foot between sites was also noted for the presence (or otherwise) of suitable dispersal and/or foraging habitat described in the *Approved Conservation Advice* (DCCEEW 2024a). Results of the habitat and water quality assessment is provided below (Table 1).

Table 1. Percentage cover of aquatic vegetation type at survey sites

Aquatic Vegetation Type	Site Number			
	1	2	3	4
Emergent (%)	10	5	5	80
Floating (%)	0	0	0	0
Open water (%)	90	95	95	20
Fringing Aquatic Vegetation (%)	100	100	100	100

Water levels were deep and water quality was low (i.e. highly turbid) (Table 2). *In situ* water quality was collected at several sites along Cowies Creek at 200 Ballan Road, Moorabool.

Table 2. In situ water quality testing results.

Site	Date	Temp (°C)	Dissolved Oxygen (mg/L)	Total dissolved solids (g/L)	Electrical Conductivity (mS/cm)	pH (pH units)	Salinity
1	2 November 2022	12.61	6.34	0.211	0.307	8.3	0.2
2	2 November 2022	11.27	4.58	0.336	0.522	8.44	0.3
3	2 November 2022	11.37	5.55	0.328	0.328	8.32	0.2
4	2 November 2022	11.27	6.5	0.209	0.322	8.18	0.2

Species observed along this section of the creek within the study area were Eastern Common Froglet *Crinia signifera* Spotted Marsh Frog *Limnodynastes tasmaniensis* and Eastern Banjo Frog *Limnodynastes dumerilii*.

Areas adjacent to the creek comprised open pasture/ introduced grasses with a noticeable absence of terrestrial habitat such as logs and rocks (Plate 1-4). Considering the critical habitat requirements of the species (DCCEEW 2024a), the study area is not likely to be occupied by Growling Grass Frog for breeding and given the absence of offstream waterbodies (e.g. large farm dams), frogs are unlikely to disperse through terrestrial habitat (e.g. pasture and cropped land) across the study area from existing populations along the creekline. Overall, the study area lacks suitable breeding and provides low quality dispersal habitat for the species.

Plate 1. High-quality ephemeral pool approximately 1-2 kilometres east of 200 Ballan Road where the species was previously detected (Ecology and Heritage Partners Pty Ltd 17/1/2020).

Plate 2. North-eastern section of Cowies Creek, 200 Ballan Road, highly turbid instream habitat (Ecology and Heritage Partners Pty Ltd 2/11/2022).

Plate 3. High biomass adjacent to the Creek within the study in fringing vegetation at 200 Ballan Road (Ecology and Heritage Partners Pty Ltd 2/11/2022).

Plate 4. Absence of emergent and floating vegetation, with open pasture and introduced grasses in areas adjacent to the creek (Ecology and Heritage Partners Pty Ltd 2/11/2022).

No suitable habitat is present within the study area for Victorian Grassland Earless Dragon (VGED), Blue-winged Parrot and other MNES with reference to the relevant DCCEEW Species Profile and Threats Databases for each species.

In accordance with the *Approved Conservation Advice for Tympanocryptis pinguicolla (Victorian grassland earless dragon;* DCCEEW 2023a), the following landscape features present in the Cowies Creek corridor were indicative of unsuitable habitat for VGED (Plate 6; Figure 6):

- Little to no cover of native vegetation (>20%);
- Little to no surface rock;
- High biomass;
- Little to no cover of bare ground (<2%);
- High pasture grass and other weed cover; and,
- No evidence of spider burrows.

Plate 6. High biomass adjacent within the Cowies Creek corridor at 200 Ballan Road (Ecology and Heritage Partners Pty Ltd 23/02/2024).

Plate 5. Evidence of historical ploughing across the study area (Ecology and Heritage Partners Pty Ltd accessed 07/11/2024).

In areas beyond the Cowies Creek corridor within the study area, evidence of historical ploughing and cropping was present throughout much of the surrounding land (Plate 6; Figure 6). Areas in proximity to the existing residence within the study area were characterised by ornamental gardens and highly modified landscapes not suitable for VGED as indicated by the Approved Conservation Advice for Tympanocryptis pinguicolla (Victorian grassland earless dragon (DCCEEW 2023a).

In accordance with the *Approved Conservation Advice for Neophema chrysostoma (blue-winged parrot;* DCCEEW 2023b), the following habitat features present in the study area were indicative of minimal to no critical Blue-winged Parrot habitat:

- No evidence of trees or stumps with hollows;
- High fragmentation and degradation of remnant grassy woodland patches;
- Little to no cover of native herbs, grasses and shrubs (>20%);
- High pasture grass and other weed cover; and,
- Evidence of historical land disturbance.

While no evidence of potential critical breeding habitat (i.e. trees or stumps with hollows) for Blue-winged Parrot was present in the study area, low quality foraging habitat (i.e. native and introduced grasses, shrubs in the riparian area) may be used by the species opportunistically on occasion (i.e. flyover) when moving between areas of higher quality habitat (e.g. Western Treatment Plant, Lake Connewarre; DCCEEW 2023b).Based on the habitat assessment findings, targeted surveys are not recommended for other MNES.

3.1.2 Desktop Assessment

There are four nationally significant (i.e. under the EPBC Act) and 16 State significant (i.e. under the FFG Act) flora species records previously recorded within 10 kilometres of the study area (DEECA 2024d) (Figure 3). The PMST nominated an additional 15 nationally significant species which have not been previously recorded but have the potential to occur in the locality (DCCEEW 2024b).

There are 34 nationally significant (i.e. under the EPBC Act) and 37 State significant (i.e. under the FFG Act) fauna species records previously recorded within 10 kilometres of the study area (DEECA 2024d) (Figure 4). The PMST nominated an additional 42 nationally significant species which have not been previously recorded but have the potential to occur in the locality (DCCEEW 2024b).

Although there are several records of the EPBC Act listed Adamson's Blown-grass *Lachnagrostis adamsonii* (Status: Endangered) within the study area, the species was last recorded in 2002 and was not detected during recent targeted survey effort within the study area (Ecology and Heritage Partners 2021). Given the failure to detect this species during recent surveys, and its preferred habitat along creekline environments (Murphy 2010), it is unlikely that Adamson's Blown-grass will be impacted by the proposed works that are due to occur outside preferred habitat for the species.

There are records of Latham's Snipe *Gallinago hardwickii* (Status: Vulnerable) along Cowies Creek, downstream from the study area. While the study area contains some suitable habitat characteristics for the species (e.g. reed bed fringing vegetation; DCCEEW 2024c), the species is highly unlikely to be impacted with its potential presence limited to Cowies Creek and vegetated embankments.

Growling Grass Frog was recorded on eight occasions downstream along Cowies Creek in the past 15 years. Growling Grass Frog occupation of the study area is expanded on below (Section 3.1.3).

Six nationally listed ecological communities are predicted to occur within 10 kilometres of the study area (DCCEEW 2024):

- Grassy Eucalypt Woodland of the Victorian Volcanic Plain;
- Subtropical and Temperate Coastal Saltmarsh;
- Natural Damp Grassland of the Victorian Coastal Plains;
- Natural Temperate Grassland of the Victorian Volcanic Plain;
- Seasonal Herbaceous Wetlands (Freshwater) of the Temperate Lowland Plains;
- White Box – Yellow Box – Blakely's Red Gum Grassy Woodland and Derived Native Grassland

Given the largely modified condition of native vegetation mapped within the study area, the presence of any significant ecological communities is highly unlikely.

3.1.3 Targeted Surveys for MNES

Growling Grass Frog

Growling Grass Frog targeted surveys were undertaken in accordance with the prescribed methods outlined in the *Significant Impact Guidelines for the Vulnerable Growling Grass Frog (Litoria raniformis)* EPBC Act Policy Statement 3.14 (DEWHA 2009) and the Survey Guidelines for Australia's Threatened Frogs (DEWHA 2010).

Growling Grass Frog habitat in the study area was initially assessed and targeted surveys undertaken during a site assessment undertaken on 17 January 2020 as part of the Existing Ecological Conditions assessment for the WGGA (Ecology and Heritage Partners 2021). The purpose of this assessment was to inform the Creamery Road Precinct Structure Plan to determine any MNES implications, and to determine the likely presence of significant flora and fauna species and/or ecological communities. Further targeted surveys for Growling Grass Frog were undertaken on 7 and 29 February and 6 March 2024.

Three nights of surveys (7, 29 February and 7 March 2024) took place during the species' active season (October - March), in weather conditions considered optimal for detection (i.e. warm and humid, overnight temperature not less than 14°C, preferably post rain; DEWHA 2009) and when the species was known to be active elsewhere in the region (Table 3).

Based on the survey protocols to be adhered to for this study, this would achieve a probability detection threshold of 0.99 as per the probability thresholds specified by DEECA (Heard *et al*. 2010).

The survey effort involved spotlighting surveys, call identification, and active searching for adults and metamorphs (DEWHA 2010). Each survey consisted of:

- Two qualified zoologists, experienced in Growling Grass Frog detection, systematically walked along (or around) each watercourse (or waterbody);
- An initial period of five minutes was spent listening to any calling frogs (all species) in and adjacent to habitats;
- The advertisement call was broadcast to elicit a response from any adult males present;
- Surveyors used "Olight" LED hand-held spotlights (up to 1020 lumens/8.4 volts) to locate any calling males on floating vegetation in the waterbody and around the perimeter of waterbodies;
- Surveyors actively searched ground-level habitat including surface rocks, underneath hard litter, and at the base of vegetation for frogs; and,
- Surveyors used the resulting information to determine the significance of any recorded Growling Grass Frog populations.

Growling Grass Frog were also confirmed to be calling at known reference sites prior to undertaking surveys (i.e. Western Treatment Plant).

Table 3. Summary of Growling Grass Frog survey results

Weather conditions									
Survey Date	Survey Time	Survey Temp C°	Wind direction	Wind speed (km/hr)	Relative Humidity (%)	Cloud Cover (%)	Rain	GGF (No.)	Other Species
7/02/2024	20:45 – 23:16	16.6	S	5.4	68.4	5	0 mm	1	Spotted Marsh Frog
29/02/2024	20:47 – 22:27	18.1	SE	4	70	20	0 mm	2	-
6/03/2024	20:40 – 23:15	18	S	22.2	79	95	0 mm	1	-

Growling Grass Frog was not recorded in the study area during initial targeted surveys in 2020. Two Growling Grass Frog specimens were recorded within the study area during targeted surveys in 2024. On 7 February 2024, one Growling Grass Frog individual was heard calling on the eastern extent of the site but was not visually observed. On 29 February 2024 two adult Growling Grass Frog individuals were visually observed in fringing vegetation along the creekline. A further Growling Grass Frog individual was recorded on the southern edge of the creekline on 6 March 2024 (Figure 2).

Based on the findings of detailed survey and habitat assessments in consideration of the critical habitat requirements of the species, the study area supports low-quality Growling Grass Frog foraging habitat, currently provides a dispersal corridor for a local Growling Grass Frog population and is unlikely to provide breeding habitat for the species (DCCEEW 2024a). Areas adjacent to the creekline are dominated by open paddocks subject to historical cropping, containing pasture/introduced grasses, and which do not provide habitat for the species (DCCEEW 2024a).

The presence of nearby records within the Cowies Creek area downstream makes it likely that the species would occasionally visit or at least use the study area as a foraging habitat between additional areas of higher quality habitat in Cowies Creek.

Other Matters of National Environmental Significance

No other MNES were recorded within the study area nor was suitable habitat identified in accordance with the relevant DCCEEW Species Profile and Threats Database. Based on the habitat assessment findings, targeted surveys are not recommended for other MNES.

3.1.4 Adequacy of Surveys

Targeted surveys for Growling Grass Frog were undertaken during optimal seasons for the identification of the targeted fauna species in accordance with the prescribed methodology outlined in the *Significant Impact Guidelines for the Vulnerable Growling Grass Frog (Litoria raniformis)* (DEWHA 2009). It is considered that the survey effort, timing and results presented meet the objectives of the surveys and provide sufficient information to support the approvals processes. Known reference sites were checked prior to the commencement of surveys to confirm that the species was calling on survey days.

Habitat assessments for Victorian Grassland Earless Dragon and Blue-winged Parrot were undertaken during late summer and early autumn, which is a suitable time of year for identifying seasonal key habitat attributes outlined in the respective *Conservation Advice* for the species (DCCEEW 2023a, b), including the presence of spider burrows and biomass cover.

3.1.5 Other Resources

Relevant literature, online-resources and databases were reviewed to provide an assessment of flora and fauna values associated with the study area. The following information sources were reviewed:

- The DEECA NatureKit Map (DEECA 2024c) and Native Vegetation Regulation Map (DEECA 2024d) for:
    - Modelled data for location risk, native vegetation patches, scattered trees and habitat for rare or threatened species; and,
    - The extent of historic and current Ecological Vegetation Classes (EVCs).
- EVC benchmarks (DEECA 2024e) for descriptions of EVCs within the relevant bioregion;
- The Victorian Biodiversity Atlas (VBA) for previously documented flora and fauna records within the project locality (DEECA 2024a);
- The Commonwealth Department of Climate Change, Energy, the Environment and Water (DCCEEW) Protected Matters Search Tool (PMST) for matters of National Environmental Significance (NES) protected under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) (DCCEEW 2024);

- Relevant listings under the Victorian *Flora and Fauna Guarantee Act 1988* (FFG Act), including the latest Threatened (DEECA 2024b) and Protected (DELWP 2019) Lists;
- The online VicPlan Map (DTP 2024) to ascertain current zoning and environmental overlays in the study area;
- Aerial photography of the study area;
- Previous ecological assessments relevant to the study area, including:
    - Conservation Management Plan: Growling Grass Frog *Litoria raniformis major* for the Proposed Development at 200 Geelong-Ballan Road, Moorabool, Victoria. Ecology and Heritage Partners 2023
    - Existing Ecological Conditions: Northern and Western Geelong Growth Areas, Victoria. Ecology and Heritage Partners 2021.
    - Growling Grass Frog Conservation Management Plan: Draft Report. Prepared for the City of Greater Geelong. 10 November 2023. Biosis 2023.

4 SPECIES SPECIFIC INFORMATION

The preliminary documentation must address the following matters in addition to the general information listed above:

a) Results from targeted surveys to confirm the status and extent of Growling Grass Frog (GGF) within, adjacent to, downstream and upstream of the proposed action and the project area, undertaken in accordance with the survey guidelines outlined in the Significant impact guidelines for the vulnerable growling grass frog.

b) The total area and quality of habitat to be impacted in hectares with details on whether any impacts are likely to be unknown, unpredictable or irreversible and the science informing these areas and impacts;

c) Provide the scientific reasoning for how the extent of known and unknown potential habitat for the GGF were derived;

d) An assessment of the adequacy of any surveys undertaken (including survey effort, timing and accordance with Department of Climate Change, Energy, Environment and Water's relevant scientific and policy guidance);

e) An assessment of the landscape context of species habitat including connectivity for patches of species habitat, including their habitat quality and approximate size of the Growling Grass Frog population.

f) Provide mapping which includes an overlay of the project footprint and known records of Blue-Winged Parrot individuals derived from desktop analysis and field surveys;

g) A discussion of all foraging and staging habitat characteristics including defined mapping of foraging and staging habitat within the proposed action area and surrounding the project area;

h) Provide the scientific reasoning for how the extent of known and unknown potential habitat for the Blue-Winged Parrot were derived;

i) Assessment of all of the habitat's specific features available in the proposed action area as per the habitat described in the *Approved Conservation Advice for Tympanocryptis pinguicolla* (Victorian grassland earless dragon); and,

j) Provide the scientific reasoning for how the extent of known and unknown potential habitat for the Victorian grassland earless dragon were derived.

4.1 Response

4.1.1 Impacts

The proposed action is unlikely to have a significant impact on any EPBC Act listed species. Potential direct impacts associated with the proposed residential development include changes in the hydrology of Cowies Creek, the deterioration of water quality, noise and lighting impacts. Potential indirect impacts associated with the proposed residential development include the introduction and spread of chytrid fungus, human access, and spread of weeds and pests. The prevention and/ or management of these impacts is outlined in the Growling Grass Frog Conservation Management Plan (Appendix 1). Potential impacts relate to 2.6 hectares of Growling Grass Frog habitat and up to four individuals recorded within the study area.

In order to reduce the potential for further unknown, unpredictable and/or irreversible impacts, Growling Grass Frog habitat within the study area is proposed to be enhanced via planting of suitable aquatic vegetation species, provision of rock mattresses and/or loose rock, and weed and pest animal control.

To ensure any potential impacts are recorded and appropriately managed, monitoring of the Cowies Creek corridor within the study area, including enhanced habitats, will be undertaken every six months for the first two years during the development and annually for the first five years during enhancement of the Growling Grass Frog habitat corridor.

4.1.2 Landscape Context and Growling Grass Frog

Targeted surveys and habitat assessments were undertaken for Growling Grass Frog along the broader extent of Cowies Creek in 2019 and 2020 as part of works on the Geelong Growth Areas assessments (Ecology and Heritage Partners 2021). Further targeted surveys for Growling Grass Frog were undertaken on 7 and 29 February and 6 March 2024.

An initial site walkover was undertaken to by a qualified zoologist on the 13 and 14 November 2019 to identify potential suitable habitat at accessible properties within the Cowies Creek corridor within, and downstream of the study area. Targeted surveys of these areas along Cowies Creek were undertaken on two occasions (6 December 2019 and 12 January 2020). Specifically, targeted surveys including call playback, and active searching focussed on the entirety of Cowies Creek within the Creamery Road PSP. Detailed habitat assessments were undertaken concurrently with the targeted surveys to further assess the suitability of habitats within the corridor.

Approximately 35 Growling Grass Frog were recorded calling within the Cowies Creek corridor on 6 December 2019 and five individuals were observed further north while spotlighting on 12 January 2020 with several additional specimens (approximately 10) heard via call-playback (Figure 5). An individual was also incidentally captured in a fyke net within this stretch of Cowies Creek (Plate 9).

Sites occupied by Growling Grass Frog during the 2019/20 surveys supported a high cover of fringing native plant species (i.e. sedges and grasses), together with exotic pasture and weed species (e.g. Toowoomba Canary grass, Chilean-Needle grass and African Boxthorn), and low to moderate cover of aquatic vegetation (i.e. submerged, emergent and floating vegetation). Male Growling Grass Frogs were observed using floating 'algal mats' within the waterbody.

A summary of weather conditions and the results of the habitat assessment are provided below (Table 4 and Table 5 respectively) (Ecology and Heritage Partners 2021).

Table 4. Growling Grass Frog Survey Weather Conditions.

Survey/ Date	Weather conditions						Species
	Survey Temp C°	Wind direction	Wind speed (km/hr)	Relative Humidity (%)	Cloud Cover (%)	Rain	
Cowies Creek							
06/12/2019	14.2	W	19	78	0	0	Growling Grass Frog (approx. 35), Common Eastern Froglet. Recorded approx. 1km SE of study area

Survey/ Date	Weather conditions						Species
	Survey Temp C°	Wind direction	Wind speed (km/hr)	Relative Humidity (%)	Cloud Cover (%)	Rain	
15/01/2020	18.5	SSE	20	94	0	0	Growling Grass Frog (approx. 15), Common Eastern Froglet. Recorded approx. 1km SE of study area

Note: Weather data taken from Bureau of Meteorology

Table 5. Habitat Assessment for Growling Grass Frog.

Hydroperiod	Instream Pools	Offstream Waterbodies	Habitat Quality	Terrestrial habitat adjacent to waterbody	Aquatic Veg % Cover
Cowies Creek					
Known Habitat					
3	Present	N/A	High	Exotic vegetation, some native sedges	80%-100% fringing, 10%-30% emergent, algal mats present
Potential Habitat					
3	Present	N/A	Low (poor water quality)	Exotic vegetation, some native sedges	80%-100% fringing, 10%-30% emergent.

Plate 7. 100 % fringing vegetation coverage by natives (Ecology and Heritage Partners Pty Ltd 16/01/2019).

Plate 8. Growling Grass Frog habitat within the WGGA (Ecology and Heritage Partners Pty Ltd 16/01/2019

Plate 9. Mature Growling Grass Frog caught within the WGGA (Ecology and Heritage Partners Pty Ltd 29/01/2019).

Two Growling Grass Frog individuals were recorded within the study area on any one survey night during targeted surveys in 2024 (Table 6). On 7 February 2024, one Growling Grass Frog individual was heard calling on the eastern extent of the site but was not visually observed. On 29 February 2024 two adult Growling Grass Frog individuals were visually observed in fringing vegetation along the creekline. A further Growling Grass Frog individual was recorded on the southern edge of the creekline on 6 March 2024 (Figure 2).

Table 6. Summary of Growling Grass Frog survey results.

Survey Date	Survey Time	Weather conditions							Other Species
		Survey Temp C°	Wind direction	Wind speed (km/hr)	Relative Humidity (%)	Cloud Cover (%)	Rain	GGF (No.)	
7/02/2024	20:45 – 23:16	16.6	S	5.4	68.4	5	0 mm	1	Spotted Marsh Frog
29/02/2024	20:47 – 22:27	18.1	SE	4	70	20	0 mm	2	-

Survey Date	Survey Time	Weather conditions							Other Species
		Survey Temp C°	Wind direction	Wind speed (km/hr)	Relative Humidity (%)	Cloud Cover (%)	Rain	GGF (No.)	
6/03/2024	20:40 – 23:15	18	S	22.2	79	95	0 mm	1	-

Growling Grass Frog recorded within the study area during 2024 surveys are likely to be part of the broader Cowies Creek population recorded during the 2019-20 targeted surveys for the species. Growling Grass Frog habitat within the study area is limited to low-quality Growling Grass Frog foraging habitat and dispersal corridor along Cowies Creek in-stream habitat and Creekline Grassy Woodland native vegetation and pasture grasses along the creek's banks. The low cover of emergent and floating vegetation, as well as a lack of exposed rock mattresses, suggests the study area is unlikely to provide breeding habitat for the species. Growling Grass Frog recorded within the study area are likely to have dispersed along the Cowies Creek corridor and used higher quality areas of habitat downstream (e.g. in-stream pools containing emergent and floating vegetation) for breeding purposes.

4.1.3 Adequacy of Surveys

Targeted surveys for Growling Grass Frog were undertaken during optimal seasons for the identification of the targeted fauna species. It is considered that the survey effort, timing and results presented meet the objectives of the surveys and provide sufficient information to support the approvals processes. Known reference sites were checked prior to the commencement of surveys to confirm that the species was calling on survey days.

Growling Grass Frog Surveys were undertaken in accordance with the methods outlined in the *Significant Impact Guidelines for the Vulnerable Growling Grass Frog* (DEWHA 2009). Three nights of surveys (7, 29 February and 7 March 2024) took place during the species' active season (October - March), in weather conditions considered optimal for detection (i.e. warm and humid, overnight temperature not less than 14°C, preferably post rain) and when the species was known to be active elsewhere in the region (Table 4). The surveys were conducted with reference to the prescribed methodology detailed in the Significant Impact Guidelines for the Vulnerable Growling Grass Frog (*Litoria raniformis*) EPBC Act Policy Statement 3.14 (DEWHA 2009), and the Survey Guidelines for Australia's Threatened Frogs (DEWHA 2009).

Growling Grass Frog habitat within the study area is limited to low-quality Growling Grass Frog foraging habitat and dispersal corridor along Cowies Creek in-stream habitat and Creekline Grassy Woodland native vegetation and pasture grasses along the creek's banks. The low cover of emergent and floating vegetation, as well as a lack of exposed rock mattresses, suggests the study area is unlikely to provide breeding habitat for the species. Areas adjacent to the creekline within the study area are dominated by open paddocks subject to historical cropping, containing pasture/introduced grasses. Given there are no other waterbodies including dams within the study area, it is unlikely the species would occupy these historically cropped areas. Moreover, the extent of Growling Grass Frog habitat within the study area and the area that received targeted surveys is limited to the creekline and immediate surrounds and is bounded by historically cropped areas to the north and south.

Habitat assessments for Victorian Grassland Earless Dragon and Blue-winged Parrot were undertaken during late summer and early autumn, which is a suitable time of year for identifying seasonal key habitat attributes for these species, including the presence of spider burrows and biomass cover.

In relation to VGED, the following landscape features discussed in the *Approved Conservation Advice for Tympanocryptis pinguicolla* (Victorian grassland earless dragon) were assessed in determining suitability of habitat for the species (DCCEEW 2023a):

- Cover of native vegetation (>20%);
- Presence of surface rock;
- Biomass;
- Cover of bare ground (<2%);
- Pasture grass and other weed cover;
- Evidence of spider burrows; and,
- Evidence of historical ploughing / cropping.

In relation to Blue-winged Parrot, evidence of potential breeding habitat (i.e. tree hollows, stumps) and foraging habitat (i.e. native and introduced grasses, shrubs in the riparian area) discussed in the *Approved Conservation Advice for Neophema chrysostoma* (Blue-winged Parrot) was assessed (DCCEEW 2023b). The proximity of larger areas of higher quality habitat (e.g. Western Treatment Plant, Lake Connewarre) was considered during the assessment.

5 RELEVANT IMPACTS

The proposed action is considered likely to have impacts to threatened species and communities (section 18 and section 18a) The preliminary documentation must include an assessment of direct, indirect, and consequential impacts as a result of the proposed action and must be assessed in accordance with relevant departmental policies and guidelines, including the SPRAT Database.

Consideration of impacts include direct, indirect, and facilitated impacts, occurring as a result of the action, including consideration of the nature, likelihood, and severity of the impacts.

The department considers the proposed action may result in, but is not limited to, the following impacts:

- Decrease in habitat quality or quantity;
- A loss of connectivity for an important population of Growling Grass Frog;
- Result in significant changes to the flow and quality of water in Cowies Creek.

For listed threatened species and communities this must include, but not be limited to:

a) An assessment of the likely impacts associated with the changes in water quality and/or water volume and flow in the Cowies Creek catchment, including known or unknown associated tributaries, drainage lines and semi-permanent or ephemeral waterbodies. The assessment must include the impacts to the landscape scale species habitat and associated buffer zones and how the impacts of the proposed action would be amplified as a result of other similar actions within the Creamery Road Precinct;

b) Include the direct and indirect loss and/or disturbance of MNES individuals and habitat as a result of the proposed action. This must include the quality of the habitat impacted and quantification of the individuals and habitat area (in hectares) to be impacted;

c) An assessment of the impacts of habitat fragmentation in the proposed action area and surrounding areas, including consideration of species' movement patterns. Include consideration of the landscape context, including connectivity with other patches of habitat and information on the long-term viability of local populations if the proposed action was to proceed;

d) An assessment of the likely duration of impacts to MNES as a result of the proposed action;

e) A discussion of whether the impacts are likely to be repeated, for example as part of maintenance;

f) A discussion of whether any impacts are likely to be unknown, unpredictable or irreversible;

g) Justification, with supporting evidence, how the proposed action will not be inconsistent with relevant conservation advice, recovery plans or threat abatement plans.

5.1 Response

5.1.1 Cowies Creek

The study area includes a section of Cowies Creek, which runs across the north-eastern corner of the property between Warners Road and Evans Road. Cowies Creek begins at Anakie to the north of the study area and flows into Corio Bay, with the entire creekline running for approximately 11 kilometres. The section of creek within and immediately adjacent to the study area contains some steep banks interspersed with undulating and low-lying floodplain areas. A rail corridor exists along the northern boundary of the study area and

intersects the Cowies Creek, while Evans Road to the east also intersects the creek. Although Growling Grass Frog is known to traverse roads and open areas to access more suitable habitat, both the rail corridor and Evans Road present a potential barrier for Growling Grass Frog dispersal. Instream habitat is varied and comprises sections of faster flowing water with limited aquatic vegetation as well as wider, slow moving sections featuring instream pools and floating and emergent vegetation favourable to Growling Grass Frog breeding. This habitat is proposed to be supplemented by six wetlands outlined in the broader draft Cowies Creek Growling Grass Frog Conservation Management Plan (Biosis 2023).

Growling Grass Frog was recorded on eight occasions adjacent to the study area along Cowies Creek within the past 15 years, including four records (2020) approximately one kilometre south of the study area and four further records two kilometres south of the study area. The degraded condition of habitats within much of the study area makes it unlikely that that any further nationally significant species would rely on habitat within the study area for foraging or breeding purposes.

In relation to stormwater impacts, stormwater associated with the proposed development will ultimately flow into Cowies Creek following water treatment via the stormwater wetland within the study area. This is not expected to directly or indirectly significantly impact the hydrology of Cowies Creek as there is not anticipated to be any long-term change in maximum flow rates along the creekline following completion of the proposed action (Rain Consulting 2024). The volume of runoff created development in the study area in post-construction will likely be of greater volume and velocity than existing runoff under current conditions due to increase in impervious area such as rooftops and road surfaces. While water flow volume in Cowies Creek is expected to increase due to the proposed development, flow rates from the development will contribute to a maximum 1.75% of the peak 1% AEP flow in Cowies Creek, with the more likely scenario being no change in peak flow rate following construction of the stormwater wetland facility (Rain Consulting 2024).

Stormwater runoff relating to the proposed action and future development associated with the Creamery Road Precinct Structure Plan (PSP) is modelled based on the requirement for retardation of any excess stormwater in developed conditions. In this context, while overall volumes of flow will increase from the proposed action and post-PSP development, the peak flow rate during a flood event is modelled to be the same as for current conditions for the peak 1% AEP flow in Cowies Creek, including downstream of the PSP development. It can be assumed that this retardation will occur as routine for development along the Cowies Creek corridor (Rain Consulting 2024).

The stormwater treatment pond will decrease the velocity of the water moving through the corridor and allow suspended particles to settle out of suspension or adhere to vegetation, and nutrients will be biologically absorbed by the macrophytes. Stormwater will be initially treated within a primary stormwater wetland facility before discharging into the Growling Grass Frog habitat corridor. This is not considered to be a significant threat to existing Growling Grass Frog habitat as the proposed stormwater pond is modelled to largely mitigate any increased runoff due to the construction of impervious areas.

To further mitigate against any hydrological impacts to Cowies Creek, a non-construction buffer of 50 metres will be applied from the outer edge of aquatic habitat for the species along Cowies Creek. A number of additional measures designed to prevent construction impacts to the Cowies Creek corridor are also proposed as part of the proposed action (Section 6) and will be addressed in comprehensive Construction Environmental Management Plan for the site. These will cover mitigation measures such as, but not limited to erosion, sedimentation, plant disease, and pest plant spread, with specific mitigation measures proposed for all potential impacts.

The proposed action is not likely to result in any invasive species that are harmful to the ecological character of the creekline being established (or an existing invasive species being spread). The proposed action broadly aligns with the management actions of the draft Cowies Creek Growling Grass Frog Conservation Management Plan (Biosis 2023). No native vegetation patches or Growling Grass Frog habitat is proposed to be removed as part of the proposed action and therefore no habitat fragmentation will occur.

It is not possible to assess the proposed action and likely impacts against the provisions to be outlined in the forthcoming Creamery Road PSP as the PSP is yet to be finalised and is not yet accessible. However, discussions with City of Greater Geelong Council have indicated that the proposed action is broadly in line with the regulatory standards to be scheduled within the PSP as well as the accepted environmental and landscape impacts provided therein. Engagement to date with City of Greater Geelong Council involved an in-person meeting in June 2024.In summary, the proposed action is unlikely to have any significant direct and/or indirect impacts on MNES within the Cowies Creek habitat corridor.

5.1.2 Direct Impacts

The proposed action is unlikely to have a significant impact on any EPBC Act listed species after proposed mitigation measures are implemented.

According to the Significant Impact Guidelines for Growling Grass Frog, any viable population is considered an important population (DEWHA 2009). A viable population is one which is not isolated from other populations or water bodies, such that it has the opportunity to interact with other nearby populations or has the ability to establish new populations when water bodies fill and become available. Interaction with nearby populations and colonisation of newly available water bodies occurs via the dispersal of individual frogs across suitable movement habitat. Removal or alteration of available terrestrial or aquatic habitat corridors (including alteration of connectivity during flood events) for an important population is likely to mean a significant impact to the species.

Taking into consideration the known distribution of the species within Cowies Creek, the distribution of key habitat attributes along the waterway and the potential for the species to occupy habitat along the waterway, Cowies Creek is considered to support an important population of the species, as described in the significant impact guidelines for the species and acts as an important habitat corridor throughout the region (Ecology and Heritage Partners 2021). Given the confirmed presence of a population that uses habitat within the study area, the proposed action may have direct and indirect impacts (i.e. reduction in water quality entering the creek from the proposed development – see below) to Growling Grass Frog habitat. Potential direct impacts associated with the proposed residential development include changes in the hydrology of Cowies Creek, the deterioration of water quality, noise and lighting impacts. The prevention and/ or management of these direct impacts is outlined in the Growling Grass Frog Conservation Management Plan (Appendix 1). Potential direct impacts relate to 2.6 hectares of Growling Grass Frog habitat and up to four individuals recorded within the study area. These impacts would result from construction activities, and impacts resulting from the replacement of open paddocks with residential development.

Hydrology and Water Quality

Based on known information of water quality tolerances and preferences by Growling Grass Frog it appears that the species requires waterbodies containing low levels of nitrates, nitrides and phosphates (Ashworth 1998; Organ 2002, 2003). Water quality may be particularly important for larval development and recruitment. Studies have shown conflicting findings on the relationship between basic water quality

parameters and wetland occupancy (Heard *et al*. 2008). For example, Wassens (2005) found a preference for wetlands with a relatively low pH, whereas Hamer and Organ (2008) found the opposite to be the case. Similar discrepancies have been found with conductivity (Heard *et al*. 2008), and this relationship is also confounded by the fact that conductivity may affect the prevalence of Chytrid fungus. Efforts to control basic water quality parameters for Growling Grass Frog may be unnecessary; however, conductivity should not increase beyond the approximate limit for the species of 10000 µS/cm (Heard *et al*. 2008). Modelling for changes in conductivity due to the proposed action could not be undertaken however based on current water quality readings (Section 3.1.1) it is highly unlikely this threshold will be reached under a development scenario.

Stormwater flow and discharge from the surrounding area will be directed toward the proposed stormwater wetland facility before discharging into Cowies Creek. There is also the potential for accidental spillage of chemicals from the construction area to runoff into the creekline. Increase in sediment input and input of toxic substances into Victorian rivers and streams due to human activities are both threatening processes under Schedule 3 of the FFG Act. The volume of runoff created development in the study area in post-construction will likely be of greater volume and velocity than existing runoff under current conditions, the most likely scenario is no change in peak flow rates following construction of the stormwater wetland facility.

Stormwater runoff relating to the proposed action and future development associated with the Creamery Road Precinct Structure Plan (PSP) is modelled based on the requirement for retardation of any excess stormwater in developed conditions. In this context, while overall volumes of flow will increase from the proposed action and post-PSP development, the peak flow rate during a flood event is modelled to be the same as for current conditions for the peak 1% AEP flow in Cowies Creek, including downstream. It can be assumed that this retardation will occur as routine for development along the Cowies Creek corridor (Rain Consulting 2024). Growling Grass Frog breeding habitat is vulnerable to faster and higher peak flows, which may wash away floating and emergent vegetation critical to the protection of tadpoles, eggs, and the facilitation of male calling activity. The scenario modelled under the proposed action does not indicate higher peak flows downstream associated with the proposed action or under a cumulative impact scenario post-PSP development. Therefore, hydrological impacts to Growling Grass Frog due to the proposed action are not anticipated to be significant once mitigation measures such as stormwater treatment are implemented.

A number of additional mitigation measures designed to prevent construction impacts to Cowies Creek are also proposed as part of the proposed action are addressed in the Conservation Management Plan and are to be further addressed in comprehensive Construction Environmental Management Plan (forthcoming).

Noise

The Growling Grass Frog population in Cowies Creek habitat corridor may be affected by potential noise impacts, however, this is likely to be minor given the large buffer (minimum 50 metres) between the residential development area and the outer edge of aquatic habitat for the species along Cowies Creek. This buffer is considered to provide sufficient protection for frogs from noise pollution created by construction activities. Nonetheless, noise from building and other works relating to the development will comply with the Building works – Local Law requirements (Greater Geelong City Council 2014), and Section 3(1)(a) of the *Environment Protection Act 2017* (the Act) and the Environment Protection Regulations 2021 (the Regulations)(EPA 2021), where building or other works may not emit excessive or offensive noise.

Works can only be carried out on any land between the hours 7.00 am and 6.00 pm on weekdays, 9.00 am and 6.00 pm on Saturdays, Sundays and public holidays. Restricting noise created by building works will allow

males to call to attract a mate, and thus the noise associated with construction and the future use of the area (i.e. commercial use) is unlikely to reduce breeding success by the species.

Light Pollution

Growling Grass Frog are a predominantly nocturnal species. Artificial light pollution may increase the risk of predation of Growling Grass Frog by foxes and cats and may also disrupt mating activities of the species. As such, sources of artificial light from the surrounding residential development will be directed away from the existing and proposed constructed habitat. There will be no additional lighting directed towards the existing habitat, to allow frogs to move along the corridor undisturbed, and to avoid any negative impact caused by artificial light pollution. Overall, there are likely to be no significant impacts related to noise and light pollution associated with the project during and post-construction once mitigation measures are considered.

No direct or indirect impacts will occur to any other MNES.

5.1.3 Indirect Impacts

Potential indirect impacts associated with the proposed residential development include the introduction and spread of chytrid fungus, human access, and spreads of weeds and pests. The prevention and/ or management of these indirect impacts is outlined in the Growling Grass Frog Conservation Management Plan (Appendix 1). Potential indirect impacts relate to 2.6 hectares of Growling Grass Frog habitat and up to four individuals recorded within the study area.

Chytrid fungus

There is evidence to suggest that the decline of many frog species in Australia and elsewhere could be related to the disease caused by the water-borne fungal pathogen *Batrachochutrium dendrobatidis*, commonly referred to as Chytrid fungus. Chytrid fungus is a major threat to amphibian populations in Australia, with at least one species driven to extinction and populations of other threatened species, particularly the Growling Grass Frog, severely compromised (DEWHA 2006). The disease that results from Chytrid fungus infection causes significant physical and physiological problems for frogs, such as skin flaking, reduced food intake, cardiac arrest and mortality (Peterson *et al*. 2013). Infection of amphibians with the fungus is listed as a 'key threatening process' under the EPBC Act.

There is an inherent risk of spreading the fungus within and between areas in the landscape by the movement of infected frogs and tadpoles, water, soil and vegetative material; the outcome of which can be extremely deleterious if it is introduced into Growling Grass Frog populations presently free of the disease. Chytrid prevalence has found to be decreased in wetlands with elevated salinity levels and higher temperatures (Heard *et al.* 2012). The risk for Chytrid fungus will be mitigated through the implementation of disease control measures contained in the Conservation Management Plan and in accordance with Hygiene Protocols for the Control of Diseases in Australian Frogs (Murray *et.al.* 2011).

Human Access

Human occupancy within the study area has the potential to result in disturbance by persons entering the existing and proposed species habitat. This may lead to the degradation of habitat in or around the waterbody due to rubbish dumping, mechanical disturbance of vegetation from trampling, and weed invasion.

The placement of walking and/or bicycle paths and trails will be prohibited within the 'no impact' buffer zone within the existing Growling Grass Frog habitat corridor to minimise human disturbance in these areas, with exclusion fencing proposed in these areas.

Weeds

Increased weed encroachment into areas of indigenous or planted terrestrial and aquatic vegetation in wetland complexes may occur due to runoff from residential development. Weeds may also be transported via construction equipment and machinery, and people/animals entering the site. Invasion of native vegetation by 'environmental weeds' is a threatening process under Schedule 3 of the FFG Act. Excessive weed growth can smother frog habitat, rendering it unsuitable as a breeding and /or foraging site.

A Weed Management Plan may be prepared to identify potential threats associated with pest plant species, that may impact environmental values within the study area. The Weed Management Plan would provide appropriate management actions to address weed infestations and vertebrate pest species, to ensure environmental values within the study area are maintained and enhanced.

Dogs, Cats and Exotic Predators

Unrestrained Dogs *Canis familiaris* and Cats *Felis catus* have the potential to roam into Growling Grass Frog wetlands within the site. Cats are known to predate upon dispersing or sheltering frogs. Predation of native wildlife by Cats is a threatening process under Schedule 3 of the FFG Act. Future residential development is likely to introduce unrestrained cats that may also hunt and kill Growling Grass Frog. It is understood that a Cat curfew is currently enforced in the City of Greater Geelong with domestic cats required to be indoors from sunset to sunrise, which will minimise the risk to frogs. The entire Cowies Creek habitat corridor within the study area and surrounding 50 metre terrestrial buffer will be appropriately fenced to exclude public access and avoid unrestrained access into the habitat corridor area by dogs and their owners.

The introduced Eastern Gambusia *Gambusia holbrooki* has been identified as a possible factor in the decline of species in the "bell frog species complex", which includes Growling Grass Frog (Mahony 1999; White and Pyke 1996; Hamer *et al*. 2002) because it eats the eggs and tadpoles of these species (Morgan and Buttermer 1996). This species may reduce the potential of a site to support breeding populations, although the extent of predation depends on aquatic vegetation and habitat complexity, and waterbody permanency (Hamer *et al*. 2002). Predation by Eastern Gambusia on tadpoles of Growling Grass Frog may be a significant threat to the species.

Red Fox sp. is likely to move through the study area. The species is known to hunt and eat adult members of the bell frog species complex. Feral Animal Control measures will be considered for development in the study area to reduce the population size of foxes.

5.1.4 Unknown, unpredictable or irreversible impacts

In order to reduce the potential for further unknown, unpredictable and/or irreversible impacts, Growling Grass Frog habitat within the study area is proposed to be enhanced via planting of suitable aquatic vegetation species, provision of rock mattresses and/or loose rock, and weed and pest animal control. Enhanced habitat will result facilitate greater dispersal and potentially breeding opportunities for the species and improve habitat connectivity between adjacent stretches of Cowies Creek (Clemann and Gillespie 2012). Habitat

enhancement actions are outlined in a Growling Grass Frog Conservation Management Plan (Appendix 1) and take into consideration DEECA's *Growling Grass Frog Habitat Design Standards* 2017 (DELWP 2017).

Enhanced habitat measures will be in accordance with the National Recovery Plan for Southern Bell Frog *Litoria raniformis* as they mitigate the following risks to the species:

- Loss and degradation of habitat via enhancement of existing habitat;
- Barriers to movement by encouraging greater frog dispersal through the study area; and,
- Disease by requiring strict hygiene protocols during construction of habitat enhancements.

Local frog populations are known to vary on spatial and temporal scales depending upon habitat conditions at a particular site. There is a potential risk that enhanced habitat may not support habitat characteristics that are conducive to ongoing breeding, recruitment and dispersal by the species. Unpredictable impacts that may lead to the degradation of Growling Grass Frog habitat as a result of the proposed action also includes:

- Unauthorised site access and significant dumping of hard rubbish;
- Introduction of fish through routine flood events, dispersal of fish eggs by birds or artificial introduction by residents;
- Habitat degradation or chemical and/or hard rubbish influx following major flood events; and,
- Invasion and excessive growth of introduced grasses and weeds (e.g. Artichoke Thistle *Cynara cardunculus* and African Boxthorn *Lycium ferocissimum*), which can smother and reduce the quality of frog habitat for breeding and foraging.

In order to reduce the likelihood of these unpredictable impacts, the ongoing maintenance of existing Growling Grass Frog habitat, particularly the maintenance of aquatic vegetation diversity and structure, will be essential to ensure these habitat types remain suitable for the species.

Monitoring of enhanced habitats will be undertaken every six months for the first two years during the development, and annually for the first five years during enhancement of the Growling Grass Frog habitat corridor. Several site-specific habitat variables will be assessed during the monitoring period. If necessary, additional measures such as habitat augmentation or invasive flora/fauna control will be undertaken to prevent further impacts to this MNES. Such measures would be required if monitoring reveals persistent declines in Growling Grass Frog population numbers, water quality, increased pest plants and animals, increased erosion and sedimentation and/or any disturbance caused by persons entering the constructed wetland habitat. Further information regarding the monitoring and management is outlined in the Growling Grass Frog Conservation Management Plan (Appendix 1).

5.1.5 Risk Assessment of Relevant Impacts

A risk-based assessment has been undertaken to identify the potential impacts that the proposed action may have on the existing Growling Grass Frog population and associated habitats. The results of the risk assessment are provided below (Table 7; Table 8; Table 9).

Table 7. Qualitative criteria for likelihood and consequence

Descriptor	Description
Likelihood	

Descriptor	Description
1 - Almost Certain	A hazard, event and pathway exist, and harm has occurred in similar scenarios and is expected to occur more than once over the duration of the development.
2 - Likely	A hazard, event and pathway exist, and harm has occurred in similar scenarios and is likely to occur at least once over the duration of the development.
3 - Possible	A hazard, event and pathway exist, and harm has occurred in similar scenarios and may occur over the duration of the development.
4 - Unlikely	A hazard, event and pathway exist, and harm has occurred in similar scenarios but is unlikely to occur over the duration of the development.
5 - Rare	A hazard, event and pathway are theoretically possible on this project and has occurred to a limited extent in similar scenarios but is not anticipated over the duration of the development.
Consequence	
Negligible/Very Low	Where impacts from development will not result in any impacts to Growling Grass Frog or the environment. Negligible impacts are localised and temporary in nature, with no noticeable consequences
Minor	Where a risk from development will not adversely affect Growling Grass Frog or the environment, provided management actions are implemented. Minor impacts are noticeable but localised to the project footprint and short-term in nature. They can be effectively mitigated through standard mitigation measures. Values affected by Minor impacts are generally recognised as being important at a local or regional level.
Moderate	Moderate impacts directly or indirectly affect Growling Grass Frog or the environment within the broader project locality and are short or moderate term in nature. Impacts can be ameliorated with specific mitigation measures.
High	Occurs when proposed activities are likely to exacerbate threatening processes. High impacts are substantial and significant changes that affect Growling Grass Frog or the environment within the project locality and are moderate to long-term in nature. Impacts are potentially irreversible and avoidance through appropriate design responses or the implementation of specific mitigation measures is required.
Major	Arises when an impact will potentially cause irreversible or widespread harm to Growling Grass Frog or the environment that is irreplaceable because of its uniqueness or rarity. Major impacts are significant or irreversible changes that affect the Growling Grass Frog or the environment.

Table 8. Risk Evaluation Matrix

		Increasing Likelihood				
		Rare	Unlikely	Possible	Likely	Almost Certain
Conse	Negligible/Very Low	Very Low	Very Low	Very Low	Low	Moderate

	Minor	Very Low	Low	Low	Moderate	Moderate
	Moderate	Low	Low	Moderate	High	High
	High	Low	Moderate	High	Major	Major
	Major	Moderate	High	Major	Major	Major

Table 9. Risk Assessment Results.

Risk	Potential Consequence(s)	Risk Assessment Matrix Score	Management Options to Minimise Risk
Introduction of Chytrid fungus	• Chytrid fungus infection • Death of Growling Grass Frog individuals • Decline or loss of Growling Grass frog population on site	**High** Likelihood: Possible Consequence: High	• Implement hygiene protocols (Section 5.1, Attachment D) • Monitor health and abundance of Growling Grass Frog population within the study area • Regular water quality monitoring
Decline in water quality within habitat corridor	• Decline of Growling Grass frog population on site • Reduced breeding activity and recruitment within habitat corridor • Loss of genetic diversity of the population due to reduced recruitment from outside the study area	**Moderate** Likelihood: Unlikely Consequence: High	• Installation and routine maintenance of sediment and erosion controls in key areas • Installation of rock banks, boulders and logs to stabilise soils in affected areas. • Habitat enhancements.
Wetlands dry over summer	• Decline of Growling Grass frog population on site • Reduced breeding activity and recruitment within constructed wetlands • Loss of genetic diversity of the population due to reduced recruitment from outside the study area	**Low** Likelihood: Unlikely Consequence: Moderate	• Monitoring of created habitats will be undertaken every six months for the first two years during the development, and annually for the first five years following Growling Grass Frog habitat enhancements.

Risk	Potential Consequence(s)	Risk Assessment Matrix Score	Management Options to Minimise Risk
Growling Grass Frog killed during development works on site	• Death of individual Growling Grass Frog leading to Decline of Growling Grass frog population on site	**Moderate** Likelihood: Unlikely Consequence: High	• Salvage and relocation procedures will be initiated to reduce the occurrence of death, injury or displacement of individuals • Salvage and relocation measures will be undertaken both immediately prior to and during the habitat enhancement works, as required • Salvage measures will be undertaken by a qualified zoologist experienced with these operations • Salvage will involve a suitably qualified Zoologist actively searching for frogs immediately prior to, and during habitat enhancement works
Chemical/petroleum spill and hard rubbish dumping	• Decline of Growling Grass frog population on site • Increased Mortality • Degradation of Growling Grass Frog Habitat quality	**Low** Likelihood: Rare Consequence: High	• Equipment to be regularly serviced and inspected daily. • Personnel to undergo adequate training in equipment usage • Engage a specialist contractor, as required, to clean up contaminants such as oil spills, etc.; • Chemical treatments (for rectifying acidity or alkalinity); • Once-off intensive hard litter removal (if required between normal maintenance schedules). • Spill kits maintained on site in areas where chemicals are stored and in construction areas
Disturbance by persons entering the habitat corridor	• Degradation of habitat • Rubbish dumping • Mechanical disturbance of vegetation from trampling • Weed invasion	**Moderate** Likelihood: Possible Consequence: Moderate	• Exclusion fencing • Regular Weed Management • Informative signage • Community awareness and education

Risk	Potential Consequence(s)	Risk Assessment Matrix Score	Management Options to Minimise Risk
	• Introduction of Chytrid fungus • Accidental spillage of chemicals		
Increased pest plants and animals	• Weed growth can smother frog habitat • Degradation of habitat • Predation of Growling Grass Frog by pest animals such as foxes • Invasion of introduced fish, particularly Eastern Gambusia and Carp leading to Growling Grass Frog eggs and tadpoles being consumed by invasive fish • Decline or loss of Growling Grass frog population on site	**Low** Likelihood: Unlikely Consequence: Moderate	• Implementation of weed and pest animal Management Plan • Weed control works monitored regularly • Regular monitoring of habitat and evidence of pest animals • The control of pest animals such as foxes • Ongoing monitoring to identify waterbodies invaded by introduced fish. • Assessment of feral predators within the Growling Grass Frog habitat area prior to the commencement of construction • If evidence of foxes is found, control measures may be implemented • Destroying any dens discovered on site • Drainage outlet installed for removing some or all water from the system within the habitat corridor • Ongoing monitoring to identify ponds invaded by introduced fish to inform if draining is required
Noise and Light Pollution	• Disturbance of Growling Grass Frog breeding activity • Decline of Growling Grass frog population on site	**Low** Likelihood: Possible Consequence: Minor	• Compliance with Geelong City Council's Building Works – Local Law requirements (2014) • No additional lighting directed towards the habitat corridor
Population decline	• Decline or loss of Growling Grass frog population on site • Loss of genetic diversity of the population	**Moderate** Likelihood: Unlikely Consequence: High	• Habitat augmentation • Planting of additional vegetation, or conversely, removal of wetland vegetation (if it is smothering the waterbody)

Risk	Potential Consequence(s)	Risk Assessment Matrix Score	Management Options to Minimise Risk
			• Identification and removal of barriers to dispersal • Increasing the intensity of feral animal controls
Erosion and sedimentation	• Decline in water quality • Reduced recruitment/breeding within habitat corridor	Low Likelihood: Possible Consequence: Minor	• Installation and routine maintenance of sediment and erosion controls in key areas • Installation of rock banks, boulders and logs to stabilise soils in affected areas • Increase maintenance and monitoring operations in affected areas until problem areas are improved.

5.1.6 Duration of Impacts to MNES

The proposed Growling Grass Frog habitat enhancement will be completed by September prior to the Growling Grass Frog breeding season, to ensure the breeding cycle is not affected.

Once completed, permanent frog exclusion fencing will be installed along the perimeter of the habitat corridor to prevent frogs accessing residential development areas. This will also prevent access into the site by unauthorised personnel and pest fauna species (i.e. potential predators).

Potential direct impacts associated with the proposed residential development include changes in the hydrology of Cowies Creek, the deterioration of water quality, noise and lighting impacts. Potential indirect impacts associated with the proposed residential development include the introduction and spread of chytrid fungus, human access, and the spread of weeds and pests. Any impacts to Growling Grass Frog are not anticipated to be significant and are proposed to be mitigated via measures outlined within a Construction Environmental Management Plan for the site.

A discussion of direct and indirect impacts is provided in Section 5.1.3. and Section 5.1.4., with management actions proposed to mitigate the risks where possible. An overview of residual impacts and their duration is provided in Table 10.

Table 10. Residual impacts on Growling Grass Frog and anticipated duration

Residual Impact	Duration
Potential injury or death of individuals associated with enhancement works	During installation of rock beds and removal of noxious weed species.
Potential contamination from chemical spill and hard rubbish dumping.	Ongoing.
Potential introduction of chytrid fungus	During habitat enhancement

Residual Impact	Duration
	During salvage and relocation
Light and noise pollution	During construction activities
	Design and installation phase
	Ongoing post-construction
Predation by pest fauna species	Ongoing
Potential introduction of predatory fish into wetland system	Ongoing
Potential breaches in access and site disturbance by humans	Ongoing
Potential deterioration of water quality	Ongoing

6 PROPOSED AVOIDANCE AND MITIGATION MEASURES

In relation to the impacts of the proposed action on MNES, the Preliminary Documentation must include:

a) A detailed summary of measures proposed to be undertaken by the proponent to avoid, mitigate and manage relevant impacts of the proposed action on relevant MNES. This should include for each measure:
    - A statement of the objectives, ongoing management and monitoring, and locations and timing;
    - The party responsible;
    - The policy basis, for instance, consideration of the *Significant impact guidelines for the vulnerable growling grass frog* (Litoria raniformis).

b) The proposed measures must be based on best available practices, appropriate standards, evidence of success for other similar actions and supported by published scientific evidence;

c) All proposed measures for MNES must be drafted to meet the 'S.M.A.R.T' principle:
    - S – Specific (what and how);
    - M – Measurable (baseline information, number/value, auditable);
    - A – Achievable (timeframe, money, personnel);
    - R – Relevant (conservation advice, recovery plans, threat abatement plans);
    - T – Time-bound (specific timeframe to complete);

d) How stormwater and runoff will be managed for the proposed action and across similar proposed actions across the Creamery Road Precinct;

e) For any proposed creation of artificial habitat for Growling Grass Frog, The Growling Grass Frog Habitat Design Standards created by the Victorian Department of Environment, Land, Water and Planning (https://www.msa.vic.gov.au/__data/assets/pdf_file/0019/73414/Growling-Grass-Frog-Habitat-Design-Standards_March2017.pdf) must be considered; and,

f) The details of the vegetation and species habitat to be retained and an associated map showing the retained vegetation and habitat for the proposed action and project area. The information and mapping must include the location and quantification of the total area of retained vegetation and species habitat when acting in combination with past, present, and reasonably foreseeable projects in the region.

6.1 Response

6.1.1 Avoidance

Approximately 2.6 hectares of Growling Grass Frog habitat is proposed to be retained as part of the proposed action and includes low-quality aquatic habitat along Cowies Creek and low-quality terrestrial dispersal habitat comprised mostly of pasture grasses. Approximately 1.5 hectares of Creekline Grassy Woodland (EVC 68) is proposed to be retained. Some exposed rock and debris in retained habitat may provide basking and overwintering opportunities for the species. The proposed action includes the enhancement of retained habitat to ensure ongoing connectivity to adjacent frog breeding habitat and dispersal corridors along Cowies

Creek. As part of this design, areas containing some characteristics of the species habitat (i.e. exposed rock, ephemeral wetlands) will be retained and enhanced.

The improvement of retained habitat will provide improved foraging and potentially breeding habitat for the species and improve habitat connectivity and frog dispersal along the broader Cowies Creek corridor. Habitat enhancement measures are further outlined below (Section 6.1.4).

6.1.2 Mitigation Measures

A range of mitigation measures will be implemented by the construction contractor to manage direct and potential indirect impacts to Growling Grass Frog and adjacent matters of NES. Measures to mitigate impacts upon terrestrial and aquatic values present within the study area are provided below.

Sediment/ Frog Exclusion Fencing

Frog exclusion fencing will be installed along the edge of the Cowies Creek habitat corridor, to provide a physical barrier between the development area and existing habitat. An example of suitable frog exclusion fencing is shown in Plate 10. The following controls apply to the installation of sediment/ frog exclusion fencing:

- Fencing must be constructed of a cloth or plastic material and only appropriate fencing material that withstands variable weather conditions over long periods of time must be used;
- Fencing must be installed at least one metre high, with an additional 0.2 metres buried below-ground. An additional 0.2 metres at the top of the fence must be bent/ angled over at less than 90 degrees to the vertical on the frog habitat side (not the excluded habitat side) to prevent frogs from climbing or hopping over the fence;
- Refugia for shelter must be placed at least one metre away from the fence and any vegetation within one metre of the fence must not exceed 0.5 metres to prevent frogs from escaping (i.e. low-growing grasses will be planted);
- Fences must be taut without creases or folds;
- Fence posts must be installed on the outer fencing side (i.e. excluded habitat side) and fastened with nails or similar, and lie flush with fencing material to prevent frogs from climbing up posts and escaping over the fence; and,
- Regular inspection of the fencing is required to ensure its effectiveness, including:
    - Inspections of fencing between May and August, prior to Growling Grass Frog breeding season and the repair or replacement of any damaged or ineffective material;
    - Maintenance of vegetation within one metre of fencing at less than 0.5 metres high; and,
    - Removal of any litter or other debris caught in fencing which could assist frogs to climb over.

Plate 10. Example of suitable frog exclusion fencing (fence posts must be on the outside and not within the Habitat Corridor)

Safety Fencing

Prior to the completion of the residential development, the entire section of the Cowies Creek habitat corridor will be appropriately fenced to exclude public access to the habitat and movement of frogs into the residential construction area.

Integration of safety fencing and frog fencing will also be considered, as a single fence which achieves the purposes of safety, unauthorised access prevention, and a barrier for preventing frogs accessing paved areas is achievable and preferable in terms of functionality, aesthetics and maintenance.

If a combined frog and safety fence is used, this will only be used along the interface between the habitat corridor and the residential estate.

As the designated proponent for the proposed action, Yih-Sheng Investment Pty Ltd will have ultimate responsibility for meeting performance criteria in accordance with the environmental objectives and mitigation measures, including satisfying requirements for monitoring, reporting and should any incidents occur, ensuring they are addressed, and appropriate corrective actions are undertaken in a timely manner.

Habitat enhancement considerations are further discussed in the Growling Grass Frog Conservation Management Plan (Appendix 1).

Pest Plant Control

The control of pest plants within Growling Grass Frog habitat is a major requirement for management, as habitat within the site is under continual pressure from the invasion of introduced pasture grasses and weeds. Excessive weed growth can smother and reduce the quality of frog habitat for breeding and foraging. In order to control and/or eradicate these weed species, several on-going techniques can be used including physical removal, brush cutting and herbicide application. Herbicide must only be applied to weeds by using the spot-spraying technique, in order to prevent off-target issues.

It is important to ensure that any weed control works using herbicides are both targeted (e.g. spot spraying) and undertaken at the right time of the year, as this can also reduce the requirement for future weed control activities.

The following controls apply to all on-site weed control works:

- Weed management must be undertaken throughout all open space areas, with attention given to vegetated areas which are not subject to routine maintenance;

- Any weed control works must be completed in a manner that minimises soil disturbance;
- Herbicide use must be minimised to avoid adverse effects on frogs and invertebrates;
- Where herbicide application is necessary, waterway sensitive products such as Roundup Bioactive®, Weedmaster Duo® or Weedmaster 360® must be employed, without the addition of surfactant;
- Where herbicides are used, selective application is preferable to broad area application;
- Non-residual herbicides must not be used; and,
- Pest plants that reproduce sexually (by seed) must be controlled before seeds ripen.

Weed control works must be monitored regularly to assess their effectiveness and follow-up / evaluation works must be completed where required. With any weed control works it is important to establish a cover of native species as soon as possible to limited the risk of weed infestation in areas of exposure bare soil. While native species will naturally re-colonise such areas, so will exotic species if weed seed is present in soil.

Disease Introduction

There is evidence to suggest that the decline of many frog species in Australia and elsewhere could be related to the disease caused by the water-borne fungal pathogen, commonly referred to as Chytrid Fungus. Chytrid Fungus is a major threat to amphibian populations in Australia, with at least one species driven to extinction and populations of other threatened species, particularly *L. raniformis*, severely compromised (DEWHA 2006). The disease that results from Chytrid Fungus infection causes significant physical and physiological problems for frogs, such as skin flaking, reduced food intake, cardiac arrest and mortality (Peterson *et al.* 2013). Infection of amphibians with the fungus is listed as a 'key threatening process' under the EPBC Act.

There is an inherent risk of spreading the fungus within and between areas in the landscape by the movement of infected frogs and tadpoles, water, soil and vegetative material, the outcome of which can be extremely deleterious if it is introduced into Growling Grass Frog populations presently free of the disease. Human activities and movements can exacerbate the risk of disease spread, and as such hygiene protocols for vehicles, equipment, footwear, handling, holding and transporting of frogs and tadpoles are paramount.

Such hygiene protocols will be implemented throughout the construction works. The Hygiene Protocol (Murray *et al.* 2011) will be used to guide best practice Chytrid management. This document includes, but is not exclusive to the following.

- All footwear and equipment (e.g. nets, buckets, callipers, headlamps, waders), will be thoroughly cleaned and disinfected before entering and exiting the constructed wetland habitat;
- Any equipment used to handle frogs and tadpoles will be cleaned and disinfected between each sample;
- A new pair of disposable latex gloves will be used between each frog and tadpole. Gloved hands will be dipped in the local water in the immediate area so that loss of skin secretions is minimised when frogs are picked up;
- Frogs will be placed into new and clean plastic sample bags, with a 'one bag– one frog' policy. Bags will not, under any circumstances, be reused;
- The tyres of all vehicles will be cleaned and disinfected before entering and exiting the constructed wetland habitat (if required);

- The tyres/tread and other parts of machinery and plant (e.g. the excavator bucket; pumps) involved in the habitat construction and associated activities, will be cleaned and disinfected before entering the construction area of the constructed wetlands habitat; and
- Disinfection methods will follow the procedures outlined in the Hygiene Protocol (Murray *et al.* 2011).

The following additional mitigation measures are proposed and are further outlined in the Growling Grass Frog Conservation Management Plan and forthcoming Construction Environmental Management Plan:

- Soil disturbance and sedimentation within the creekline will be prevented, to avoid, or minimise impacts to fauna habitats;
- All habitat improvement works within the enhancement area will be undertaken by a qualified and experienced wetland revegetation specialist/ contractor in accordance with the provisions of the Growling Grass Frog Conservation Management Plan;
- All contractors will be made aware of ecologically sensitive areas in order to minimise the likelihood of inadvertent disturbance to areas marked for retention. Areas of sensitivity and no-go zones will be included as a mapping overlay on any construction plans;
- Construction stockpiles, machinery, roads, and other infrastructure will be placed away from areas of sensitivity including Cowies Creek. As such, there will be no direct or indirect disturbance to surrounding habitat for Growling Grass Frog;
- Best practice sedimentation and pollution control measures will be undertaken at all times, in accordance with Environment Protection Authority guidelines (EPA 1991; EPA 2020; Victorian Stormwater Committee 1999) to prevent offsite impacts into surrounding areas (e.g. broader Cowies Creek environs);
- Given that indigenous flora provides valuable habitat for indigenous fauna, landscape plantings as part of the proposed residential development will include indigenous species sourced from a local provenance, rather than exotic deciduous trees and shrubs. The *Growling Grass Frog Habitat Design Standards* (DELWP 2017) will be reviewed to provide a list of suitable species to be used when establishing vegetation within Growling Grass Frog habitat (Table A1, Appendix 1); and,
- Trees and/or large shrubs must not be planted within 20 metres of the banks of Growling Grass Frog wetlands as this may shade out wetlands, thus potentially rendering them unsuitable for the species.

6.1.3 Stormwater Management

In relation to stormwater impacts, stormwater associated with the proposed development will ultimately flow into Cowies Creek following water treatment via the stormwater wetland within the study area. This is not expected to directly or indirectly significantly impact the hydrology of Cowies Creek as there is not anticipated to be any long-term change in maximum flow rates along the creekline following completion of the proposed action (Rain Consulting 2024). The volume of runoff created development in the study area in post-construction will likely be of greater volume and velocity than existing runoff under current conditions due to increase in impervious area such as rooftops and road surfaces. While water flow volume in Cowies Creek is expected to increase due to the proposed development, flow rates from the development will contribute to a maximum 1.75% of the peak 1% AEP flow in Cowies Creek, with the more likely scenario being no change in peak flow rate following construction of the stormwater wetland facility (Rain Consulting 2024).

The stormwater treatment wetlands will decrease the velocity of the water moving through the corridor and allow suspended particles to settle out of suspension or adhere to vegetation, and nutrients will be biologically absorbed by the macrophytes. Stormwater will be initially treated within a primary stormwater wetland facility before discharging into the Growling Grass Frog habitat corridor. This is not considered to be a significant threat to existing Growling Grass Frog habitat as the proposed stormwater pond is modelled to largely mitigate any increased runoff due to the construction of impervious areas.

The proposed development area does not intersect with Growling Grass Frog habitat, with a further 50 metre buffer proposed from the outer edge of aquatic habitat for the species along Cowies Creek to any proposed construction areas. Potential direct impacts associated with the proposed residential development include changes in the hydrology of Cowies Creek, the deterioration of water quality, noise and lighting impacts. Potential indirect impacts associated with the proposed residential development include the introduction and spread of chytrid fungus, human access, and the spread of weeds and pests. No direct impacts are proposed to occur to any other MNES. Impacts to Growling Grass Frog are not anticipated to be significant and are proposed to be mitigated via measures outlined within a Construction Environmental Management Plan for the site.

The proposed residential development footprint has been situated to ensure ongoing connectivity between along the Cowies Creek habitat corridor.

6.1.4 Habitat Enhancement

The improvement of retained habitat will provide improved foraging and potentially breeding habitat for the species and improve habitat connectivity and frog dispersal along the broader Cowies Creek corridor. Habitat enhancement measures are further outlined below and are further outlined in the Growling Grass Frog Conservation Management Plan (Appendix 1).

Ongoing Management

A Growling Grass Frog Conservation Management Plan has been prepared for the proposed residential development within the study area (Appendix 1). This Plan provides detailed information relating to the enhancement of existing habitat within the Cowies Creek corridor to ensure the species persists within Cowies Creek. The Growling Grass Frog Conservation Management Plan includes specific information on the proposed residential development (extent and timing), potential impacts to the species, and proposed management actions to ensure a resident population persists along Cowies Creek in the long-term.

The ongoing survival of the extant Growling Grass Frog population can be established by maintaining or enhancing wetland hydroperiods and aquatic vegetation cover. Long term persistence of the species requires a network of populations, within which migration and re-colonisation can occur. Hydroperiod and aquatic vegetation cover are considered the most important features to maintain Growling Grass Frog occupancy (Heard *et al.* 2010). Efforts will be made to maintain or enhance aquatic vegetation cover in the Cowies Creek corridor.

Greater aquatic vegetation cover, inclusive of emergent, submergent and floating aquatic vegetation will be provided to ensure continued Growling Grass Frog occupancy and persistence at the site.

Management of the habitat corridor will be undertaken over the life of the Growling Grass Frog Conservation Management Plan, followed by potential arrangements with relevant organisations (for example, Greater

Geelong City Council, DEECA) to manage the sites thereafter. This will be determined during further discussions with the relevant authorities.

Monitoring

Ongoing population and habitat monitoring will be conducted in accordance with the detailed Growling Grass Frog Conservation Management Plan to assess any impacts associated with proposed residential development and to ensure habitat conditions within the study area remain suitable for the species. Monitoring at Growling Grass Frog habitat will be conducted during the species' active period between September and March following the initial disturbance event, and then once annually (in the active season) for the life of the Conservation Management Plan.

The results of the annual monitoring will be presented in an annual report and provided to the DCCEEW. If monitoring suggests an unacceptable population size of Growling Grass Frog at the site (i.e. not as a result of prevailing conditions), adaptive management actions will be implemented to improve Growling Grass Frog habitat. The constructed wetland colonisation rate depends on the number, proximity (taking into account barriers such as roads) and size of neighbouring populations. During each monitoring event, the proponent will also undertake surveys in the neighbouring wetlands to determine prevailing conditions of the broader Cowies Creek area, primarily relating to water quality and Growling Grass Frog occupancy.

Local frog populations are known to vary on spatial and temporal scales depending upon habitat conditions at a particular site. For the study area, regular population monitoring will determine if Growling Grass Frog is declining. Due to natural variation in habitats available within the study area, it is expected that the creekline is likely to be occupied during some seasons, but unoccupied in others. This fluctuation in occurrence can be due to obvious causes, such as unsuitable habitat conditions (i.e. high water turbidity), and other causes which may be difficult to identify (i.e. water chemistry). In the event that no Growling Grass Frog are recorded within the study area for three consecutive seasons, some of the following actions will be implemented subject to the results of habitat monitoring:

- Habitat augmentation, such as the installation of additional rocks and other refuge features;
- Planting of additional vegetation, or conversely, removal of wetland vegetation (if it is smothering the waterbody);
- Identification and removal of barriers to dispersal; and,
- Introduction of feral animal controls.

Some further contingency management actions that may be required to be undertaken by the proponent or council include:

- Intervene to remove silt or other debris, or to rectify chemical imbalances;
- Minimise and control erosion or active sources of sedimentation;
- The implementation of water quality improvement measures which could include supplementary vegetation planting or installation of additional rock beach or screen areas;
- Maintain permanent signage within and throughout the constructed wetland area adjacent to pathways, to identify dogs to be on leash throughout the area, and no fishing or introduction of fish into wetlands.

7 RESIDUAL IMPACTS AND PROPOSED OFFSETS

Environmental offsets are measures that compensate for the residual significant impacts of an action on the environment. Offsets provide environmental benefits to counterbalance the impacts that remain after consideration of avoidance and mitigation measures. It is important to consider environmental offsets early in the assessment process. Correspondence with the department regarding offsetting is highly encouraged. The department's EPBC Act Environmental Offsets Policy (2012) (Offsets Policy) is available at: www.environment.gov.au/epbc/publications/epbc-act-environmental-offsets-policy.

The package must include, but not be limited to, the following:

a) An assessment of the likelihood of residual significant impacts occurring on relevant MNES, after avoidance, mitigation and management measures have been applied;

b) If residual impacts are likely to be significant, please provide a summary of the proposed environmental offset and key commitments to achieve a conservation gain for each protected matter with residual significant impacts;

c) Where offset area/s have been nominated, include a draft OAMP (Offset Area Management Plan) as an appendix to the PD. The draft OAMP must meet the information requirements set out in Appendix B, and must be prepared by a suitably qualified ecologist and in accordance with the department's Environmental Management Plan Guidelines (2014), available at: www.environment.gov.au/epbc/publications/environmental-management-plan-guidelines.

7.1 Response

7.1.1 Residual Impacts

Potential direct impacts associated with the proposed residential development include changes in the hydrology of Cowies Creek, the deterioration of water quality, noise and lighting impacts. Potential indirect impacts associated with the proposed residential development include the introduction and spread of chytrid fungus, human access, and the spread of weeds and pests. The prevention and/ or management of these impacts is outlined in the Growling Grass Frog Conservation Management Plan (Appendix 1) and a Construction Environmental Management Plan (forthcoming). Potential impacts relate to 2.6 hectares of Growling Grass Frog habitat and up to four individuals recorded within the study area.

After consideration of mitigation measures, any potential residual impacts are unlikely to be significant. Potential residual impacts to Growling Grass Frog are considered in relation to the Significant Impact Guidelines for Growling Grass Frog below (DEWHA 2009) (Table 11).

Table 11. Significant impact assessment – Growling Grass Frog: Vulnerable matters of NES (EPBC Act).

Significant Impact Criteria - will the activity:	Feature and Conservation Status **Growling Grass Frog**
Lead to a long-term decrease in the size of an important population of a species	Potential direct impacts associated with the proposed residential development include changes in the hydrology of Cowies Creek, the deterioration of water quality, noise and lighting impacts. Potential indirect impacts associated with the proposed residential development include the introduction and spread of chytrid fungus, human access, and the spread of weeds and pests. Impacts may occur if appropriate mitigation measures aren't implemented. Conclusion: **Significant impact unlikely**
Reduce the area of occupancy of an important population	The proposed action will not alter impact the availability of available habitat for the species. Conclusion: **Significant impact unlikely**
Fragment an existing important population into two or more populations	The proposed action will not remove Growling Grass Frog habitat and therefore fragmentation of an existing important population of Growling Grass Frog is unlikely to occur. Conclusion: **Significant impact unlikely**
Adversely affect habitat critical to the survival of a species	No critical habitat for this species is listed under the EPBC Act. The proposed action involves temporary construction works and permanent change in adjacent land use to residential, however this is unlikely to have any adverse long-term impacts on the species after mitigation measures are implemented. Conclusion: **Significant impact unlikely**
Disrupt the breeding cycle of an important population	There are no proposed impacts to known breeding habitat for Growling Grass Frog. Impacts may occur such as disturbance from construction activities and impacts to water quality. Appropriate mitigation measures will be implemented. Conclusion: **Significant impact unlikely**
Modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	No habitat for Growling Grass Frog is proposed to be impacted as part of the proposed action. Conclusion: **Significant impact unlikely**
Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat	After the implementation of appropriate mitigation measures, it is not likely that harmful invasive species would become further established as a result of the project. **Significant impact unlikely**
Introduce disease that may cause the species to decline	Growling Grass Frog are susceptible to Chytrid Fungus. Given appropriate hygiene measures will be implemented, it is not likely that this disease would be introduced or spread as a result of the project. Conclusion: **Significant impact unlikely**
Interfere substantially with the recovery of the species	While the proposed action may result in a minor disturbance to these species (i.e. increase in light and noise), it is not considered likely interfere with the recovery of this species given the mitigation proposed and availability of similar habitat in the vicinity. Conclusion: **Significant impact unlikely**

8 ECOLOGICALLY SUSTAINABLE DEVELOPMENT (ESD)

If updated from the information provided in the referral, provide any other requirements for approval or conditions that apply, or that you reasonably believe are likely to apply, to the proposed action.

This must include a description of how the proposed action meets the principles of ESD, as defined in section 3A of the EPBC Act. The following principles are principles of ecologically sustainable development:

- decision making processes should effectively integrate both long term and short term economic, environmental, social and equitable considerations;
- if there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation;
- the principle of inter-generational equity—that the present generation should ensure that the health, diversity and productivity of the environment is maintained or enhanced for the benefit of future generations;
- the conservation of biological diversity and ecological integrity should be a fundamental consideration in decision making; and,
- improved valuation, pricing and incentive mechanisms should be promoted.

8.1 Response

The National Strategy for Ecologically Sustainable Development (1992) sets out the policy framework for the Australian Government to make decisions and take actions to pursue ecologically sustainable development (ESD). The National Strategy requires government departments to develop institutional arrangements to ensure that the principles and objectives of ESD are delivered and sets out the following core objectives for achieving ESD:

- To enhance individual and community well-being by following a path of economic development that safeguards the welfare of future generations.
- To provide for equity within and between generations.
- To protect biological diversity and maintain essential ecological processes and life-support systems.

The delivery of habitat enhancement works will generate employment opportunities through the engagement of civil contractors and landscape contractors for its implementation on-site.

It is expected that a range of full time and part time jobs will be created due to the proposed action from a civil works and landscaping perspective. Additional economic benefits will include the provision of housing for between 330 and 350 residential lots, and potentially bring additional economic benefits to the local region in terms of job creation, spending, etc.

The proposed residential development will see the enhancement of existing Growling Grass Frog habitat to support a population of Growling Grass Frog to enable greater dispersal, foraging and potential breeding opportunities for the species.

9 SOCIAL AND ECONOMIC MATTERS

If updated from the information provided in the referral, address the economic and social impacts (both positive and negative) of the proposed action. This may include:

a) An analysis of the economic and social impacts of the action, both positive and negative;

b) Details of any public consultation activities undertaken and their outcomes;

c) Details of any consultation with Indigenous stakeholders. Identify existing or potential native title rights and interests, including any areas and objects that are of particular significance to Indigenous peoples and communities, possibly impacted by the proposed action and the potential for managing those impacts. Describe any Indigenous consultation that has been undertaken, or will be undertaken, in relation to the proposed action and their outcomes.

   The department considers that best practice consultation, in accordance with the The Interim Engaging with First Nations People and Communities on Assessments and Approvals under Environment Protection and Biodiversity Conservation Act 1999 (interim guidance) - DCCEEW includes:

   - identifying and acknowledging all relevant affected Indigenous peoples and communities;
   - committing to early engagement;
   - building trust through early and ongoing communication for the duration of the project, including approvals, implementation and future management;
   - setting appropriate timeframes for consultation; and,
   - demonstrating cultural awareness.

   Describe any state requirements for approval or conditions that apply, or that the proponent reasonably believes are likely to apply, to the proposed action with regards to Indigenous peoples and communities.

d) Projected economic costs and benefits of the project, including the basis for their estimate through cost/benefit analysis or similar studies; and,

e) Employment opportunities expected to be generated by the project (including construction and operational phases).

9.1 Response

9.1.1 Economic and Social Impacts

The subject land has been identified to be developed for urban housing. Initially the land was identified as a future residential growth area in 2013 and subsequently within the City of Greater Geelong Settlement Strategy (2020). The strategy outcomes were introduced into the City of Greater Geelong the Planning Scheme via Amendment C395 in 2021.

The Amendment C395 requires the preparation of the Creamery Road PSP to set a framework for the development of new housing & urban development. The PSP will deliver substantial new housing and investment in significant public infrastructure (including drainage, open space, roads, community uses, etc) valued at over $200 million for the incoming community.

The subject land has the capacity to deliver over 330 new dwellings.

As a result of the introduction of new urban development the existing agricultural land use will be discontinued.

9.1.2 Public Consultation Activities

The City of Greater Geelong consulted extensively on the Settlement Strategy and Amendment C395, which included public exhibition and an assessment of the proposed application of the land for urban residential purposes by an Independent Planning Panel in 2019. The Panel recommended that the land be developed for urban residential purposes via the preparation of the PSP and subsequent planning permit applications.

Council commenced preparation of the PSP in 2021. To date they have undertaken significant background technical reporting and consultation with landowners and Government agencies via drafts of the proposed PSP and Development Contributions Plan (DCP).

The PSP is likely to be released for formal public comment later in 2024.

9.1.3 Consultation with Indigenous Stakeholders

A Cultural Heritage Management Plan (CHMP) is required to be prepared and approved prior to any planning permit being issued (post PSP approval) for urban development, as the subject site is located within an area of cultural heritage sensitivity (Cowies Creek).

Consultation with the relevant Registered Aboriginal Party (Wadawurrung Traditional Owners Aboriginal Corporation) will occur as part of the CHMP process. All required stakeholder engagement will be undertaken as part of that CHMP process.

9.1.4 Projected Economic Costs and Benefits

The draft DCP prepared by the City of Greater Geelong for the PSP area will provide essential infrastructure for the health, safety and wellbeing of the incoming community. The DCP estimates projects with a value of over $200M+, which include transport, community, recreation and drainage projects within the PSP area.

Drainage infrastructure required to be developed on the subject land includes precinct based storm water catchment and treatment off line along the existing Cowies Creek waterway. The City of Greater Geelong also proposes landscape treatment and public engagement along the waterway contributing to the overall public open space contribution for the incoming community.

9.1.5 Employment Opportunities

Ongoing employment opportunities (and multipliers) will be provided by the project (for the subject site) during the planning process and construction of the urban development outcome.

10 ENVIRONMENTAL RECORD OF PROPONENT

Include details of any past or present proceedings under a Commonwealth, State or Territory law for the protection of the environment or the conservation and sustainable use of natural resources against:

a) the person proposing to take the action;

b) for an action for which a person has applied for a permit, the person making the application;

c) if the person is a body corporate—the history of its executive officers in relation to environmental matters; and,

d) if the person is a body corporate that is a subsidiary of another body or company (the parent body)—the history in relation to environmental matters of the parent body and its executive officers.

10.1 Response

10.1.1 Person Proposing to take the action

Mr David Liao, Yih Sheng Investments Pty Ltd. The proponent is the owner of the subject land and has used the property for rural / agricultural purposes.

10.1.2 Person Making the application (if applied for a permit)

N/A - No permit application has been submitted to the City of Greater Geelong at this stage.

10.1.3 History of Executive Officer (if body corporate)

N/A.

10.1.4 History in relation to Environmental Matters

The proponent has not had any warnings or infringements issued to them under the EPBC Act.

11 CONCLUSION

The Preliminary Documentation must provide an overall conclusion as to the environmental acceptability of the proposal with regards to the objects and requirements of the EPBC Act including the principles of Ecologically Sustainable Development (ESD). You may wish to include a statement as to whether or not the controlled action should be approved and may recommend conditions pertaining to an approval. This should include justification for undertaking the proposed action in the manner proposed.

11.1 Response

Direct and indirect impacts to 2.6 hectares of existing habitat for Growling Grass Frog may occur, however any impacts are highly unlikely to be significant following implementation of mitigation measures outlined in the Growling Grass Frog Conservation Management Plan (Ecology and Heritage Partners Pty Ltd 2024) and a forthcoming Construction Environmental Management Plan.

Growling Grass Frog habitat enhancement will facilitate greater connectivity (i.e. along the Cowies Creek corridor), improve existing foraging and dispersal habitat, and potential enable greater breeding opportunities for the species within the site. Terrestrial areas adjacent to the creekline will be protected via a 50-metre development buffer from the outer edge of aquatic habitat for the species along Cowies Creek, and augmented through the provision of rock banks, logs and other ground debris which will provide shelter and overwintering resources. In addition, ongoing management of threatening processes such as weed and pest animal control will be undertaken.

As a result of these efforts, the proposed residential development plan adequately mitigates the potential for significant impacts to Growling Grass Frog. Further, it will result in a net increase in the extent of high-quality aquatic habitat, protection and augmentation of existing terrestrial habitat, provision of new resources (e.g. rock banks), and increased connectivity at a local scale, thereby promoting the persistence and recovery of the species.

Proposed conditions

Yih Sheng Investments Pty Ltd intends to meet the obligations outlined within the Growling Grass Frog Conservation Management Plan for the site.

The project should be approved subject to conditions, including the proposed management of the existing Growling Grass Frog habitat, along with regular reporting and auditing requirements to ensure the management commitments outlined in the Growling Grass Frog Conservation Management Plan (Ecology and Heritage Partners 2024) are undertaken, and that the Growling Grass Frog population persists within the Cowies Creek habitat corridor.

12 INFORMATION SOURCES

The preliminary documentation must state for the information provided, the following:

a) the source and currency (date) of the information

b) how the reliability of the information was tested

c) the uncertainties (if any) in the information

d) the guidelines, plans and/or policies considered

12.1 Response

Information used in this report was appraised and assessed for quality, research rigour and relevance to the topic. Academic research, grey literature and policy documents were reviewed in preparation of this Preliminary Documentation, with research conducted prior to 2000 only considered on the basis that it is a seminal source or provides necessary background.

Relevant studies were identified using a range of methods, including:

- Academic journal databases in the herpetology, biodiversity conservation, zoology, and aquatic biology fields;
- General internet searching of online policy communities and information clearinghouses (including government departments); and,
- Follow up of bibliographic references in found studies.

The following guidelines, plans and policies were considered (see also 12.1.1):

- National Recovery Plan for the Southern Bell Frog *Litoria raniformis* (2012);
- Growling Grass Frog Habitat Design Standards (2017);
- Conservation Advice for *Tympanocryptis pinguicolla* (*Victorian grassland earless dragon*) (2023);
- National Recovery Plan for the Grassland Earless Dragon *Tympanocryptis pinguicolla* (2012);
- Conservation Advice for *Neophema chrysostoma (blue-winged parrot)* (2023);
- *Flora and Fauna Guarantee Act 1988* Threatened List (2024);
- Threat Abatement Plan: Infection of amphibians with chytrid fungus resulting in chytridiomycosis (2006);
- Significant impact guidelines for the vulnerable growling grass frog (*Litoria raniformis*). Nationally threatened species and ecological communities EPBC Act policy statement 3.14 (2009);
- Environmental Management Plan Guidelines (2004);
- Biodiversity Precinct Structure Planning Kit (2010);
- EPBC Act Environmental Offsets Policy (2012);
- Offsets Assessment Guide: For use in determining offsets under the Environment Protection and Biodiversity Conservation Act 1999 (2012);

- Growling Grass Frog Conservation Management Plan for 200 Geelong-Ballan Road, Moorabool, Victoria (2024);
- Civil construction building and demolition guide. Publication 1834. (2020);
- Construction Techniques for Sediment Pollution Control. (1991);
- Legislative Noise Framework. (2021);
- City of Greater Geelong Building works – Local Law Procedure Manual (2014);
- Guidelines for managing the endangered Growling Grass Frog in urbanising landscapes (2010);
- Urban Stormwater: Best Practice Environmental Management Guidelines (1999); and,

REFERENCES

Ashworth J. M. 1998. An appraisal of the Conservation of Litoria raniformis (Kefferstein) in Tasmania. University of Tasmania March 1998. Unpublished Masters Thesis.

Biosis 2023. Draft Cowies Creek Growling Grass Frog Conservation Area Management Plan. Prepared for City of Greater Geelong.

Cleman N. and Gillespie G. R. 2012. National Recovery Plan for the Southern Bell Frog Litoria Raniformis. Published document prepared by the Department of Sustainability and Environment.

DCCEEW 2023a. Conservation Advice for Tympanocryptis pinguicolla (*Victorian grassland earless dragon*). Commonwealth Department of Climate Change, Energy, the Environment and Water, Canberra, Australia. 1 June 2023.

DCCEEW 2023b. Conservation Advice for Neophema chrysostoma *(blue-winged parrot)*. Commonwealth Department of Climate Change, Energy, the Environment and Water, Canberra, Australia. 31 March 2023.

DCCEEW 2024a. Conservation Advice for Litoria raniformis *(southern bell frog)*. Commonwealth Department of Climate Change, Energy, the Environment and Water, Canberra, Australia. 20 August 2024.

DCCEEW 2024b. Protected Matters Search Tool: Interactive Map [www Document]. URL: <http://www.environment.gov.au/epbc/pmst/>. Commonwealth Department of Climate Change, Energy, the Environment and Water, Canberra, ACT.

DCCEEW 2024c. Conservation Advice for Gallinago hardwickii (*Latham's snipe*). Commonwealth Department of Climate Change, Energy, the Environment and Water, Canberra, Australia. 5 January 2024.

DELWP 2017. *Growling Grass Frog Habitat Design Standards*, Melbourne Strategic Assessment. Published document prepared by the Department of Environment, Land, Water and Planning, Melbourne, Victoria.

DEECA 2024a. Victorian Biodiversity Atlas. Sourced from GIS layers: "VBA_FLORA25", "VBA_FLORA100", "VBA_FAUNA25", "VBA_FAUNA100". June 2024. Victorian Department of Energy, Environment and Climate Action, Melbourne, Victoria.

DEECA 2024b. *Flora and Fauna Guarantee Act 1988* Threatened List – June 2024 [www Document]. URL: https://www.environment.vic.gov.au/__data/assets/pdf_file/0025/707416/FFG_Threatened_List_June_2024.pdf. Victorian Department of Energy, Environment and Climate Action, Melbourne, Victoria.

DEECA 2024a. NatureKit Map [www Document]. URL: https://maps2.biodiversity.vic.gov.au/Html5viewer/index.html?viewer=NatureKit. Victorian Department of Energy, Environment and Climate Action, Melbourne, Victoria.

DEECA 2024d. Native Vegetation Regulation Map [www Document]. URL: https://mapshare.vic.gov.au/nvr/. Victorian Department of Energy, Environment and Climate Action, Melbourne, Victoria.

DEECA 2024e. Ecological Vegetation Class (EVC) Benchmarks for each Bioregion [www Document]. URL: https://www.environment.vic.gov.au/biodiversity/bioregions-and-evc-benchmarks. Victorian Department of Energy, Environment and Climate Action, Melbourne, Victoria.

DEWHA 2006. Threat Abatement Plan: Infection of amphibians with chytrid fungus resulting in chytridiomycosis. Department of Environment, water, Heritage and the Arts. Commonwealth of Australia, ACT.

DEWHA 2009. Significant impact guidelines for the vulnerable growling grass frog (*Litoria raniformis)*. Nationally threatened species and ecological communities EPBC Act policy statement 3.14. Department of Environment, Water, Heritage and the Arts. Commonwealth of Australia, Canberra.

DEWHA 2010. Survey guidelines for Australia's threatened frogs. EPBC Act survey guidelines 6.3. (Department of the Environment, Water, Heritage and the Arts (DEWHA), 2010) [Admin Guideline].

DoE 2014. Environmental Management Plan Guidelines. Department of the Environment.

DSE 2010. Biodiversity Precinct Structure Planning Kit. Department of Sustainability and Environment.

DSEWPaC 2012a. *Environment Protection and Biodiversity Conservation Act 1999* Environmental Offsets Policy (October 2012). Department of Sustainability, Environment, Water, Population and Communities, Canberra.

DSEWPaC 2012b. Offsets Assessment Guide: For use in determining offsets under the *Environment Protection and Biodiversity Conservation Act 1999* (2 October 2012). Microsoft Excel spreadsheet developed by the Department of Sustainability, Environment, Water, Population and Communities, Canberra.

DTP 2024. VicPlan Map [www Document]. URL: https://mapshare.maps.vic.gov.au/vicplan/. Victorian Department of Transport and Planning, Melbourne, Victoria.

Ecology and Heritage Partners 2021. Existing Ecological Conditions: Northern and Western Geelong Growth Areas, Victoria.

Ecology and Heritage Partners 2024. Growling Grass Frog Conservation Management Plan: 200 Geelong-Ballan Road, Moorabool. Prepared for Tango Projects.

EPA 1991. Construction Techniques for Sediment Pollution Control. Published document prepared by the Victorian Environment Protection Authority, Melbourne, Victoria.

EPA 2020. Civil construction building and demolition guide. Publication 1834. Published document prepared by the Victorian Environmental Protection Authority, Melbourne, Victoria.

EPA 2021. Legislative Noise Framework. URL: https://www.epa.vic.gov.au/for-business/find-a-topic/noise-guidance-for-businesses/unreasonable-noise-guidelines/legislative-noise-framework#5.2-unreasonable-noise. Environmental Protection Authority, Melbourne Australia

Greater Geelong City Council 2014. Building works – Local Law Procedure Manual.

Greater Geelong City Council 2025a. Creamery Road Precinct Structure Plan. URL: https://www.geelongaustralia.com.au/futuregrowth/article/item/8db2a17ff25b390.aspx. Greater Geelong City Council, Geelong Australia.

Greater Geelong City Council 2025b. Geelong Growth Areas Strategic Assessment. URL: https://yoursay.geelongaustralia.com.au/GGASA. Greater Geelong City Council, Geelong Australia.

Hamer A. J., Lane S. J. and Mahony M. 2002. Management of freshwater wetlands for the endangered Green and Golden Bell Frog *Litoria aurea*: roles of habitat determinants and space. *Biological Conservation* 106, pp. 413-424.

Hamer A. J. and Organ, A. K. 2008. Aspects of the ecology and conservation of the Growling Grass Frog *Litoria raniformis* in an urban-fringe environment, southern Victoria. *Australian Zoologist*: **34**(3), pp. 393-407.

Heard G. W. 2010. Pattern, process and the conservation of threatened amphibian metapopulations. PhD thesis, La Trobe University, Melbourne.

Heard G. W., Robertson, P. and Scroggie, M. P. 2008. Microhabitat preferences of the endangered Growling Grass Frog *Litoria raniformis* in southern Victoria. Australian Zoologist **34**(3), pp. 414-425.

Heard G.W., Scroggie M. and Clemann N. 2012. *Correlates and consequences of chytridiomycosis for populations of the Growling Grass Frog in peri-urban Melbourne*. Report to the Victorian Department of Sustainability and Environment. Arthur Rylah Institute for Environmental Research, Heidelberg.

Heard G. W., Scroggie M. P. and Clemann N. 2010. Guidelines for managing the endangered Growling Grass Frog in urbanising landscapes. Report to the Victorian Department of Sustainability. Arthur Rylah Institute for Environmental Research, Heidelberg.

Heard G. W and Scroggie M. P. 2009. Assessing the impact of urbanisation on Growling Grass Frog metapopulations. Report to the Victorian Department of Sustainability. Arthur Rylah Institute for Environmental Research, Heidelberg.

Mahony M. 1999. Review of the declines and disappearances within the bell frog species group (Litoria aurea species group) in Australia. In A. Campbell, ed. *Declines and disappearances of Australian frogs*, pp. 81-93.

Morgan L. and Buttermer W. 1996. Predation by the non-native fish Gambusia holbrookion on small Litoria aurea and L.dentata tadpoles. Australian Zoologist **30**(2), pp. 143-149.

Murphy, A. 2010. National Recovery Plan for Adamson's Blown-grass *Lachnagrostis adamsonii*. Department of Sustainability and Environment, Melbourne.

Murray K., Skerratt L., Marantelli G., Berger L., Hunter D., Mahony M. and Hines H. 2011. Hygiene protocols for the control of diseases in Australian frogs. Published document prepared for the Department of Sustainability, Environment, Water, Population and Communities.

Organ A. 2002. Warty Bell Frog *Litoria raniformis* ecological advice for the proposed Edgars Road extension, Epping Victoria. Unpublished report prepared for VicRoads (Biosis Research Pty Ltd.)

Organ A. 2003. Conservation strategy for the Warty Bell Frog *Litoria raniformis* at the proposed Edgars Road extension, Epping, Victoria. Unpublished report prepared for VicRoads (Biosis Research Pty Ltd.)

Peterson J. D., Steffen J. E., Reinert L. K., Cobine P. A., Appel A., Rollins-Smith L. and Medonca M. T. 2013. Host stress response is important for the pathogenesis of the deadly amphibian diseases, Chytridiomycosis, in Litoria caerulea. *PLoS ONE*, doi: https://doi.org/10.1371/journal.pone.0062146.

Rain Consulting 2024. Cowies Creek Stormwater Impacts: 200 Ballan Road, Moorabool.

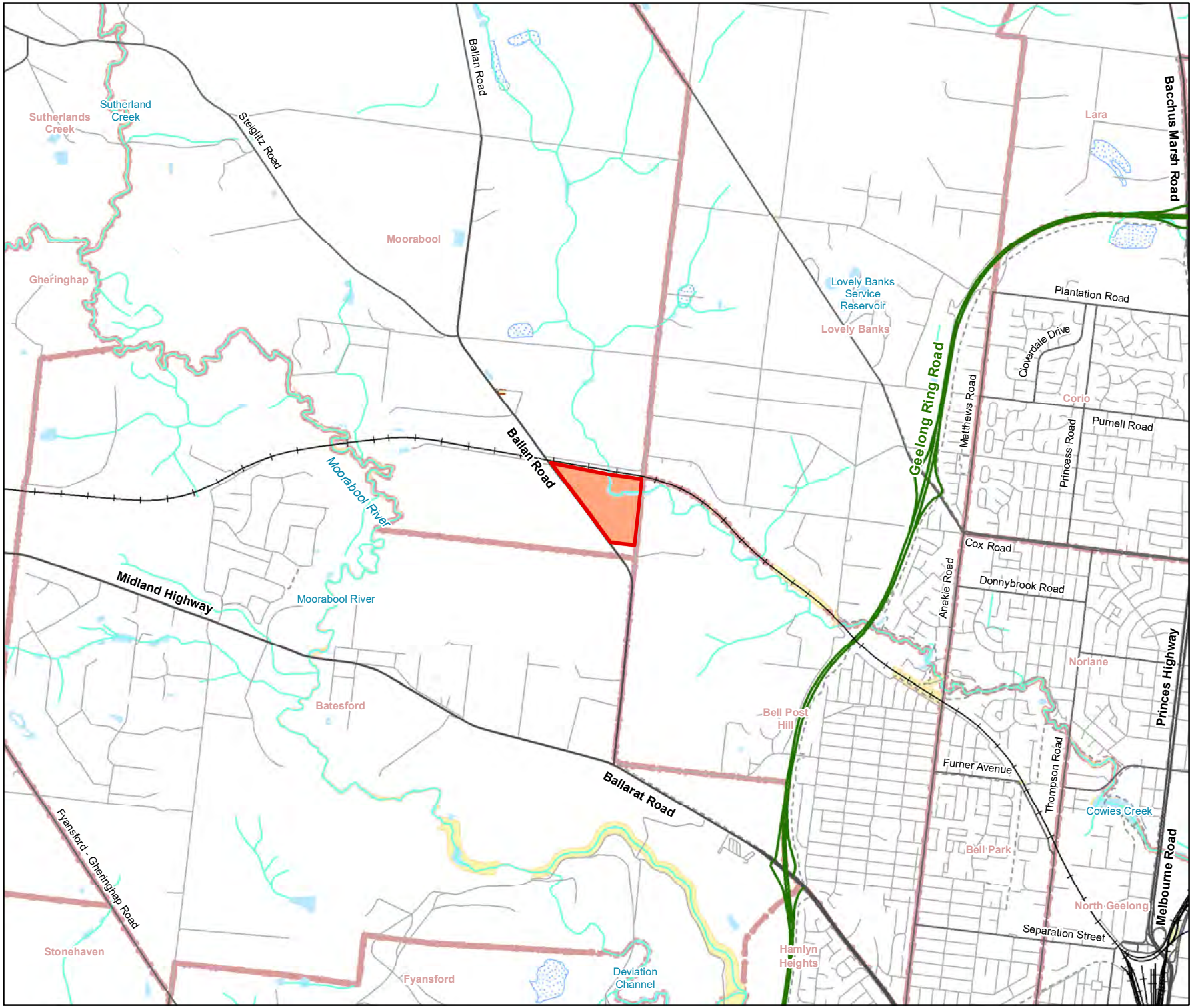
Robertson, P., Evans, M. 2012. National Recovery Plan for the Grassland Earless Dragon *Tympanocryptis pinguicolla*

Victorian Urban Stormwater Committee 1999. *Urban Stormwater: Best Practice Environmental Management Guidelines*. CSIRO, Collingwood, Victoria.

Wassens S. 2005. The use of Space by the Endangered Southern Bell Frog *Litoria raniformis* in the Semi-Arid Region of New South Wales, Australia. PhD Thesis, Charles Sturt University, Wagga Wagga, NSW.

White A. W. and Pyke G. H. 1996. Distribution and conservation status of the green and golden bell frog *Litoria aurea* in New South Wales. *Australian Zoologist* 30, pp. 177-189.

FIGURES



Legend

- Study Area
- Railway
- Freeway
- Major Road
- Collector Road
- Minor Road
- Proposed Road
- Minor Watercourse
- Permanent Waterbody
- Land Subject To Inundation
- Commonwealth Land
- Crown Land
- Localities

Figure 1

Location of the study area

Growling Grass Frog Conservation Management Plan for 200 Geelong-Ballan Road, Moorabool

N

0 450 900

Metres

Map Scale: 1:40,000 @ A4
Coordinate System: GDA 1994 MGA Zone 55

ecology & heritage partners

17861_Fig01_StudyArea 1/02/2024 dvaladares

Legend

- Study Area
- Growling Grass Frog habitat
- 50m buffer around Cowies Creek
- Cowies creek coridor
- Residential development

Survey locations

- Growling Grass Frog
- Other species
- Call playback

Figure 2

Growling Grass Frog survey results

Growling Grass Frog Conservation Management Plan for 200 Geelong-Ballan Road, Moorabool

DRAFT

N

0 50 100

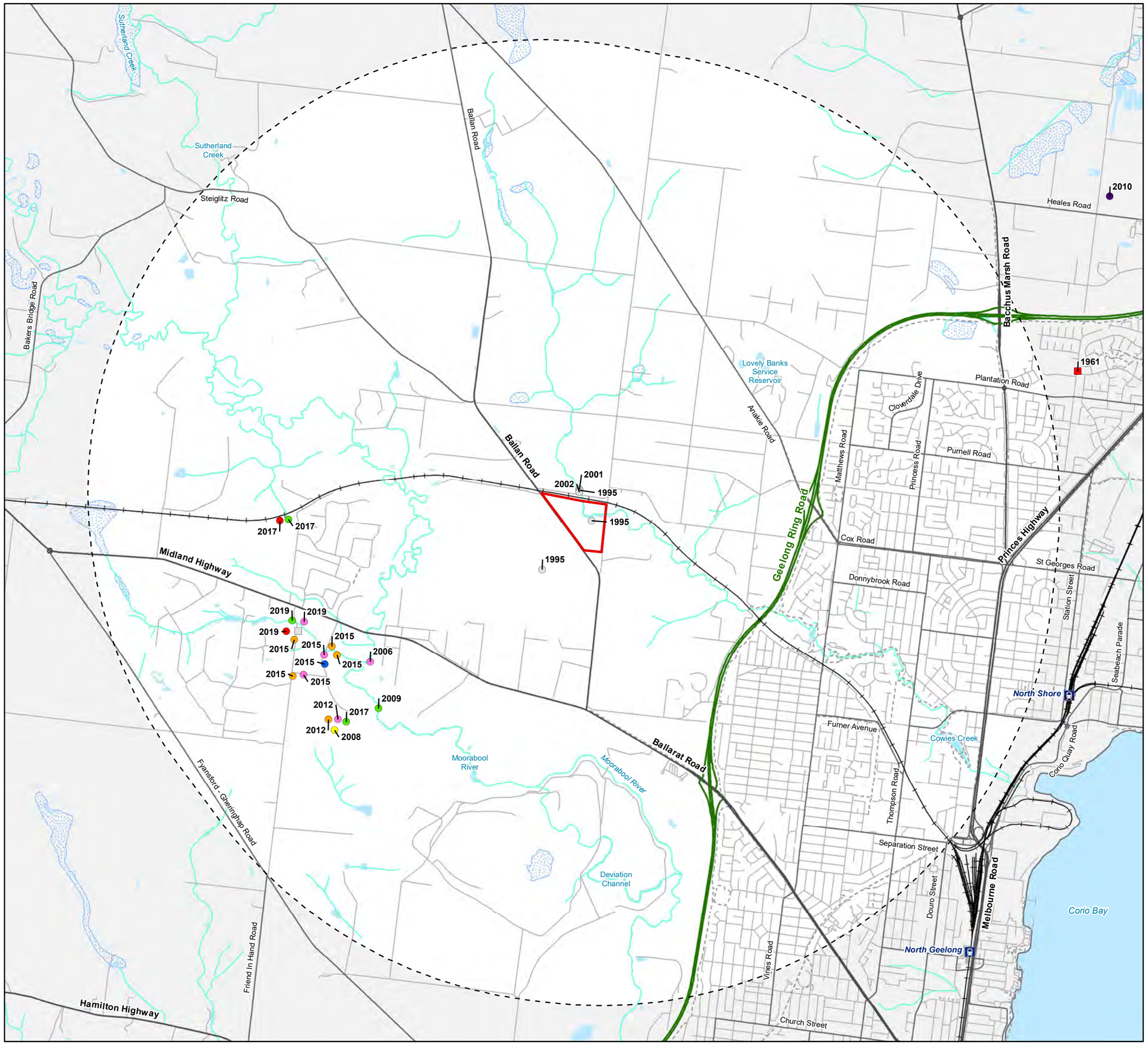
Metres

Map Scale: 1:3,500 @ A4
Coordinate System: GDA 1994 MGA Zone 55

ecology & heritage partners

17861_Fig02_GGFResults 27/11/2024 Melsley

Aerial source: Nearmap 2023



Legend

- Study Area

Significant flora

- Adamson's Blown-grass
- Fragrant Saltbush
- Giant Honey-myrtle
- Hairy Tails
- Melbourne Yellow-gum
- Mugga
- Snowy Mint-bush
- Spiny Rice-flower
- Spotted Gum
- Straw Wallaby-grass

Figure 3

Previously documented significant flora within 5km of the study area

Growling Grass Frog Conservation Management Plan for 200 Geelong-Ballan Road, Moorabool

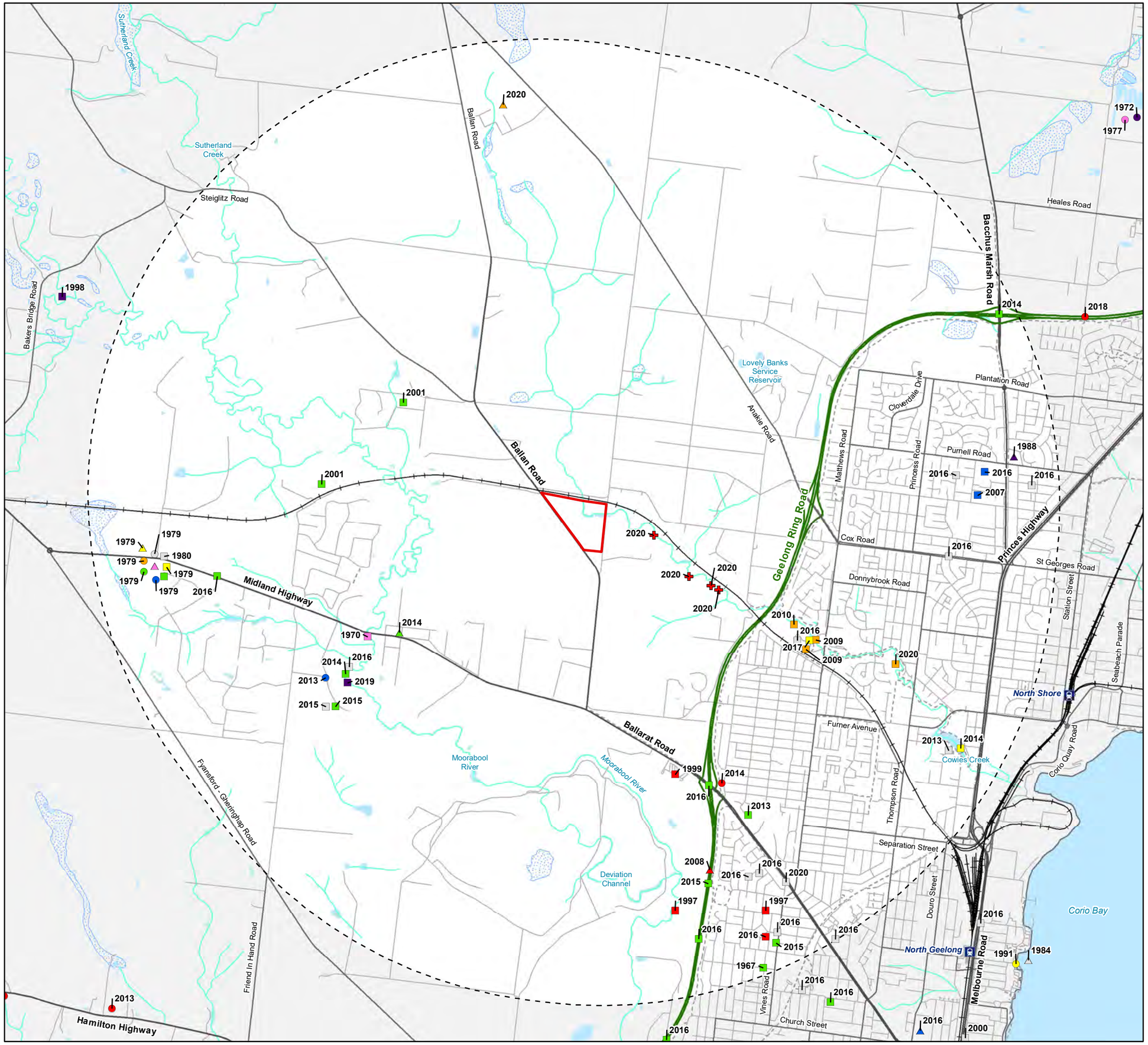
N

0 1 2

Kilometres

Map Scale: 1:40,000 @ A3
Coordinate System: GDA 1994 MGA Zone 55

ecology & heritage partners



Legend

Study Area

Significant fauna

- Australasian Shoveler
- Black Falcon
- Blue-winged Parrot
- Burrunan Dolphin
- Caspian Tern
- Diamond Firetail
- Eastern Barred Bandicoot
- Fat-tailed Dunnart
- Gang-gang Cockatoo
- Grey Goshawk
- Growling Grass Frog
- Latham's Snipe
- Little Eagle
- Little Egret
- Macquarie Perch
- Platypus
- Southern Humpback Whale
- Square-tailed Kite
- Striped Legless Lizard
- Swift Parrot
- White-bellied Sea-Eagle
- White-faced Storm-Petrel
- White-throated Needletail
- Yellow Sedge-skipper Butterfly

Ecology and Heritage Partners records

- Growling Grass Frog

Figure 4

Previously documented significant fauna within 5km of the study area

Growling Grass Frog Conservation Management Plan for 200 Geelong-Ballan Road, Moorabool

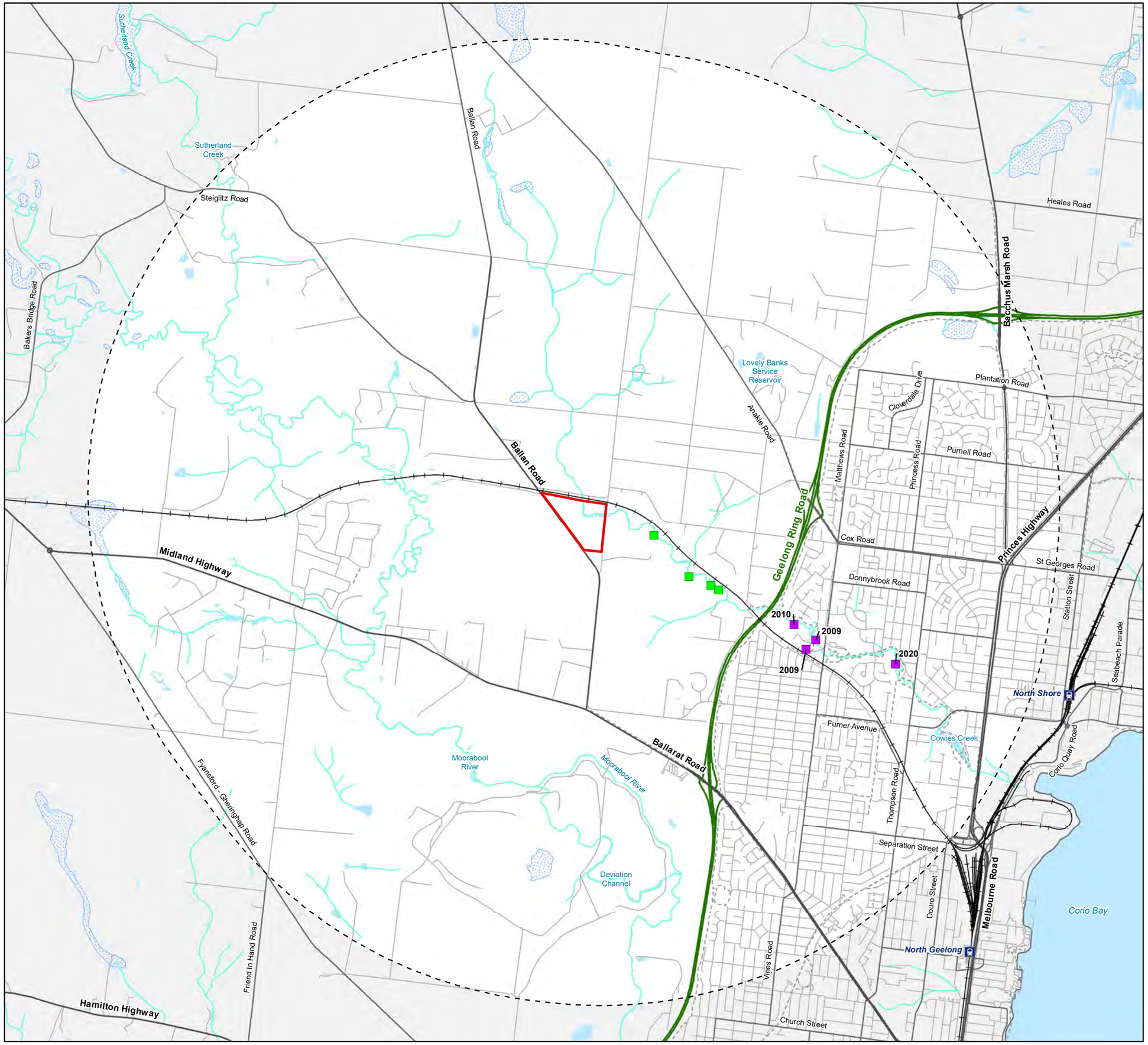
N

0 1 2

Kilometres

Map Scale: 1:40,000 @ A3
Coordinate System: GDA 1994 MGA Zone 55

ecology & heritage partners



Legend

- Study Area
- Growling Grass Frog records (VBA 2024)
- Growling Grass Frog records (Ecology and Heritage Partners 2020)

Figure 5

Previously documented Growling Grass Frog records within 5km of the study area

Growling Grass Frog Conservation Management Plan for 200 Geelong-Ballan Road, Moorabool

N

0 1 2

Kilometres

Map Scale: 1:40,000 @ A3
Coordinate System: GDA 1994 MGA Zone 55

ecology & heritage partners

Legend

- Study Area

Victorian Grassland Earless Dragon habitat assessment:

- Modified ornamental gardens
- Cropped/ploughed
- Unsuitable habitat

Figure 6

Habitat assessment for Victorian Grassland Earless Dragon

200 Geelong-Ballan Road, Moorabool

DRAFT

0 50 100

Metres

Map Scale: 1:4,800 @ A4
Coordinate System: GDA 1994 MGA Zone 55

ecology & heritage partners

17861_Fig06_GED_Habitat 27/11/2024 Melsley

Aerial source: Nearmap 2023

APPENDICES

APPENDIX 1 – GROWLING GRASS FROG CONSERVATION MANAGEMENT PLAN

Draft Report v2

Growling Grass Frog Litoria raniformis major Conservation Management Plan for the Proposed Development at 200 Geelong-Ballan Road, Moorabool, Victoria

Prepared for

Tango Projects

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Ecology and Heritage Partners acknowledge the Traditional Owners of the country we live and work on, and we pay our respect to Elders past, present and emerging.

ACRONYMS AND ABBREVIATIONS

Acronym	Description
CaLP	*Catchment and Land Protection Act 1994*
CMA	Catchment Management Authority
DCCEEW	Commonwealth Department of Climate Change, Energy, the Environment and Water
DEECA	Victorian Department of Energy, Environment and Climate Action
DELWP	Victorian Department of Environment, Land, Water and Planning
DEPI	(former) Victorian Department of Environment and Primary Industries
DoE	(former) Commonwealth Department of Environment
DoEE	(former) Commonwealth Department of Environment and Energy
DSEWPaC	(former) Commonwealth Department of Sustainability, Environment, Water, Populations and Communities.
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999*
EVC	Ecological Vegetation Class
FFG Act	*Flora and Fauna Guarantee Act 1988*
FIS	Flora Information System
GGF	Growling Grass Frog *Litoria raniformis major*
HabHa	Habitat Hectare
NES	National Environmental Significance
NVIM Tool	Native Vegetation Information Management Tool (DEECA)
P&E Act	*Planning and Environment Act 1987*
PMST	Protected Matters Search Tool (DCCEEW)
VBA	Victorian Biodiversity Atlas (DEECA)

EXECUTIVE SUMMARY

Introduction

Ecology and Heritage Partners Pty Ltd were commissioned by Tango to prepare a Conservation Management Plan (CMP) for the nationally threatened Growling Grass Frog *Litoria raniformis major* for the property at 200 Geelong-Ballan Road, Moorabool, Victoria (Figure 1). The site is proposed to be developed for residential purposes, with construction planned to commence following adoption of the wider Creamery Road Precinct Structure Plan (PSP).

This document provides a detailed plan to mitigate against potential impacts to the existing Growling Grass Frog population and associated habitats within the study area during pre-development, development, and post-development stages. A development plan has been prepared for the property, with approximately 330-350 residential lots proposed (A Different City 2024).

The overall aim of this CMP is to provide detailed measures to ensure any proposed activities for the property do not have a significant impact on the Growling Grass Frog population and supporting habitat along Cowies Creek. This CMP outlines management actions to meet this objective through the protection, enhancement, and ongoing management of Growling Grass Frog habitat. The CMP also outlines monitoring requirements to ensure that the species is not adversely affected during works and following development of the site.

Growling Grass Frog Habitat Enhancement

The enhancement of the Growling Grass Frog Cowies Creek habitat corridor will provide high quality foraging and potentially breeding habitat for the species and improve habitat connectivity and dispersal corridors through the property to ensure that dispersal opportunities along the habitat corridor are maintained.

Growling Grass Frog habitat enhancement is proposed through the provision of the following:

- Planting of suitable emergent and floating vegetation species, enabling greater basking and breeding opportunities for the species while providing additional protective habitat;
- Provision of rock mattresses or loose rock, as refuge and overwintering sites around the creek margin; and,
- Weed and pest animal control.

Management Actions

The Cowies Creek habitat corridor will be protected from the surrounding future land uses through the proposed Conservation Area and be managed for the purposes of conservation of Growling Grass Frog through the control of pest animals and environmental weeds.

The use of the study area as a dispersal corridor will be maintained and enhanced via the enhancement improvement of existing Growling Grass Frog foraging habitat.

Appropriate population and habitat monitoring schedules will be implemented to assess the impact of the development and/or monitor the suitability of the site's management regime.

CONTENTS

1 INTRODUCTION

1.1 Project Background

Ecology and Heritage Partners Pty Ltd were commissioned by Tango to prepare a Conservation Management Plan (CMP) for the nationally threatened Growling Grass Frog *Litoria raniformis major* for the property at 200 Geelong-Ballan Road, Moorabool, Victoria (Figure 1). The site is proposed for development following adoption of the wider Creamery Road Precinct Structure Plan (PSP).

Targeted surveys for Growling Grass Frog conducted by Ecology and Heritage Partners (Ecology and Heritage Partners 2024) confirmed that the study area is used by an existing population of the species present along Cowies Creek (Figure 1).

This document provides a detailed plan to mitigate against potential impacts to the existing Growling Grass Frog population and associated habitats within the study area during pre-development, development, and post-development stages. A development plan has been prepared for the property, with approximately 330-350 residential lots proposed (A Different City 2024).

A Conservation Area is proposed for the property and surrounds either side of the Cowies as part of the Cowies Creek Growling Grass Frog Conservation Management Plan (GGFCMP), prepared by Biosis as part of the Creamery Road Precinct Structure Plan (PSP) process.. However, the Cowies Creek GGFCMP and Conservation Area boundary had yet to be finalised at the time of writing this report, with the Landscape Masterplan currently in preparation. The objective of the Cowies Creek GGFCMP is to provide protection and adaptive management measures to ensure the long-term viability of a Growling Grass Frog population within the Western Geelong Growth Area (WGGA), particularly along the Cowies Creek habitat corridor as part of the future development of the Precinct. The management actions proposed in this CMP will be largely in accordance with the Cowies Creek GGFCMP and the Growling Grass Frog Habitat Design Standards where possible (DELWP 2017).

1.2 Objectives

The overall aim of this CMP is to provide detailed measures to ensure any proposed activities for the property do not have a significant impact on the Growling Grass Frog population and supporting habitat along Cowies Creek. This CMP outlines management actions to meet this objective through the protection, enhancement, and ongoing management of Growling Grass Frog habitat. The CMP also outlines monitoring requirements to ensure that the species is not adversely affected during works and following development of the site. Specifically, this CMP aims to:

- Determine what management actions are required to avoid negatively impacting the resident Growling Grass Frog population;
- Provide a map showing the extent of current Growling Grass Frog habitat within the study area and surrounds;
- Provide detailed management measures to further minimise impacts on the Growling Grass Frog population during any development works;

- Provide detailed management and habitat design measures which provide for the maintenance and enhancement of habitat for Growling Grass Frog including:
    - Pre-development: habitat enhancement requirements, including development design considerations; details of design;
    - During development: management requirements for protecting existing habitat from sedimentation and pollution and direct disturbance that may result from development activities; providing advice and recommendations on other habitat protection requirements, such as establishment of 'no-go' zones and clearly marked fencing; and,
    - Post-development: management requirements, including vegetation, water quality, protection of habitat from current and potential future threats (such as foxes, feral and domestic cats and Eastern Gambusia); and,
- Outline monitoring, maintenance and reporting requirements post development.

The following sections detail the subject site, the project and legislative context and the key project stakeholders.

1.3 Study Area

The study area is located at 200 Geelong-Ballan Road, Moorabool and is approximately 9 kilometres north-west of Geelong's CBD (Figure 1). The study area covers approximately 30 hectares, including approximately 6 hectares likely to be subject to a Growling Grass Frog conservation area in the north-east corner of the property. The study area is bound Warners Road to the north, Evans Road to the east, and Geelong-Ballan Road to the south-west. Importantly, Cowies Creek traverses the study area in the north-east corner of the property, and forms part of a larger Growling Grass Frog habitat corridor for an important population.

The study area is currently used for agriculture and farming, with a residence and outbuildings on site. No dams or ponds are present in the study area. The study area gently slopes in the direction of Cowies Creek, with a depression also running in a north-south direction from Cowies Creek towards the existing residence. The study area is within the Creamery Road Precinct Structure Plan (PSP). A Native Vegetation Precinct Plan for Creamery Road PSP is yet to have been produced.

Patches of Creekline Grassy Woodland were recorded within the study area during existing conditions surveys in 2020 (Ecology and Heritage Partners 2021). All areas of native vegetation are likely to be protected under the Conservation Area, according to the draft design. According to the Department of Energy, Environment and Climate Action (DEECA) NatureKit Map (DEECA 2024), the study area is located in Victorian Volcanic Plain. It is situated within the jurisdiction of the Corangamite Catchment Management Authority (CMA) and the Greater Geelong City Council municipality.

1.4 Project and Legislative Context

The study area is within the Creamery Road PSP, which is currently being developed alongside a Native Vegetation Precinct Plan. A Conservation Area is currently in development for the Cowies Creek Growling Grass Frog habitat corridor and is yet to have been finalised. Currently, a stormwater facility is proposed for the area to the west of Cowies Creek in the northern extent of the study area.

To mitigate against the potential impacts to the resident Growling Grass Frog population, habitat protection and conservation will be undertaken within the study area.

There is a need to ensure protection for the existing Cowies Creek species habitat corridor from future residential and infrastructure development as part of the Creamery Road PSP. Where possible, Growling Grass Frog habitat should be enhanced, to ensure the ongoing persistence of an important Growling Grass Frog population. The extent of likely Growling Grass Frog aquatic and dispersal habitat is described below (Table 1) and represented on Figure 2. Areas identified for habitat protection and enhancement have the primary aim of ensuring there is an overall improvement for the species (i.e. provision of high-quality breeding and foraging habitat) (Figure 1).

Table 1. Growling Grass Frog habitat breakdown

Habitat Area	Description	Approx. area of Habitat (Ha)
Cowies Creek	Existing aquatic habitat	1
Cowies Creek	Existing terrestrial habitat	1.6

1.5 Previous Reports

This CMP has been developed with reference to relevant research, best practice management guidelines and the following reports previously prepared for the site and immediate surrounds:

- Preliminary Documentation: Proposed development at 200 Geelong-Ballan Road, Moorabool (Ecology and Heritage Partners 2024);
- Cowies Creek Stormwater Impacts: 200 Ballan Road, Moorabool (Rain Consulting 2024);
- Draft Cowies Creek Growling Grass Frog Conservation Management Plan (Biosis 2023);
- Existing Ecological Conditions report, including Targeted Growling Grass Frog surveys for Northern and Western Geelong Growth Areas (Ecology and Heritage Partners 2021); and,
- Matters of National Environmental Significance Assessment: Creamery Road PSP Area, Geelong West (Nature Advisory 2020).

In addition to reports focussing on the 200 Geelong-Ballan Road, Moorabool, the literature review has included numerous reports and research papers that have either referenced the site or provided information specific to the retention and management of Growling Grass Frog on site.

2 GROWLING GRASS FROG

2.1 Species Profile

The Growling Grass Frog is listed as Vulnerable under the EPBC Act, Endangered under the *Flora and Fauna Guarantee Act* 1988 (FFG Act), and Vulnerable under the National Action Plan for Australian Frogs (Tyler 1997). It is one of the largest frog species in Australia, reaching up to 104 millimetres in length, with females usually larger (60–104 millimetres) than males (55–65 millimetres) (Barker *et al*. 1995). The species varies in colour and pattern, but is generally olive to bright emerald green, with irregular gold, brown, black or bronze spotting (Plate 1). Vörös *et al.* (2023) identified two lineages for *Litoria raniformis, L. r. raniformis* for the northern lineage and *L. r. major* for the southern lineage.

Growling Grass Frog is largely associated with permanent or semi-permanent still and slow flowing waterbodies (i.e. streams, lagoons, farm dams and old quarry sites) (Barker *et al*. 1995). Individuals can also use temporarily inundated waterbodies for breeding purposes providing they contain water over the breeding season (Organ 2010). The species is typically associated with waterbodies supporting an extensive cover of emergent, submerged and floating vegetation (Robertson *et.al*. 2002; Heard *et.al*. 2010).

Plate 1. Growling Grass Frog (Source: Ecology and Heritage Partners Pty Ltd)

Emergent vegetation provides basking sites for frogs and protection from predators, while floating vegetation provides suitable calling stages for adult males, breeding and oviposition (egg deposition) sites (Heard *et.al*. 2004). Terrestrial vegetation (grasses, sedges), rocks and other ground debris around a wetland perimeter also provide foraging, dispersal and over-wintering sites for frogs (Heard *et.al*. 2010). Studies have revealed that the spatial orientation of waterbodies across the landscape is one of the most important habitat determinants influencing the presence of the species at a given site (Robertson *et al*. 2002; Heard *et al*. 2010). Waterbodies supporting the aforementioned habitat characteristics, and which are located within close proximity to each other are more likely to support a population of Growling Grass Frog, compared with isolated sites lacking important habitat features.

Although formerly widely distributed across southern eastern Australia, including Tasmania (Littlejohn 1963, 1982; Hero *et al*. 1991), the species has declined markedly across much of its former range (Mahony 1999). Historically, this species has been recorded from most regions of Victoria, with the exception of Mallee and Alpine areas (Littlejohn 1963, 1982; Hero *et al*. 1991). The known range of this species has contracted dramatically over the past two decades and in many areas, particularly in south and central Victoria, populations have experienced serious declines and local extinctions. The key factors in decline include habitat destruction and fragmentation, drought, increased predation by vertebrate predators, and adverse impacts from the water-borne fungal pathogen Batrachochytrium dendrobatydis, which causes chytridiomycosis disease (Chytrid Fungus) (Heard *et.al*. 2012). This highlights the importance of preserving the species by protecting or enhancing remnant or intact habitat areas, particularly those surrounded by high density or impending development.

2.2 Local Abundance and Distribution

Growling Grass Frog has previously been recorded in high abundance within the Cowies Creek in 2020 (Ecology and Heritage Partners 2021). The results of the targeted surveys identified a large population of the nationally listed Growling Grass Frog that occurred throughout Cowies Creek within the Western Geelong Growth Area (WGGA). Individuals were recorded within areas of pooling water with fringing habitat. Although sections of Cowies Creek were dry, the entire extent of the Creek within the WGGA was considered habitat for the species (Ecology and Heritage Partners 2021).

Five Growling Grass Frogs were recorded approximately 500 metres east of the study area along Cowies Creek, while a further 45 individuals were recorded approximately 1-2 kilometres east of the study area along the same habitat corridor (Ecology and Heritage Partners 2021a).

More recently, targeted surveys for Growling Grass Frog were undertaken on 7 and 29 February and 6 March 2024. A maximum of two Growling Grass Frog specimens were recorded within the study area on any one survey event during targeted surveys in 2024. On 7 February 2024, one Growling Grass Frog was heard calling on the eastern extent of the site but was not visually observed. On 29 February 2024 two adult Growling Grass Frogs were visually observed in fringing vegetation along the creekline. A further Growling Grass Frog individual was recorded on the southern edge of the creekline on 6 March 2024 (Figure 2).

Given the connectivity between the study area and the large extent of suitable habitat along Cowies Creek with the confirmed presence of an important population, it is likely that the study area is used by the species as a dispersal corridor. Based on the findings of detailed survey and habitat assessments, this section of creekline supports low-quality Growling Grass Frog breeding and foraging habitat, and is unlikely to provide breeding habitat for the species.

2.3 Relevant Threatening Processes

Potential threatening processes for Growling Grass Frog resulting from future development come from two main sources: indirect and direct impacts from construction activities (including removal of known habitat) on an important population present along the Cowies Creek habitat corridor. Potential impacts to Growling Grass Frog are to be mitigated via this GGFCMP and the preparation of a Construction Environmental Management Plan.

2.3.1 Hydrology and Water Quality

Based on known information of water quality tolerances and preferences by Growling Grass Frog it appears that the species requires waterbodies containing low levels of nitrates, nitrides and phosphates (Ashworth 1998; Organ 2002, 2003). Water quality may be particularly important for larval development and recruitment. It should also be noted that studies have shown conflicting findings on the relationship between basic water quality parameters and wetland occupancy (Heard and Scroggie 2008). For example, Wassens (2005) found a preference for wetlands with a relatively low pH, whereas Hamer and Organ (2008) found the opposite to be the case. Similar discrepancies have been found with conductivity (Heard and Scroggie 2008), and this relationship is also confounded by the fact that conductivity may affect the prevalence of Chytrid fungus (2.3.2). Efforts to control basic water quality parameters for Growling Grass Frog may be unnecessary;

however, conductivity should not increase beyond the approximate limit for the species of 10000 µS/cm (Heard and Scroggie 2008).

All stormwater flow and discharge from the surrounding area will be directed away from the Cowies Creek habitat corridor or treated before entering the creek to ensure that there is no negative impact to water quality or that external contaminants are inadvertently introduced. However, construction activities associated with future development have the potential to result in release of sediment-laden runoff. There is also the potential for accidental spillage of chemicals from any future construction area to runoff into the creek. Increase in sediment input and input of toxic substances into Victorian rivers and streams due to human activities are both threatening processes under Schedule 3 of the FFG Act.

2.3.2 *Chytrid fungus*

There is evidence to suggest that the decline of many frog species in Australia and elsewhere could be related to the disease caused by the water-borne fungal pathogen *Batrachochutrium dendrobatidis*, commonly referred to as Chytrid fungus. Chytrid fungus is a major threat to amphibian populations in Australia, with at least one species driven to extinction and populations of other threatened species, particularly the Growling Grass Frog, severely compromised (DEWHA 2006). The disease that results from Chytrid fungus infection causes significant physical and physiological problems for frogs, such as skin flaking, reduced food intake, cardiac arrest and mortality (Peterson 2012). Infection of amphibians with the fungus is listed as a 'key threatening process' under the EPBC Act.

There is an inherent risk of spreading the fungus within and between areas in the landscape by the movement of infected frogs and tadpoles, water, soil and vegetative material; the outcome of which can be extremely deleterious if it is introduced into Growling Grass Frog populations presently free of the disease. Chytrid prevalence has found to be decreased in wetlands with elevated salinity levels and higher temperatures (Heard *et al.* 2012).

2.3.3 *Human Access*

Human occupancy within the study area has the potential to result in disturbance by persons entering the Growling Grass Frog habitat corridor. This may lead to the degradation of habitat in or around the creek due to rubbish dumping, mechanical disturbance of vegetation from trampling, and weed invasion.

The placement of walking and/or bicycle paths and trails will be prohibited within the 50 metres 'no impact' buffer zone from Cowies Creek aquatic habitat (i.e. the creekline) to minimise human disturbance in these areas. Construction activities must also be restricted in known habitat areas to minimise human and vehicular disturbance during the development phase. An exclusion zone will be implemented around the habitat corridor to protect the core Growling Grass Frog habitat on site.

2.3.4 *Weeds*

Increased weed encroachment into areas of indigenous or planted terrestrial and aquatic vegetation in wetland complexes may occur due to runoff from development. Weeds may also be transported via construction equipment and machinery, and people/animals entering the Precinct. Invasion of native vegetation by 'environmental weeds' is a threatening process under Schedule 3 of the FFG Act. Excessive

weed growth can smother frog habitat, rendering it unsuitable as a breeding and /or foraging site. Environmental (*Brassica sp*.) and noxious weeds (Spiny Rush *Juncus acutus*) were recorded on site during the site assessment.

Consequently, a Weed Management Plan may need to be prepared to identify potential threats associated with pest plant species, that may impact environmental values within the study area. The Weed Management Plan should provide appropriate management actions to address weed infestations and vertebrate pest species, to ensure environmental values within the study area are maintained and enhanced.

2.3.5 Noise

Noise from building and other works relating to the development will comply with the Building works – Local Law requirements (Greater Geelong City Council 2014), where building or other works may not emit excessive or offensive noise. Works can only be carried out on any land between the hours 7.00 am and 6.00 pm on weekdays, 9.00 am and 6.00 pm on Saturdays, Sundays and public holidays. Restricting noise created by building works will allow males to call to attract a mate, and thus the noise associated with construction and the future use of the area (i.e. commercial use) is unlikely to reduce breeding success by the species.

2.3.6 Light Pollution

Growling Grass Frog are a predominantly nocturnal species. Artificial light pollution may increase the risk of predation of Growling Grass Frog by foxes and Cats and may also disrupt mating activities of the species. As such, sources of artificial light from the surrounding development will be directed away from the existing and proposed constructed habitat. There should be no additional lighting directed towards the existing and proposed habitat associated with future development works, to allow frogs to move along the corridor undisturbed, and to avoid any negative impact caused by artificial light pollution.

2.3.7 Dogs, Cats and Exotic Predators

Dogs and Cats

Unrestrained dogs *Canis vulpes* and Cats *Felis catus* have the potential to roam into the Growling Grass Frog habitat corridor. Cats in particular are known to predate upon dispersing or sheltering frogs. Predation of native wildlife by Cats is a threatening process under Schedule 3 of the FFG Act. Surrounding residential development is likely to introduce unrestrained cats that may also hunt and kill Growling Grass Frog. It is understood that a Cat curfew is currently enforced in the City of Greater Geelong with domestic cats required to be indoors from sunset to sunrise, which will minimise the risk to frogs.

The entire Growling Grass Frog habitat corridor and surrounding 50 metre terrestrial buffer will be appropriately fenced to exclude public access and avoid unrestrained access into the created habitat areas by dogs and their owners.

Eastern Gambusia

The introduced Eastern Gambusia has been identified as a possible factor in the decline of species in the "bell frog species complex", which includes Growling Grass Frog (Mahony 1999; White and Pyke 1996; Hamer *et al*.

2002) because it eats the eggs and tadpoles of these species (Morgan and Buttermer 1996). Eastern Gambusia may reduce the potential of a site to support breeding populations, although the extent of predation depends on aquatic vegetation and habitat complexity, and waterbody permanency (Hamer et al. 2002). Predation by Eastern Gambusia on tadpoles of Growling Grass Frog may be a significant threat to the species.

Eastern Gambusia was detected within Cowies Creek during recent ecological surveys for the WGGA (Ecology and Heritage Partners 2021).

Red Fox

Red Fox is likely to move through the study area. The species is known to hunt and eat adult members of the bell frog species complex. Feral Animal Control measures may be required in the study area to reduce the population size of foxes.

2.4 Growling Grass Frog Habitat within the Study Area

Growling Grass Frog habitat in the study area was initially assessed during a site assessment undertaken in 2020 as part of the Existing Ecological Conditions assessment for the WGGA (Ecology and Heritage Partners 2021). Additional detailed habitat assessments were undertaken on 2 November 2022 and 7 February 2024. During the site assessment, the quality and extent of suitable habitat was determined, considering the following habitat variables:

- Quality of vegetation and presence of weeds;
- Aquatic vegetation cover (% cover of emergent, submergent and floating aquatic plants);
- Hydroperiod, water depth and water flow;
- Availability of refuge sites (e.g. rocks, logs)
- Proximity to other suitable habitat in the surrounds;
- Evidence of introduced predators; and
- Evidence of litter and/ or disturbance.

The study area supports low-quality Growling Grass Frog breeding habitat due to the lack of key habitat features for the species, including floating and emergent vegetation, and structural fringing habitat such as rushes and grasses forming large tussocks (Plate 2-5). Fringing vegetation is present throughout Growling Grass Frog habitat in the study area and is typically in the form of *Juncas spp.* and exotic pasture grasses such as Toowoomba Canary-grass. There is minimal basking habitat (i.e. exposed rock) while this section of the creek does not contain floating or submerged vegetation (e.g. Floating Pondweed such as Sago Pondweed *Potamogeton pectinatus* which is an important habitat component required for calling males and which is a high predictor of site occupancy of the species). There is also low-moderate percentage cover (<20%) of emergent vegetation.

Species observed using habitat within the study area were restricted to Eastern Common Froglet *Crinia signifera* and Eastern Banjo Frog *Limnodynastes dumerilii*, Spotted Marsh Frog *Limnodynastes tasmaniensis*. At least two Growling Grass Frog specimens were recorded within the study area during targeted surveys in 2024 (Ecology and Heritage Partners 2024). Given the connectivity between the study area and the large

extent of suitable habitat along Cowies Creek with the confirmed presence of an important population, it is likely that the study area is used by the species as a dispersal corridor. Based on the findings of detailed survey and habitat assessments, this section of creekline supports low-quality Growling Grass Frog breeding and foraging habitat and is unlikely to provide breeding habitat for the species.

Areas adjacent to the waterbody consisted of open pasture/ introduced grasses and may be used by Growling Grass Frog during dispersal events (i.e. warm, wet conditions) (Plate 4). However, Growling Grass Frog are unlikely to disperse through areas greater than 50 metres from the creekline as no further aquatic habitat (i.e. dams or ponds) is present within or adjacent to the site beyond Cowies Creek. No disturbance (i.e. pugging, scats) was noted along the creek as the area had been fenced off from cattle.

In situ water quality was collected at several sites (Plate 6) along Cowies Creek within the study area and included the following parameters (Table 2):

- Water temperature;
- pH;
- Electrical conductivity;
- Dissolved oxygen; and
- Turbidity.

Water quality results show low-quality Growling Grass Frog aquatic habitat. Water along the creek line is shown to be highly turbid, which is detrimental to Growling Grass Frog. It is also likely that high nutrient levels are present along this section of the creek due to the high number of waterbirds observed using the site and the proximity of historical cropping areas.

Table 2. In situ water quality testing results.

Water quality testing site	Date	Temp °C	Dissolved Oxygen mg/L	Total dissolved solids g/L	Electrical Conductivity (mS/cm)	pH (pH units)	Salinity
1	2 November 2022	12.61	6.34	0.211	0.307	8.3	0.2
2	2 November 2022	11.27	4.58	0.336	0.522	8.44	0.3
3	2 November 2022	11.37	5.55	0.328	0.328	8.32	0.2
4	2 November 2022	11.27	6.5	0.209	0.322	8.18	0.2

Plate 2. Near Site 4 (Ecology and Heritage Partners Pty Ltd 2/11/2022).

Plate 3. Site 1 (Ecology and Heritage Partners Pty Ltd 2/11/2022).

Plate 4. Site 3 (Ecology and Heritage Partners Pty Ltd 2/11/2022).

Plate 5. Near Site 2 (Ecology and Heritage Partners Pty Ltd 2/11/2022).

Plate 6. Water quality testing site locations

3 CONSERVATION MANAGEMENT PLAN

3.1 Proposed Habitat Enhancement

Growling Grass Frog habitat enhancement is proposed through the provision of the following:

- Planting of suitable emergent and floating vegetation species, enabling greater basking and breeding opportunities for the species while providing additional protective habitat;
- Provision of rock mattresses or loose rock, as refuge and overwintering sites around the creek margin; and,
- Weed and pest animal control.

The No-Go Area will be established in the Conservation Area extent. All habitat improvement works within the No-Go-Area will be undertaken by a qualified and experienced wetland revegetation specialist / contractor in accordance with the provisions of this CMP and an approved Landscape Masterplan. There will be ongoing management of threatening processes such as weed and pest animal control, and there will be no introduction of predatory species to created habitat.

As indigenous flora provides valuable habitat for indigenous fauna, any landscape plantings that are undertaken as part of the proposed works will be conducted using indigenous species sourced from a local provenance, rather than exotic deciduous trees and shrubs (Attachment C). The Growling Grass Frog Habitat Design Standards (DELWP 2017) has been reviewed to provide a list of suitable species to be used when establishing vegetation within the Growling Grass Frog habitat (Attachment C). Trees and/or large shrubs must not be planted within 20 metres of the banks of Growling Grass Frog habitat corridor as this may shade out the creek, thus potentially rendering it unsuitable for the species and providing vantage points for predatory birds.

3.1.1 Growling Grass Frog Enhancement

The enhancement of Growling Grass Frog habitat will provide breeding and dispersal opportunities for the species, thus ensuring future dispersal connectivity for the known population through the study area between along Cowies Creek. The habitat enhancement will be implemented during and immediately following development, in years 1 and 2 of the CMP, and will be broadly informed by the *Growling Grass Frog habitat design standards* (DELWP 2017).

The Cowies Creek Growling Grass Frog habitat corridor must be:

- Designed to ensure water runoff from rooftops within any future development is appropriately treated;
- Supplied with the best feasible water quality consistent with Melbourne Water standard stormwater treatment practice;
- Able to sustain appropriate vegetation to provide habitat (see below);
- Include rock mattresses and/or loose rock as alternative refuge and overwintering sites around the creek margins (Plate 7); and,

- Trees and/or large shrubs must not be planted within 20 metres of the banks of Growling Grass Frog habitat corridor as this may shade out aquatic habitat, thus potentially rendering it unsuitable for the species.

A typical arrangement of a Growling Grass Frog wetland is provided below (Plate 7).

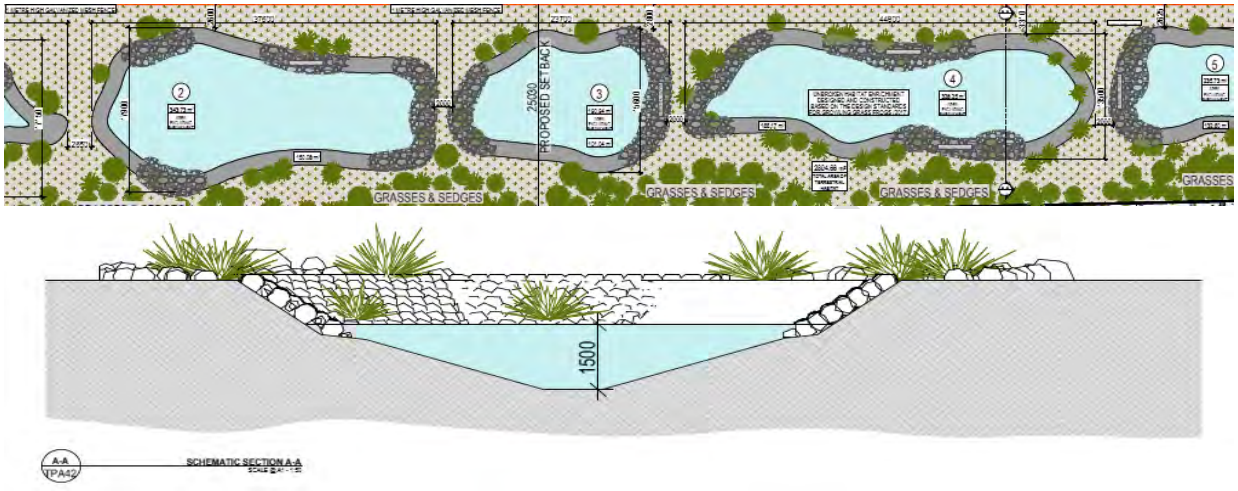


Plate 7. Rocky areas located between and around the perimeter of the wetland creek / wetlands extending into the aquatic habitat.

Growling Grass Frog aquatic habitat is required to support an extensive cover of aquatic and semi-aquatic vegetation, specifically to cater for an extant breeding population of Growling Grass Frog and to ensure that there is sufficient nutrient uptake to enhance water quality in the creek. To achieve these habitat requirements, Growling Grass Frog habitat corridor enhancements must aim to achieve three distinct zones (as shown in Plate 8):

- Zone 1: Littoral/ Ephemeral Wetland Zone: This zone incorporates the terrestrial planting area. Here the aim is to establish a moderate percentage cover of vegetation with bare ground areas for frog refuge occupying the margins of the creek. The margins will remain dry for extended periods, whilst the littoral/ephemeral zone will be subject to periodic inundation, and therefore must support plants able to tolerate wet conditions. A study by Heard *et al.* (2008) recorded most frogs perching on bare soil, rocks and leaf litter near the water's edge, with few occupying terrestrial vegetation stands. Their results indicated a preference for a low structural diversity in the vertical plane of terrestrial microhabitats. This zone must be created to incorporate the following structural features based on known sites where the species occurs:
    - A minimum width of five metres of ephemeral creek zone;
    - A minimum topsoil depth of 150 mm within all creek planting areas;
    - The planting area to contain floristically diverse and structurally similar vegetation planted at a nominal density of six individuals per square metre with the provision for areas of bare ground between plantings;
    - Plant species to reflect the Wet Verge Sedgeland Ecological Vegetation Class (EVC 932) and include, where appropriate, native vegetation including Common Spike-sedge (in low densities to prevent spreading), rushes *Juncus* spp and Tussock Grasses *Poa* spp. High

density planting is not encouraged as Growling Grass Frog seek refuge under rocks and timber debris;

- A selection of large concave (300-1,500 mm diameter) and small (3-5 boulders/m^2) rocks, extending at least one metre into the entry zone;
- Rock mattresses, as alternative refuge and overwintering sites around the pond margins; and,
- Rock piles and large woody debris around the outer creek margins and dense areas of rocks and logs along the banks, extending down five metres from the water's edge. Exposed rocks retain heat more readily and are beneficial to frogs compared to cooler shaded sections (i.e. Growling Grass Frog is known to use rocks for thermoregulation). Woody debris provide additional refugia and attract invertebrate prey. The location and spacing of refugia will vary to optimise microhabitat diversity.

- Zone 2: Entry Zone - This zone incorporates part of the aquatic planting area and refers to the edge of the creek where frogs can enter the water. The zone will be subject to frequent drying and will require plant species capable of tolerating fluctuating water levels. The following structural features must be considered:
  - A profile length of at least one metre;
  - A shallow 1:8 grade slope containing a variety of rocks and logs from the bank, with rocks down to at least one metre below the freeboard water level; and,
  - The shallow marsh planting area will extend from 0-0.25 metres below the water level. Terrestrial and aquatic species to be planted at a density of six plants per square metre;
- Zone 3: Embankment - This zone incorporates part of the aquatic planting area and provides a variety of aquatic vegetation, i.e. emergent (low density), submergent and floating plants (higher densities), for potential frog courtship, egg-laying, metamorphling/ tadpole cover and territorial displays. Typical aquatic vegetation will include Water Ribbon *Triglochin procerum*, Water Plantain *Alisma platago-aquatica*, and submerged or floating aquatic vegetation including Floating Pondweed *Potamogeton tricarinatus*, Nardoo *Marsilea drummondii*, and White Purslane *Neobassia proceriflora* (refer Attachment C). Heard *et al*. (2008) observed many Growling Grass Frog in or on mats of submergent and floating vegetation in post-breeding months. The study demonstrated that occupied microhabitats characterised by a high cover of floating vegetation over still, deep water, were more frequently occupied than high emergent or fringing cover, or high woody stem density. This zone must incorporate the following structural features:
  - A profile length of at least five metres;
  - A 1:2.5 grade slope abruptly steepening (variable grade) in the final approach to the adjacent deep-water zone;
  - A deep marsh planting area extending from 0.25-0.5 metres below the water level;
  - Plantings at a nominal six individuals per square metre for semi-aquatic plants (emergent species) and three individuals per square metre for aquatic species to a depth of 0.5 metres; and,

- Within 1-3 years the zone can support at least 40% submergent, 20% floating, and 30% emergent vegetation.

Recommended species for wetland planting known to be present in Growling Grass Frog habitats are provided in Attachment C. Newly vegetated wetlands are particularly vulnerable to damage caused by species of waterfowl, from foraging, roosting and nesting. Accordingly, any newly planted vegetation will be protected by appropriate netting, to allow vegetation to establish and provide suitable habitat for Growling Grass Frog.

The wetland revegetation specialist must consider the following additional issues:

- Timing of works - works will be undertaken between April and September inclusively and ideally planting should occur in late winter/ early spring, providing there is adequate rainfall;
- All works must be subject to disease control in accordance with the measures contained in Section 5.1 and the *Hygiene Protocols for the Control of Diseases in Australian Frogs* (Murray *et.al*. 2011) (Attachment D); and,
- Protective netting to be installed, where required, to prevent damage to aquatic plants by waterfowl.

The following species must not be included in the list of suitable species to be planted in order to avoid the risk of the creek becoming choked with vegetation;

- Narrowleaf Cumbungi *Typha domingensis*
- Broadleaf Cumbungi *Typha orientalis*
- Lesser Reed-mace *Typha latifolia*
- Common Reed *Phragmites australis*
- Tall Spike-rush *Eleocharis sphacelate*

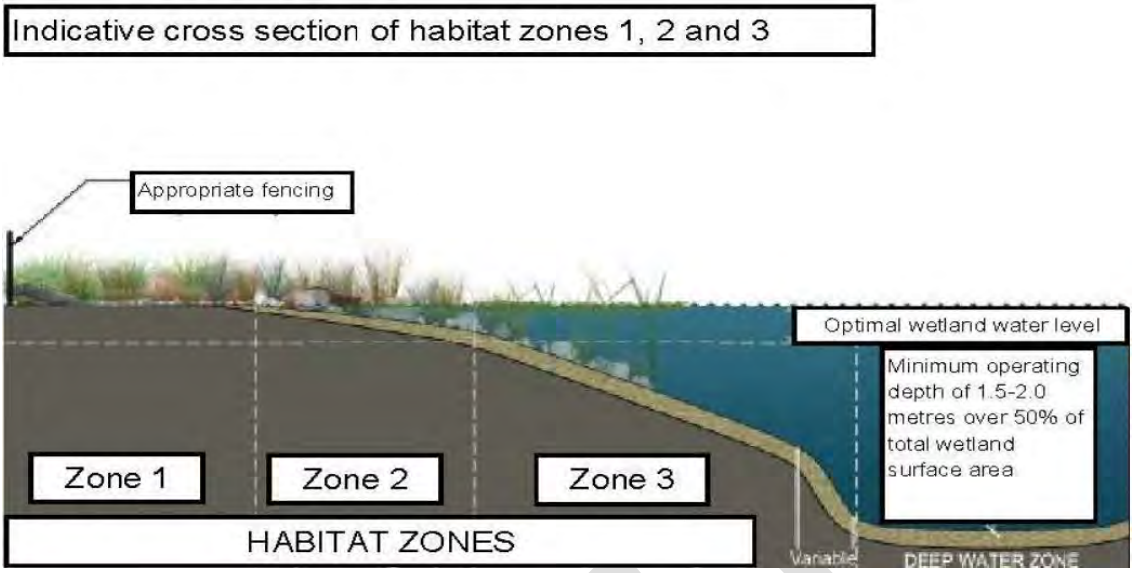


Plate 8. Growling Grass Frog wetland habitat zones

3.1.2 Habitat Maintenance

Maintenance of the constructed wetlands habitat area is to be undertaken as is identified through monitoring, with particular focus on the maintenance of aquatic vegetation diversity and structure. Once habitat improvement works are complete, habitat maintenance works will commence and be implemented by the developer until the completion of the 5-year plan, upon which the responsible authority will carry out ongoing maintenance of enhanced habitat within public land. It is considered that the enhanced habitat will primarily be self-sustaining and not require significant interventionist management, including the regulation of water levels.

Overall habitat conditions for Growling Grass Frog will be maintained within the site through the identification of issues during the monitoring program and through the implementation of suitable rectification measures. A summary of general maintenance requirements include:

- Regularly consult an experienced zoologist for maintenance issues that could impact on the Growling Grass Frog population and associated habitat;
- Undertake routine monitoring to investigate the success of aquatic and terrestrial plant establishment and weed densities;
- Replace any failed plantings;
- Control any weeds invading terrestrial habitat by hand, or spot treatment methods with frog sensitive herbicides;
- Revise mitigation and monitoring measures in agreement with responsible authorities, if necessary; and,
- Monitor the level of any public disturbance in and around Growling Grass Frog habitat and manage accordingly (e.g. fencing repairs and signage).

3.1.3 *Habitat Connectivity Surrounding the Study Area*

Aside from providing crucial habitat for Growling Grass Frog and other locally common frog species, habitat enhancement within the study area will provide an important source of connectivity between other high-quality stretches of Growling Grass Frog breeding and dispersal habitat along Cowies Creek.

Habitat enhancements that are created within a suitable distance of known Growling Grass Frog breeding populations are likely to be colonised by the species, provided they contain the necessary habitat characteristics such as suitable size, patches of emergent, floating and submerged vegetation, have good water quality, and provide a diversity of habitats.

Through the design, construction and establishment of aquatic vegetation and ongoing maintenance and management, there is a significant opportunity to increase the overall quality of Growling Grass Frog habitat in and surrounding the study area. This will contribute to the long-term viability (population processes) of local populations.

3.2 Roles and Responsibilities

The developer, consultants, contractors and staff associated with the development works, have a duty of care to:

- Avoid and minimise the occurrence and extent of potential impacts and threats to Growling Grass Frog individuals, populations, and the species, during any development and associated activities;
- Take all reasonable actions to protect and maintain the environment, during construction and associated activities;
- Report any issues or actions that may have the potential (even if marginal) to cause or exacerbate impacts and threats to the Growling Grass Frog population as well as the environment; and,
- Ensure that their actions are in accordance with the relevant environmental legislation, policies, management authorisations, permits and management protocols, including this CMP.

Implementation of this CMP will require the collaboration of a range of stakeholders. The following parties will be responsible for, or may potentially become involved in the implementation and support of the plan:

3.2.1 *Direct Involvement*

- The developer – Overall implementation of this CMP across the 5-year life of the plan, including:
    - Ensure that the Growling Grass Frog population, existing and enhanced habitats are protected within the study area;
    - Ensuring appropriate resources are available for the implementation of this CMP, including monitoring and maintenance;
    - Ensuring all site personnel who are implementing the CMP are appropriately qualified and have been inducted (Section 3.3.1);
    - Providing assistance and advice to all project personnel to fulfil the requirements of this CMP;
    - Acting as the principal point of contact in relation to environmental performance;

- Commissioning a Zoologist during salvage and relocation operations and ongoing monitoring, compliance and providing to DCCEEW;
- Addressing any complaints and adopting a consistent approach to achieving the objectives of this CMP; and,
- Liaising with relevant authorities and organisations when necessary.

- Wetland revegetation specialist/ contractor – Required to adhere to the recommendations of this CMP, in relation to all works relating to the enhancement of Growling Grass Frog habitat. Any amendment to the location or design of the enhanced Growling Grass Frog habitat would need to be discussed with a suitably qualified zoologist and DEECA.
- DEECA – DEECA will assess the suitability of this plan under the FFG Act, particularly the requirements specified in the action plan developed for Growling Grass Frog.
- Experienced zoologist (in relation to Growling Grass Frog) – Will be involved during the implementation of the plan, including undertaking salvage and relocation, and the monitoring of populations and habitats prior to, during and after any proposed development in the study area to ensure habitats remain suitable. The zoologist is also required to provide ongoing advice in relation to on-site management issues.
- Geelong City Council – Responsible for assessing the suitability of future developments (e.g. residential, industrial) in the vicinity of the study area, and would need to consider the implications of these proposals on the Growling Grass Frog population and habitats. Local authorities will be responsible for habitat and vegetation maintenance in public land within the study area following completion of the 5-year plan. They are also encouraged to provide assistance in the implementation of the plan, particularly in relation to the future monitoring and management of the Growling Grass Frog population and associated habitats. Community education about the importance of the resident Growling Grass Frog population and associated habitats is also encouraged.

3.2.2 Encouraged Involvement

- Local Community Groups – Are encouraged to become involved in habitat and vegetation maintenance in public land within the study area upon completion of the 5-year plan.

3.3 Management Safeguards and Controls

3.3.1 Inductions

A suitably qualified and experienced zoologist will conduct site inductions for all persons engaged to work on site throughout the duration of the development. The induction will include the following.

- Information regarding the environmental values within and surrounding the study area, including the significance of the site and the local region for Growling Grass Frog;
- Diagnostic, ecological and behavioural information relating to Growling Grass Frog;
- The legislative context of the proposed action;
- An outline of the Duty of Care of all persons on site to avoid and minimise the occurrence and extent of potential impacts to the environment and Growling Grass Frog;

- All no-go zones and sensitive habitat areas for Growling Grass Frog;
- The key objectives and measures outlined in this CMP; and,
- The provision of an information pamphlet (Attachment A) summarising key points.

3.4 Habitat Protection

Protection of the existing habitat will be achieved through the installation of temporary frog exclusion fencing around the outer perimeter of the habitat area prior to the commencement of construction to provide a physical barrier between the development area and existing habitat. Details of the fencing requirements are provided below. Following completion of construction and habitat enhancement, the entire habitat corridor will be appropriately fenced.

3.4.1 Habitat Protection and Management

Sediment/ Frog Exclusion Fencing

Temporary frog exclusion fencing will be instated around the creekline prior to the commencement of construction to provide a physical barrier between the development area and existing habitat proposed for enhancement. An example of suitable frog exclusion fencing is shown in Plate 9. The following controls apply to the installation of sediment/ frog exclusion fencing:

- Fencing must be constructed of a cloth or plastic material and only appropriate fencing material that withstands variable weather conditions over long periods of time must be used;
- Fencing must be installed at least one metre high, with an additional 0.2 metres buried below-ground. An additional 0.2 metres at the top of the fence must be bent/ angled over at less than 90 degrees to the vertical on the frog habitat side (not the excluded habitat side) to prevent frogs from climbing or hopping over the fence;
- Refugia for shelter must be placed at least one metre away from the fence and any vegetation within one metre of the fence must not exceed 0.5 metres to prevent frogs from escaping (i.e. low-growing grasses will be planted).
- Fences must be taut without creases or folds;
- Fence posts must be installed on the outer fencing side (i.e. excluded habitat side) and fastened with nails or similar, and lie flush with fencing material to prevent frogs from climbing up posts and escaping over the fence; and,
- Regular inspection of the fencing is required to ensure its effectiveness, including:
    - Inspections of fencing between May and August, prior to Growling Grass Frog breeding season and the repair or replacement of any damaged or ineffective material;
    - Maintenance of vegetation within one metre of fencing at less than 0.5 metres high; and,

- Removal of any litter or other debris caught in fencing which could assist frogs to climb over.

Plate 9. Example of suitable frog exclusion fencing

Safety Fencing

Prior to the completion of the development, the Growling Grass Frog habitat corridor will be appropriately fenced to exclude public access to the habitat and habitat enhancement activities.

Integration of safety fencing and frog fencing will also be considered, as a single fence which achieves the purposes of safety, unauthorised access prevention, and a barrier for preventing frogs accessing paved areas is achievable and preferable in terms of functionality, aesthetics and maintenance.

3.5 Timing of the Management Actions

The proposed Growling Grass Frog habitat enhancements will be completed at a time of year that minimises impacts to Growling Grass Frog (i.e. during the species active season).

The control of pest animals such as foxes will be undertaken in accordance with local government laws and relevant legislation. Given the threat posed by feral predators such as Red Fox, an assessment of feral predators in the habitat corridor will be completed prior to the commencement of construction, and if evidence of these species is found, appropriate control measure may be implemented immediately to reduce the potential threat posed by predatory pests.

3.6 Management of Wetland Hydroperiod

The volume of runoff created development in the study area in post-construction will likely be of greater volume and velocity than existing runoff under current conditions due to increase in impervious area such as rooftops and road surfaces. While water flow volume in Cowies Creek is expected to increase due to the proposed development, flow rates from the development will contribute to a maximum 1.75% of the peak 1% AEP flow in Cowies Creek, with the more likely scenario being no change in peak flow rate following construction of the stormwater wetland facility (Rain Consulting 2024). The stormwater treatment pond will decrease the velocity of the water moving through the corridor and allow suspended particles to settle out of suspension or adhere to vegetation, and nutrients will be biologically absorbed by the macrophytes. Stormwater will be initially treated within a primary stormwater wetland facility before discharging into the

Growling Grass Frog habitat corridor. This is not considered to be a significant threat to existing Growling Grass Frog habitat as the proposed stormwater pond is modelled to largely mitigate any increased runoff due to the construction of impervious areas.

The ongoing persistence of suitable habitat for Growling Grass Frog within the study area will be achieved through the monitoring of creekline hydroperiods, and through the establishment and ongoing management of fringing and aquatic vegetation within habitat corridor. Water levels will be assessed over the species breeding season (October to March).

Depth gauges will be installed along the creekline, and wetland depth will be monitored 3-monthly for the first two years following construction. Based on previous studies, fluctuating water levels and flooding are known to stimulate breeding in Southern Bell Frogs in the semi-arid region of Western NSW (Wassens 2005).

3.7 Salvage and Relocation

The salvage and relocation of Growling Grass Frog individuals from within the study area is unlikely to be required during construction works as no removal of Growling Grass Frog habitat is proposed. However, salvage and relocation may be required during habitat enhancement works outlined within this CMP. Salvage and relocation are proposed from an animal ethics perspective and aims to reduce the occurrence of death, injury or displacement of individuals.

The salvage and relocation methods outlined below will be undertaken both prior to and during any habitat enhancement works within the proposed Growling Grass Frog Conservation Area, as required. Salvage measures will be undertaken by a qualified zoologist experienced with these operations. Salvage will be undertaken in proposed enhancement areas and involve a suitably qualified zoologist actively searching soil, vegetation and other ground debris (i.e. checking under boulders or logs that may be shifted) for frogs immediately prior to, and during enhancement works. Salvage may be conducted during the breeding season for the species as this places frogs at a lower risk of injury/mortality from excavation works, as detection rates during the inactive period are lower. Several relocation projects of frogs have occurred during the breeding season as this is when surface activity is highest and therefore capture success the greatest (Koehler *et al.* 2015).

Pre-habitat enhancement salvage and relocation will be performed during the breeding activity period, immediately before works are to commence to ensure as many frogs as possible are relocated.

A suitably qualified zoologist will also train a designated staff member from the relevant contracting group to temporary salvage (i.e. frog handling) Growling Grass Frogs in the absence of a zoologist onsite (i.e. when construction activity is not occurring) only if the frog is in immediate harms way. The works supervisor will be required to contact a nominated zoologist immediately should Growling Grass Frog be detected on site.

3.7.1 Timing

Salvage during active season (September to April)

Salvage activities during the breeding/active season for Growling Grass Frog when surface activity is highest and therefore capture success the greatest (Koehler *et al.* 2015) is the preferred time. This places frogs at a lower risk of injury/mortality from excavation works, as detection rates during the inactive period would be lower. Several relocation projects of frogs have occurred during the breeding season (Koehler et al. 2015).

Salvage during inactive season (April to August)

As any Growling Grass Frog that may be present will be aestivating, no nocturnal surveys prior to construction activities will need to be undertaken:

- Salvage during construction will be conducted. This will involve two observers actively searching soil, vegetation and other ground debris for frogs immediately prior to, and during excavation works; and,
- Footwear will be washed in disinfectant at the beginning and end of each salvage period to prevent the introduction and/or spread of any diseases.

3.7.2 Methods

Capture

The following procedure will be undertaken:

- Frogs will only be captured by suitably qualified and experienced zoologists, who are capable of purposeful capture that does not result in unnecessary stress, energy expenditure or injury to the fauna.
- Zoologists will change to a new pair of disposable latex gloves between each frog capture in accordance with the Hygiene Protocol (Murray *et.al*. 2011) (Attachment D). Gloved hands will be dipped in the local water in the immediate area so that loss of skin secretions is minimised when frogs are picked up.

Handling

The following procedure will be undertaken:

- Frogs and tadpoles will only be handled by suitably qualified and experienced zoologists, and will be handled as little as possible to avoid inadvertent removal of skin secretions which can predispose them to infection.
- Zoologists will change to a new pair of disposable latex gloves between the handling of each frog and tadpole, in accordance with the Hygiene Protocol (Murray *et.al*. 2011) (Attachment D). Gloved hands will be dipped in the local water in the immediate area so that loss of skin secretions is minimised when frogs are handled.

Holding

The following procedure will be undertaken:

- Frogs will be placed into new and clean plastic sample bags, with a 'one bag – one frog' policy, in accordance with the Hygiene Protocol (Murray *et.al*. 2011) (Attachment D). Bags will not, under any circumstances, be reused.
- All frogs captured will be assessed for signs of injury or illness, particularly for signs of Chytrid Fungus infection, in accordance with the Hygiene Protocol (Murray *et.al*. 2011) (Attachment D). If any individuals show signs of illness, their sample bag will be clearly marked, and the necessary actions outlined in the Protocol will be implemented.

- If a large number of frogs are being captured, additional resources will be called upon to assist, so that frogs and tadpoles can be captured and released within a nearby section of the Cowies Creek creekline. This is to avoid individuals being held in the sample bags for any longer than necessary.

Transporting

The following procedure will be undertaken:

- As only on-site relocation will be undertaken, the transportation of frogs will only require ferrying of individuals in their sample bags on foot along the Cowies Creek creekline.

Releasing

The following procedure will be undertaken:

- Frogs salvaged during habitat enhancement works will be released into a nearby section of Cowies Creek creekline within 100 metres, immediately into favourable micro-habitats that afford protection from exposure and predation. Frogs will be released into areas with suitable rock, debris and/or dense vegetation providing adequate refuge.
- All frogs will be visually monitored after release to ensure that they do not show signs of stress or vulnerability. If individuals show such signs, they will continue to be monitored until adequate recovery is evident. If recovery does not become apparent and no signs of recovery are being displayed, the individual may be required to be re-captured and transported to a veterinarian or wildlife carer.

Stressed and Injured Animals

The following procedure will be undertaken:

- Prior to the commencement of construction activities, the zoologists will locate and obtain the contact details of the closest wildlife carer and veterinarian.
- The zoologists undertaking the salvage and relocation of the frogs will be suitably qualified and experienced in recognising the indicators of mild-moderate stress in animals. Such recognition informs the judgement to intervene. The following are indicators of mild-moderate stress in animals:
- Fast and shallow breathing; and,
- Temporarily unresponsive to stimuli (listless).
- If an animal is displaying greater than one of these indicators at the same time, an extreme of one of these indicators, or one of these indicators for a prolonged time, then the zoologists will be prepared to intervene. Depending on the situation, such intervention may include:
    - Continued visual monitoring of the individual until adequate recovery is evident;
    - A pause of any activities that may cause further stress; and,
    - Re-capture of the individual and transportation to a veterinarian or wildlife carer.
- If an animal is injured or sick, the zoologist will call for a pause on any activities that may exasperate the situation and immediately make arrangements for the animal to be taken care of. Depending on the severity of injury or illness, this may mean organising the animal to be transported to a wildlife shelter for rehabilitation; or to a veterinarian for medical attention or euthanasia.

- In the event that an animal is severely injured and requires euthanasia immediately (i.e. on site) this is to be undertaken at the zoologists discretion using methods outlined in their Animal Ethics Permit.

Contingency Plan

The following procedure will be undertaken:

- If a suitably qualified zoologist is not present during a stage of development where GGF is located on site, contractors will be required to contact a zoologist and temporarily halt works. Contractors will be made fully aware of the appearance of GGF, via a site induction by a qualified zoologist to the Project Manager and/or Contractor(s), to describe GGF and how to identify them if found during works.
- The person encountering the frog will report it to a nominated principal contact of the developer upon which all works will stop within the vicinity of the site. The zoologist will be contacted immediately.
- No one may attempt to capture the frog unless it is directly within harm's way. If possible, a photo of the frog will be taken and sent to the zoologist via mobile phone messaging for identification; and,
- Any specimens found in harm's way will be stored in an appropriate container and kept in a cool place out of direct sunlight until a qualified zoologist arrives.

3.8 Population and Habitat Monitoring

Appropriate survey and monitoring methods for Growling Grass Frog is an important component to effectively conserve the species (Heard *et al.* 2010). Methods based on research and commensurate with the objective (e.g. determining wetland occupation versus population size versus reproductive success) are required to adequately identify the impact of an action, along with the most appropriate management actions and the effectiveness of such actions (Heard *et al.* 2010). Such surveys will be conducted to assess the impact of the development and/or monitor the suitability of a site's management regime, or to monitor the species status throughout a region (which may also relate to regional scale management strategies etc.).

3.8.1 Population Monitoring

Population monitoring will be undertaken annually during the development and for the first five years following the completion of enhancement of the Growling Grass Frog habitat corridor.

Each monitoring event will comprise diurnal and nocturnal surveys and will include the following (as a minimum). If, at the end of the annual monitoring the results indicate a decline in the Growling Grass Frog population or degradation of Growling Grass Frog habitat, the CMP will be re-evaluated and adapted accordingly.

Diurnal Surveys

The following will be undertaken as part of the diurnal surveys:

- Habitat assessment documenting: the type and cover of fringing, emergent, submerged and floating aquatic vegetation, and other refugia; in situ water quality; evidence of disturbance including pest animals, litter, soil disturbance and erosion.

- Active searching for frogs in and around the waterbody. The search area will extend for at least 20 meters from the edge of the waterbody and will include actively searching through aquatic and terrestrial vegetation, and under rocks, logs and other refuge.
- Dip netting for tadpoles and predatory fish.

Nocturnal Surveys

The following will be undertaken as part of the nocturnal surveys:

- At least two nights of surveys will be conducted; at least one in the early part of the active season (to collect data when calling and mobility is high) and one later in the season (when reproductive output is greatest i.e. tadpoles, metamorphs).
- During the early part of the active season each survey will extend for at least 120 minutes. Call playback and active searching for frogs in and around the waterbody will be undertaken. The search area will extend for at least 20 meters from the edge of the waterbody and will include actively searching through aquatic and terrestrial vegetation, and under rocks, logs and other refuge.
- During the latter part of the active season, the 120-minute survey will involve dip netting for tadpoles and metamorphs, along with active searching for metamorphs and sub-adults in and around the waterbody. The search area will extend for at least 20 meters from the edge of the waterbody and will include actively searching as detailed above.

All surveys will be conducted in weather conditions considered optimal for detection (i.e. warm and humid, overnight temperature not less than 14°C, preferably post rain) and when the species is known to be active elsewhere (reference sites).

Tadpoles

Surveys will be undertaken annually for the first five years post-development. Dip nets will be used to sample for tadpoles at, or in the vicinity of sites where calling males are identified during diurnal surveys. Dipnets will be checked for tadpoles and predatory fish. All tadpoles caught will be identified to species level, counted and released.

3.8.2 Habitat Monitoring

Monitoring of enhanced habitats will be undertaken every six months for the first two years during the development, and annually for the first five years during enhancement of the Growling Grass Frog habitat corridor. Several site-specific habitat variables will be assessed during the monitoring period, including:

- Wetland depth, flow, permanency and a visual assessment of water quality;
- Availability and suitability of shelter and over-wintering sites;
- Vegetation diversity, structure, composition and percentage of cover;
- Presence of introduced fish, particularly Eastern Gambusia and Goldfish;
- Presence of pollutants, rubbish and other threatening processes; and,
- A photographic reference will be taken at each wetland at a marked location so that comparisons of habitat conditions can be made over time.

3.8.3 Water Quality Monitoring

Water quality monitoring sites will be established within the Growling Grass Frog habitat corridor. Water quality sampling will adhere to the EPA's reference document: S*ampling and analysis of waters, wastewaters, soils and wastes* (EPA 2009). Water quality results will be compared to the State Environment Protection Policy (SEPP) Water for Victoria objectives (EPA 2018).

A monitoring program has been designed to identify any potential reduction in water quality if conditions deteriorate from the baseline (immediate post-construction) water quality conditions. Management actions will be implemented if chemical spills are detected or if there is a noticeable deterioration in water quality. Several 'Spill Response Kits' will be provided if an oil or fuel spill occurs, appropriate training will be provided on how to use the kits if a spillage occurs on site. If water quality results exceed trigger values (see below) and/or are outside SEPP objectives, appropriate measures will be implemented and correction actions will be taken to ensure the water quality is suitable for Growling Grass Frog.

Site Specific Trigger Values

Trigger values will be established and based on immediate post-construction water quality within any created waterbodies and the creekline. The following trigger values will be used:

- If turbidity is >20% of the background condition (downstream Cowies Creek locations);
- If electrical conductivity is >1% of the background condition;
- If dissolved oxygen concentration is <1% of the background condition;
- If pH ±0.5pH unit from background condition; and,
- All other water quality parameters (including any nutrients or heavy metals) have not substantially exceeded background conditions (i.e. no statistically significant difference (alpha >0.05).

Sampling frequency

Water quality monitoring will be conducted every six months for two years post-construction to demonstrate if water quality has improved / remained at background conditions. The frequency of the water quality monitoring will be reviewed after the initial two-year period and a decision will be made on whether ongoing water chemistry monitoring is required.

3.9 Annual Monitoring Reporting and Review

The following will be implemented to inform of relevant issues, milestones and habitat and population monitoring results to ensure the regulatory authorities (i.e. DEECA, DCCEEW) are informed of the progress of the implementation of this CMP (Table 3):

- A summary of the results of all monitoring procedures, habitat enhancement and any maintenance activities will be provided to DEECA on an annual basis throughout the 5-year implementation of the CMP. This annual audit will also outline the progress of the CMP implementation and identify any key issues and management responses.
- Management actions may need to be amended or updated if new information becomes available, or if management actions are considered inappropriate or inadequate for the long-term persistence of

Growling Grass Frog within the site. New information may become available through ongoing monitoring procedures or following review of ongoing reporting submitted to DEECA. Recommendations based on this information will be provided to the responsible land manager.

- Any proposed amendments or deviations to the actions and requirements of this CMP must be approved by DEECA, and the plan must be updated with any approved changes.

3.10 Schedule of Management Actions

Table 3. Schedule of management actions

Year	Objective	Timing of activity	Standard to be achieved	Related section(s)
1 and ongoing	**Establish no-go zones and temporary exclusion fencing.** Protect Growling Grass Frog habitat corridor and no-go areas during construction.	Prior to commencement of construction	Temporary frog exclusion fencing and signage will be installed around the outer perimeter of the Growling Grass Frog habitat corridor prior to the commencement of construction (see Figure 3).	3.1 3.4 3.5
		Prior to and during construction of habitat enhancement / construction activities	Fencing will be installed along the entire boundary of the development areas during construction during construction of Growling Grass Frog habitat enhancement. This is to prevent Growling Grass Frog from entering any development area during and after construction.	
		Following completion of permanent exclusion fencing	Temporary frog fencing in all areas will be decommissioned once all construction activities are complete, and permanent frog exclusion fencing has been completed.	
		Monthly	Fencing and "no-go" zones inspected monthly for damage or evidence of dumping/activity.	
		As required	All no-go zones and sensitive habitat areas for Growling Grass Frog clearly signed and discussed during on site inductions.	
1 and ongoing	**Enhancement of Growling Grass Frog habitat corridor.** The enhancement of Growling Grass Frog habitat corridor along Cowies Creek will provide improved dispersal and	Following establishment of no-go zone and exclusion fencing, between April and September	Design feature of enhanced Growling Grass Frog habitat: ○ Designed to ensure water runoff from rooftops within any future development is appropriately treated; ○ Supplied with the best feasible water quality consistent with Melbourne Water standard stormwater treatment practice; ○ Able to sustain appropriate vegetation to provide habitat (see below);	3.1 3.4 5.1

Year	Objective	Timing of activity	Standard to be achieved	Related section(s)
	potentially additional breeding habitat for the species and improve habitat connectivity and frog dispersal.		○ Include rock mattresses and/or loose rock as alternative refuge and overwintering sites around the creek margins (Plate 7); and, ○ Trees and/or large shrubs must not be planted within 20 metres of the banks of Growling Grass Frog habitat corridor as this may shade out aquatic habitat, thus potentially rendering it unsuitable for the species. The wetland revegetation specialist must consider the following additional issues: ○ To achieve habitat enhancements, in the Growling Grass Frog habitat corridor there will be three distinct zones (as shown in Plate 8). ○ Timing of works - works will be undertaken between April and August inclusively and ideally planting should occur in late winter/ early spring, providing there is adequate rainfall; ○ All works must be subject to disease control in accordance with the measures contained in Section 5.1 and the Hygiene Protocols for the Control of Diseases in Australian Frogs (Murray *et.al.* 2011) (Attachment D); ○ Protective netting to be installed, where required, to prevent damage to aquatic plants by waterfowl; ○ A minimum topsoil depth of 150 mm within all pond planting areas; ○ The planting area will contain floristically diverse and structurally similar vegetation, planted at a nominal density of six individuals per square meter with the provision for areas of bare ground between plantings; and, ○ Recommended species for wetland planting known to be present in Growling Grass Frog habitats are provided in Attachment C. The following species must not be included in the list of suitable species to be planted in order to avoid the risk of the creek becoming choked with vegetation; ○ Narrowleaf Cumbungi *Typha domingensis* ○ Broadleaf Cumbungi *Typha orientalis* ○ Lesser Reed-mace *Typha latifolia* ○ Common Reed *Phragmites australis*	

Year	Objective	Timing of activity	Standard to be achieved	Related section(s)
			○ Tall Spike-rush Eleocharis sphacelate.	
1 and ongoing	**Salvage and Relocation** The salvage and relocation of Growling Grass Frog individuals from within the Conservation Area prior to, and during habitat enhancement works (including rock beaching installation, if completed)	Both immediately prior to and during the development works, as required	Salvage and relocation (if required) will be undertaken as follows: ○ The salvage and relocation of Growling Grass Frog individuals from within the Conservation Area may need to be undertaken prior to habitat enhancement activities. ○ Salvage and relocation procedures may be initiated to reduce the occurrence of death, injury or displacement of individuals. ○ All areas where rock beaching is to be incorporated must be identified using clearly visible timber stakes and/or bunting prior to works being carried out. ○ The area will be searched by a suitably qualified zoologist and appropriate salvage and relocation protocols initiated. ○ If a suitably qualified zoologist is not present during a stage of development where GGF is located on site, contractors are required to temporarily halt works in that area, contact a zoologist and follow procedures outlined in section 3.7.2	3.7
1 and ongoing	**Chemical/petroleum spill and hard rubbish dumping.** Protect existing and enhanced Growling Grass Frog habitat from contamination.	Both immediately prior to and during the development works, as required	1. Chemical and fuel storage area to be established as far from Growling Grass Frog habitat as practical. 2. Equipment to be regularly serviced and inspected daily. 3. Personnel to undergo adequate training in equipment usage. 4. Engage a specialist contractor, as required, to clean up contaminants such as oil spills, etc. 5. Inspection of all drainage points leading to the water bodies for chemical spills, leaks, and rectify where necessary. 6. Once-off intensive hard litter removal (and if required between normal maintenance schedules). 7. Several 'Spill Response Kits' will be maintained on site in areas where chemicals are stored and in construction areas. Appropriate training will be provided on how to use the kits if a spillage occurs on site.	2.3.1 3.9.1 5.3.2

Year	Objective	Timing of activity	Standard to be achieved	Related section(s)
1 and ongoing	**Chytrid management.** Chytrid fungus is a major threat to amphibian populations in Australia. Hygiene Protocol will be used to guide best practice Chytrid management.	During habitat enhancement, management of habitat areas and throughout construction.	1. All footwear and equipment (e.g. nets, buckets, callipers, headlamps, waders), will be thoroughly cleaned and disinfected before entering and exiting the habitat corridor, and between sites including between the site of salvage and No-Go-Areas. 2. Any equipment used to handle frogs and tadpoles will be cleaned and disinfected between each use. 3. The tyres of all vehicles will be cleaned and disinfected before entering and exiting the habitat corridor (if required). 4. The tyres/tread and other parts of machinery and plant (e.g. the excavator bucket; pumps) involved in the habitat construction and associated activities, will be cleaned and disinfected before entering any construction area within the Conservation Area. 5. A new pair of disposable latex gloves will be used between each frog and tadpole. Gloved hands will be dipped in the local water in the immediate area so that loss of skin secretions is minimised when frogs are picked up. 6. Frogs will be placed into new and clean plastic sample bags, with a 'one bag– one frog' policy. Bags will not, under any circumstances, be reused. 7. Disinfection methods will follow the procedures outlined in the Hygiene Protocol.	2.3.2 3.6 5.1 Attachments B, D
		During salvage and relocation.	Follow handling guidelines for salvage and relocation (see section 5.1 and Attachments B, D).	
		Ongoing	Sterilise footwear before entering created habitat areas.	
1 and ongoing	**Manage artificial lighting and noise.** Artificial light and noise will be kept to a minimum to reduce impacts to Growling Grass Frogs.	During construction activities	1. Construction activities will comply with the Greater Geelong City Council Building works – Local Law requirements (Greater Geelong City Council 2014). 2. Building or other works that may produce noise can only be carried out between the hours 7.00 am and 6.00 pm on weekdays, 9.00 am and 6.00 pm on Saturdays, Sundays, and public holidays. 3. Sources of artificial light from the surrounding development will be directed away from the Growling Grass Frog habitat corridor.	2.3.5 2.3.6

Year	Objective	Timing of activity	Standard to be achieved	Related section(s)
		Design and installation phase	1. No additional lighting directed towards the Growling Grass Frog habitat corridor. 2. Shields will be placed on lights to reduce lateral light spill. 3. If necessary embedded lights will be used on walkways adjacent to the Growling Grass Frog habitat corridor. 4. Use of high intensity lights in white or blue range (<50 nm wavelengths) will be avoided.	
1 and ongoing	**Monitor and control pest fauna species.** If Eastern Gambusia is observed within Created Habitat Area 1, protocols outlined in Section 3.7 will be implemented. Feral Animal Control measures may be implemented in the study area to reduce the population size of foxes.	Both immediately prior to and during the development works, as required	1. Assessment of feral predators within Growling Grass Frog habitat corridor and wider study area prior to the commencement of construction. 2. If evidence of foxes is found, appropriate control measures may be implemented. 3. Destroying any dens discovered on site.	2.3.7 3.4 3.8 5.3.7
		Monitor fish in autumn and September.	1. Monitoring of enhanced habitats will be undertaken every six months for the first two years during the development, and annually for the first five years following the completion of Growling Grass Frog habitat enhancement.	
		Opportunistic and ongoing	Destroy any fox dens found on site.	
1 and ongoing	**Monitor and managed vegetation in habitat corridor.** Once constructed, habitat enhancements in the habitat corridor will need to be maintained through ongoing revegetation or slashing.	Twice annually (autumn and spring) in years 1 and 2. Annually for the first five years following the completion of construction.	1. Monitoring of created habitats will be undertaken every six months for the first two years during the development, and annually for the first five years following the completion Growling Grass Frog habitat enhancements. 2. Monitoring of vegetation will be conducted in autumn and spring. 3. Replace any failed plantings. 4. Increase planting density by planting additional vegetation, or conversely, removal of wetland vegetation (if it is smothering the waterbody); as required.	5.3

Year	Objective	Timing of activity	Standard to be achieved	Related section(s)
			5. Control any weeds invading terrestrial habitat by hand, or spot treatment methods with frog sensitive herbicides. 6. Building material and other unwanted materials (e.g. plastic, polystyrene) will be removed from wetlands/waterways and ponds. 7. Identify and remove barriers to frog dispersal. 8. Where relevant gross pollutant traps and/or sediment filters will be checked and, if necessary, subsequently cleaned, particularly after heavy rain or storm events.	
		As required, based on conditions.	1. Increasing the intensity of feral animal controls. 2. Additional refuge sites such as rocks, logs and dense low-lying vegetation will be added if it is considered, during site monitoring, that the area of shelter is insufficient. 3. Routine maintenance of grassed areas within the reserve area around the periphery of the waterbody. 4. Monitor the level of any public disturbance in and around Growling Grass Frog habitat and manage accordingly (e.g. fencing repairs and signage). 5. Revise monitoring measures in agreement with responsible authorities, if necessary.	
1 and ongoing	**Pest plant monitoring and control.** It is important to ensure that any weed control works using herbicides are both targeted (i.e. spot spraying) and undertaken at the right time of the year. Where possible, weeds will be controlled by hand or with the use of implements.	Monitoring 6-monthly for two years, then annually.	Monitoring of the habitat corridor will be undertaken every six months for the first two years during the development, and annually for the years following the completion of Growling Grass Frog habitat enhancement.	3.1 5.3.5 5.3.10
		Ongoing pest plant controls as required	1. Where possible, weeds will be controlled by hand or with the use of implements. 2. Where herbicide application is necessary, waterway sensitive products such as Roundup Bioactive®, Weedmaster Duo® or Weedmaster 360® must be employed, without the addition of surfactant; 3. When used in riparian areas, will be directly sponged or wicked onto weeds to minimise off target damage.	

Year	Objective	Timing of activity	Standard to be achieved	Related section(s)
			4. Herbicides must not be used within 10 meters of wetlands during the breeding season (October-March). 5. Any weed control works must be completed in a manner that minimises soil disturbance. 6. Pest plants that reproduce sexually (by seed) must be controlled before seeds ripen. The following species must not be introduced into the habitat corridor or included in the list of suitable species to be planted in order to avoid the risk of the habitat corridor becoming choked with vegetation; • Narrowleaf Cumbungi *Typha domingensis* • Broadleaf Cumbungi *Typha orientalis* • Lesser Reed-mace *Typha latifolia* • Common Reed *Phragmites australis* • Tall Spike-rush *Eleocharis sphacelate* If these species are observed within the habitat corridor during habitat monitoring a nominated principal contact of the developer must be notified, and a wetland revegetation specialist contractor must be engaged to remove these species so that waterbodies remain clear and support open water. A suitably qualified zoologist must be notified prior to removal so that appropriate salvage and relocation activities can be assessed and implemented.	
1 and ongoing	Water quality monitoring. A monitoring program has been designed to identify any potential reduction in water quality if conditions deteriorate from the baseline (pre-	Both immediately prior to and during the development works, as required	1. A water quality monitoring site will be established at two sites within the habitat corridor prior to the commencement of construction. 2. Water quality monitoring will be conducted every six months for two years post-construction to demonstrate if water quality has improved / remained at background conditions. The frequency of the water quality monitoring will be reviewed after the initial two-year period and a decision will be made on whether ongoing water chemistry monitoring is required.	3.8.3

Year	Objective	Timing of activity	Standard to be achieved	Related section(s)
	construction) water quality conditions.			
1 to 5	**Growling Grass Frog Population Monitoring** Surveys will be conducted to assess the impact of the habitat enhancement.	Annually during the development and for the first 5 years following the completion of construction	Each monitoring event will comprise diurnal and nocturnal surveys. If, at the end of the annual surveys will be conducted to monitor the suitability of a site's management regime monitoring the results indicate a decline in the Growling Grass Frog population or degradation of Growling Grass Frog habitat, the CMP will be re-evaluated and adapted accordingly. 1. At least 2 nights of surveys will be conducted; at least one in the early part of the active season (to collect data when calling and mobility is high) and one later in the season (when reproductive output is greatest i.e. tadpoles, metamorphs). 2. Tadpole surveys will be undertaken annually for the first five years post-development.	3.8.1
2 and ongoing	**Management of habitat hydroperiod** Water levels will be checked over the species breeding season (October to March).	Following completion of habitat enhancements and ongoing	Design features and active management to be implemented: 1. The stormwater wetland will treat water from the rooftops of buildings and structures within the development before discharging into Cowies Creek habitat corridor. 2. Water levels will be checked over the species breeding season (October to March). 3. Depth gauges will be installed creekline depth will be monitored for the first two years following construction.	3.6
1 to 5	**Annual Monitoring Reporting and Review.** A summary of the results of all monitoring procedures, habitat enhancements and any maintenance activities will be provided to DEECA on an annual basis throughout the 5-year implementation of the CMP.	Annual reporting as required	1. The annual audit will outline the progress of the CMP implementation and identify any key issues and management responses. 2. Management actions may need to be amended or updated if new information becomes available, or if management actions are considered inappropriate or inadequate for the long-term persistence of Growling Grass Frog within the site. 3. New information may become available through ongoing monitoring procedures or following review of ongoing reporting submitted to DEECA. Recommendations based on this information will be provided to the responsible land manager.	3.9

Year	Objective	Timing of activity	Standard to be achieved	Related section(s)
			4. In addition to revisions triggered by adaptive management, additional changes to this CMP may be required. Any proposed amendments or deviations to the actions and requirements of this CMP must be approved by DEECA, and the plan must be updated with any approved changes.	

4 RISK ASSESSMENT

An assessment of potential risks associated with the objectives of this plan are outlined within Table 6. All risks are considered manageable and actions within subsequent sections of this CMP address relevant risks.

4.1 Risk Assessment Matrix

A risk-based assessment has been undertaken to identify the potential threat the planned future development poses on the existing Growling Grass Frog population and associated habitats.

The adopted framework involved the following steps:

- Establish context. Set the context for the risk-based assessment through the identification and definition of values.
- Identify potential impacts and issues. Review potential effects and the identification of possible causes of changes to environmental values.
- Consequence analysis. Assess the consequences of identified effects assuming the effective implementation of risk reduction through elimination, mitigation and management. The criteria for determining the consequence of impacts are outlined below (Table 4). In some instances, the consequence criteria may produce inconsistent designations (i.e. an impact may be assessed as widespread but readily reversible). In these instances, the technical specialists used their professional judgement to determine the overall consequence on the ecological value.
- Frequency analysis. Estimate the frequency or likelihood of a change to environmental values occurring assuming the effective implementation of risk reduction. The criteria for determining the likelihood of impacts are outlined below (Table 5).
- Analyse residual risk. Analyse the risk of change to environmental values occurring using qualitative or quantitative techniques that define risk as follows: Risk = Consequence x Likelihood. The risk evaluation matrix is provided below.
- Risk reduction. Identify risk reduction controls and measures (avoidance, mitigation and management measures).

The results of the risk assessment are provided in below.

Table 4. Qualitative criteria for likelihood and consequence

Descriptor	Description
Likelihood	
1 - Almost Certain	A hazard, event and pathway exist, and harm has occurred in similar scenarios and is expected to occur more than once over the duration of the development.
2 - Likely	A hazard, event and pathway exist, and harm has occurred in similar scenarios and is likely to occur at least once over the duration of the development.

Descriptor	Description
3 - Possible	A hazard, event and pathway exist, and harm has occurred in similar scenarios and may occur over the duration of the development.
4 - Unlikely	A hazard, event and pathway exist, and harm has occurred in similar scenarios but is unlikely to occur over the duration of the development.
5 - Rare	A hazard, event and pathway are theoretically possible on this project and has occurred to a limited extent in similar scenarios but is not anticipated over the duration of the development.
Consequence	
Negligible/Very Low	Where impacts from development will not result in any impacts to Growling Grass Frog or the environment. Negligible impacts are localised and temporary in nature, with no noticeable consequences
Minor	Where a risk from development will not adversely affect Growling Grass Frog or the environment, provided management actions are implemented. Minor impacts are noticeable but localised to the project footprint and short-term in nature. They can be effectively mitigated through standard mitigation measures. Values affected by Minor impacts are generally recognised as being important at a local or regional level.
Moderate	Moderate impacts directly or indirectly affect Growling Grass Frog or the environment within the broader project locality and are short or moderate term in nature. Impacts can be ameliorated with specific mitigation measures.
High	Occurs when proposed activities are likely to exacerbate threatening processes. High impacts are substantial and significant changes that affect Growling Grass Frog or the environment within the project locality and are moderate to long-term in nature. Impacts are potentially irreversible and avoidance through appropriate design responses or the implementation of specific mitigation measures is required.
Major	Arises when an impact will potentially cause irreversible or widespread harm to Growling Grass Frog or the environment that is irreplaceable because of its uniqueness or rarity. Major impacts are significant or irreversible changes that affect the Growling Grass Frog or the environment.

Table 5. Risk Evaluation Matrix

		Increasing Likelihood				
		Rare	Unlikely	Possible	Likely	Almost Certain
Consequenc	Negligible/Very Low	Very Low	Very Low	Very Low	Low	Moderate
	Minor	Very Low	Low	Low	Moderate	Moderate

	Moderate	Low	Low	Moderate	High	High
	High	Low	Moderate	High	Major	Major
	Major	Moderate	High	Major	Major	Major

Table 6. Risk Assessment Results.

Risk	Potential Consequence(s)	Risk Assessment Matrix Score	Management Options to Minimise Risk
Introduction of Chytrid fungus	• Chytrid fungus infection • Death of Growling Grass Frog individuals • Decline or loss of Growling Grass frog population on site	**High** Likelihood: Possible Consequence: High	• Implement hygiene protocols (Section 5.1, Attachment D) • Monitor health and abundance of Growling Grass Frog population within the study area • Regular water quality monitoring
Decline in water quality within habitat corridor	• Decline of Growling Grass frog population on site • Reduced breeding activity and recruitment within habitat corridor • Loss of genetic diversity of the population due to reduced recruitment from outside the study area	**Moderate** Likelihood: Unlikely Consequence: High	• Installation and routine maintenance of sediment and erosion controls in key areas • Installation of rock banks, boulders and logs to stabilise soils in affected areas. • Habitat enhancements.
Wetlands dry over summer	• Decline of Growling Grass frog population on site • Reduced breeding activity and recruitment within constructed wetlands • Loss of genetic diversity of the population due to reduced recruitment	**Low** Likelihood: Unlikely Consequence: Moderate	• Monitoring of created habitats will be undertaken every six months for the first two years during the development, and annually for the first five years following Growling Grass Frog habitat enhancements.

Risk	Potential Consequence(s)	Risk Assessment Matrix Score	Management Options to Minimise Risk
	from outside the study area		
Growling Grass Frog killed during development works on site	• Death of individual Growling Grass Frog leading to Decline of Growling Grass frog population on site	**Moderate** Likelihood: Unlikely Consequence: High	• Salvage and relocation procedures will be initiated to reduce the occurrence of death, injury or displacement of individuals • Salvage and relocation measures will be undertaken both immediately prior to and during the habitat enhancement works, as required • Salvage measures will be undertaken by a qualified zoologist experienced with these operations • Salvage will involve a suitably qualified Zoologist actively searching for frogs immediately prior to, and during habitat enhancement works
Chemical/petroleum spill and hard rubbish dumping	• Decline of Growling Grass frog population on site • Increased Mortality • Degradation of Growling Grass Frog Habitat quality	**Low** Likelihood: Rare Consequence: High	• Equipment to be regularly serviced and inspected daily. • Personnel to undergo adequate training in equipment usage • Engage a specialist contractor, as required, to clean up contaminants such as oil spills, etc.; • Chemical treatments (for rectifying acidity or alkalinity); • Once-off intensive hard litter removal (if required between normal maintenance schedules). • Spill kits maintained on site in areas where chemicals are stored and in construction areas
Disturbance by persons entering the habitat corridor	• Degradation of habitat • Rubbish dumping	**Moderate** Likelihood: Possible	• Exclusion fencing • Regular Weed Management

Risk	Potential Consequence(s)	Risk Assessment Matrix Score	Management Options to Minimise Risk
	• Mechanical disturbance of vegetation from trampling • Weed invasion • Introduction of Chytrid fungus • Accidental spillage of chemicals	Consequence: Moderate	• Informative signage • Community awareness and education
Increased pest plants and animals	• Weed growth can smother frog habitat • Degradation of habitat • Predation of Growling Grass Frog by pest animals such as foxes • Invasion of introduced fish, particularly Eastern Gambusia and Carp leading to Growling Grass Frog eggs and tadpoles being consumed by invasive fish • Decline or loss of Growling Grass frog population on site	**Low** Likelihood: Unlikely Consequence: Moderate	• Implementation of weed and pest animal Management Plan • Weed control works monitored regularly • Regular monitoring of habitat and evidence of pest animals • The control of pest animals such as foxes • Ongoing monitoring to identify waterbodies invaded by introduced fish. • Assessment of feral predators within the Growling Grass Frog habitat area prior to the commencement of construction • If evidence of foxes is found, control measures may be implemented • Destroying any dens discovered on site • Drainage outlet installed for removing some or all water from the system within the habitat corridor • Ongoing monitoring to identify ponds invaded by introduced fish to inform if draining is required
Noise and Light Pollution	• Disturbance of Growling Grass Frog breeding activity • Decline of Growling Grass frog population on site	**Low** Likelihood: Possible Consequence: Minor	• Compliance with Geelong City Council's Building Works – Local Law requirements (2014) • No additional lighting directed towards the habitat corridor

Risk	Potential Consequence(s)	Risk Assessment Matrix Score	Management Options to Minimise Risk
Population decline	• Decline or loss of Growling Grass frog population on site • Loss of genetic diversity of the population	**Moderate** Likelihood: Unlikely Consequence: High	• Habitat augmentation • Planting of additional vegetation, or conversely, removal of wetland vegetation (if it is smothering the waterbody) • Identification and removal of barriers to dispersal • Increasing the intensity of feral animal controls
Erosion and sedimentation	• Decline in water quality • Reduced recruitment/breeding within habitat corridor	**Low** Likelihood: Possible Consequence: Minor	• Installation and routine maintenance of sediment and erosion controls in key areas • Installation of rock banks, boulders and logs to stabilise soils in affected areas • Increase maintenance and monitoring operations in affected areas until problem areas are improved.

5 RISK MANAGEMENT AND CONTINGENCY PLANNING

This section identifies a range of management actions to ensure that the Growling Grass Frog habitat corridor is maintained to appropriate standards. If any of these circumstances arise, this section outlines the management responses required in order to ensure habitat within the site continues to support the species. Adaptive management is paramount to the successful implementation of this CMP.

It should be noted that this section does not aim to identify an exhaustive list of possible stochastic events and subsequent resolutions, but a select number of key issues based on existing knowledge gained through the implementation of other Growling Grass Frog CMPs across the greater Melbourne and Geelong region.

Some issues that are likely to require contingency measures are provided.

5.1 Disease Transmission and Spread

There is evidence to suggest that the decline of many frog species in Australia and elsewhere could be related to the disease caused by the water-borne fungal pathogen, commonly referred to as Chytrid Fungus. Chytrid Fungus is a major threat to amphibian populations in Australia, with at least one species driven to extinction and populations of other threatened species, particularly L. raniformis, severely compromised (DEWHA 2006). The disease that results from Chytrid Fungus infection causes significant physical and physiological problems for frogs, such as skin flaking, reduced food intake, cardiac arrest and mortality (Peterson 2012). Infection of amphibians with the fungus is listed as a 'key threatening process' under the EPBC Act.

There is an inherent risk of spreading the fungus within and between areas in the landscape by the movement of infected frogs and tadpoles, water, soil and vegetative material, the outcome of which can be extremely deleterious if it is introduced into Growling Grass Frog populations presently free of the disease. Human activities and movements can exacerbate the risk of disease spread, and as such hygiene protocols for vehicles, equipment, footwear, handling, holding and transporting of frogs and tadpoles are paramount.

Such hygiene protocols will be implemented throughout the construction works. The Hygiene Protocol (Murray *et al.* 2011) will be used to guide best practice Chytrid management. This document is provided as Attachment D, and includes, but is not exclusive to the following.

- All footwear and equipment (e.g. nets, buckets, callipers, headlamps, waders), will be thoroughly cleaned and disinfected before entering and exiting the Conservation Area;
- Any equipment used to handle frogs and tadpoles will be cleaned and disinfected between each sample;
- A new pair of disposable latex gloves will be used between each frog and tadpole. Gloved hands will be dipped in the local water in the immediate area so that loss of skin secretions is minimised when frogs are picked up;

- Frogs will be placed into new and clean plastic sample bags, with a 'one bag– one frog' policy. Bags will not, under any circumstances, be reused;
- The tyres of all vehicles will be cleaned and disinfected before entering and exiting the Conservation Area (if required);
- The tyres/tread and other parts of machinery and plant (e.g. the excavator bucket; pumps) involved in the habitat enhancement and construction activities will be cleaned and disinfected before entering the Conservation Area; and
- Disinfection methods will follow the procedures outlined in the Hygiene Protocol.

5.2 Population Decline

Local frog populations are known to vary on spatial and temporal scales depending upon habitat conditions at a particular site. For the site as a whole, regular population monitoring will determine if the Growling Grass Frog population is no longer present. Obvious causes of decline will be rectified if possible and as close as possible to the time of detection. In the event that no Growling Grass Frog are recorded within the study area for three consecutive seasons, some of the following actions will be implemented subject to the results of habitat monitoring:

- Habitat augmentation, such as the installation of additional rocks and other refuge features;
- Planting of additional vegetation, or conversely, removal of wetland vegetation (if it is smothering the waterbody);
- Identification and removal of barriers to dispersal; and,
- Introduction of feral animal controls.

5.3 Degradation of Habitat

The degradation of Growling Grass Frog habitats can occur through a wide range of active and passive processes. Typical processes contributing to habitat degradation include:

- Lack of adequate maintenance;
- Ongoing erosion and sedimentation;
- Chemical and/or hard rubbish influx following flood events;
- Increased weed encroachment into areas of indigenous or planted terrestrial and aquatic vegetation
- Vegetation trampling, removal and/or dieback; and,
- Low water levels and/or poor water quality.

Significantly degraded habitat is unlikely to support Growling Grass Frog, as it reduces the dispersal and breeding opportunities which would normally be facilitated by areas of non-degraded habitat. Any evidence of habitat degradation will be noted as part of the monitoring program (Section 3.10) and management response actions will depend on the type of process that is causing a reduction in overall

habitat quality for Growling Grass Frog. Potential processes leading to habitat degradation and possible responses are detailed in the following sections.

5.3.1 *Erosion and sedimentation*

The following procedure will be undertaken:

- Installation and routine maintenance of sediment and erosion controls in key areas;
- Installation of rock banks, boulders and logs to stabilise soils in affected areas; and,
- Increase maintenance and monitoring operations in affected areas until problem areas are improved.

5.3.2 *Chemical and/or hard rubbish influx following flood events*

The following procedure will be undertaken:

- Developer will engage a specialist contractor, as required, to clean up contaminants such as oil spills, etc.;
- Chemical treatments (for rectifying acidity or alkalinity);
- Inspection of all drainage points leading to the waterbody for chemical spills, leaks, and rectify where necessary; and,
- Once-off intensive hard litter removal (if required between normal maintenance schedules);
- Increased frequency of habitat monitoring (3-months rather than 6-months) immediately following damaging flood events and subsequent clean-up.

5.3.3 *Vegetation dieback*

The following procedure will be undertaken:

- Increase maintenance and monitoring operations in affected areas; and,
- Replace dead vegetation as required.

5.3.4 *Unauthorised site access and significant dumping of hard rubbish*

The following procedure will be undertaken:

- Maintenance of protective fencing and addition of signage; and,
- Once-off intensive hard litter removal (if required between normal maintenance schedules).

5.3.5 *Management and Maintenance*

The ongoing maintenance of the Growling Grass Frog habitat corridor, particularly the maintenance of aquatic vegetation diversity and structure and terrestrial habitats will be essential to ensure these habitat types remain suitable for the species. Maintenance of enhanced habitats will be implemented every six months for the first two years post habitat and vegetation installation, and on an annual basis for the

remainder of the 5-year plan. Following completion of the 5-year plan, the responsible authority will be required to undertake ongoing maintenance of all enhanced habitats within public land to ensure a minimum standard for the ongoing persistence of suitable Growling Grass Frog habitat (and population, if present).

- If necessary, additional vegetation will be planted to ensure that habitat with waterbodies and terrestrial habitats remains suitable;
- Additional refuge sites such as rocks, logs and dense low-lying vegetation will be added if it is considered during site monitoring, that the area of shelter is insufficient;
- Routine maintenance of grassed areas around the periphery of the waterbody;
- The waterbody will be kept free of predatory fish, such as Eastern Gambusia and Redfin, as much as possible. The ongoing monitoring program will identify invaded waterbodies;
- Where possible, weeds will be controlled by hand or with the use of implements. Alternatively, a frog sensitive herbicide (non-residual herbicide) will be selectively used. The use of other herbicides or pesticides within, or in proximity to ponds, wetlands/waterways, shelter sites and likely dispersal areas will be prohibited;
- Building material and other unwanted materials (e.g. plastic, polystyrene) will be removed from the constructed wetland. The removal of rubbish is particularly important over the first few years during establishment of habitat enhancements, however refuge habitat such as woody debris must remain in place, as covered in section 3.8; and,
- Where relevant, gross pollutant traps and/or sediment filters will be checked every 6 months and cleaned when required, particularly after heavy rain or storm events.

5.3.6 Pest Fish Management

In areas that are subject to routine flooding, where the incursion of fish is unavoidable, the provision and maintenance of dense submerged and floating aquatic vegetation can increase Growling Grass Frog recruitment and survival rates by providing a greater amount of submerged cover for eggs and tadpoles. While it is preferred that all waterbodies be kept fish-free, in an urban setting the introduction of fish through routine flood events, dispersal of fish eggs by birds or artificial introduction by residents, is likely. However, if Eastern Gambusia is observed, the protocols outlined in section 3.4.1 will be implemented.

5.3.7 Trenching

Any trenches left open overnight must be backfilled in intervals of approximately 10 metres, in order to provide temporary escape ramps for any fauna which may fall in. If trenches are left open overnight, checks for trapped fauna must be made in the morning, prior to any works commencing on-site. Fauna salvage activities must be undertaken by a qualified fauna handler, under a current Management Authorisation.

5.3.8 *Signage*

Temporary signage will be installed along the perimeters of all the Growling Grass Frog habitat corridor in order to:

- Prevent accidental entry by construction personnel; and,
- Discourage vegetation trampling, introduction of fish into wetlands or waterways, rock disturbance and rubbish ingress by construction workers during the construction phase.

All signage will be maintained until construction works are complete.

Permanent signage will be installed at key locations near the habitat corridor in order to:

- Educate local residents about the presence of Growling Grass Frog;
- Discourage vegetation trampling, rock disturbance and rubbish ingress and prohibit rubbish dumping within the habitat corridor; and,
- Restrict public access to the habitat corridor.

5.3.9 *Pest Plant Control*

The control of pest plants within dedicated Growling Grass Frog habitat is a major requirement for management, as habitat within the site is under continual pressure from the invasion of introduced grasses and weeds (e.g. Spiny Rush *Juncus acutus*). Excessive weed growth can smother and reduce the quality of frog habitat for breeding and foraging. In order to control and/or eradicate these weed species, several on-going techniques can be used including physical removal, brush cutting and herbicide application. Herbicide must only be applied to weeds by using the spot-spraying technique, in order to prevent off-target issues.

It is important to ensure that any weed control works using herbicides are both targeted (i.e. spot spraying) and undertaken at the right time of the year, as this can also reduce the requirement for future weed control activities.

The following controls apply to all on-site weed control works:

- Weed management must be undertaken throughout all open space areas, with particular attention given to vegetated areas which are not subject to routine maintenance;
- Any weed control works must be completed in a manner that minimises soil disturbance;
- Herbicide use must be minimised to avoid adverse effects on frogs and invertebrates;
- Where herbicide application is necessary, waterway sensitive products such as Roundup Bioactive®, Weedmaster Duo® or Weedmaster 360® must be employed, without the addition of surfactant;
- Where herbicides are used, selective application is preferable to broad area application;
- Non-residual herbicides must not be used; and,
- Pest plants that reproduce sexually (by seed) must be controlled before seeds ripen.

Weed control works must be monitored regularly to assess their effectiveness and follow-up / evaluation works must be completed. With any weed control works it is important to establish a cover of native species as soon as possible to occupy the newly vacated environment. While native species will naturally re-colonise such areas, so will exotic species if weed seed is present in soil.

REFERENCES

Ashworth, J.M. 1998. An appraisal of the Conservation of Litoria raniformis (Kefferstein) in Tasmania. University of Tasmania March 1998. Unpublished Masters Thesis.

Atlas of Living Australia 2022. Atlas of Living Australia Website. URL: https://doi.org/10.26197/5d7f2348165a0. Accessed September 2022

Barker, J., Grigg, G.C. & Tyler, M.J. 1995. A Field Guide to Australian Frogs. Surrey Beatty & Sons. New South Wales.

Biosis 2023. Draft Cowies Creek Growling Grass Frog Conservation Area Management Plan. Prepared for City of Greater Geelong.

DELWP 2017. Growling Grass Frog Habitat Design Standards, Melbourne Strategic Assessment. Published document prepared by the Department of Environment, Land, Water and Planning, Melbourne, Victoria.

DEECA 2024. NatureKit Map [www Document]. URL: http://maps.biodiversity.vic.gov.au/viewer/?viewer=NatureKit. Victorian Department of Energy, Environment and Climate Action, Melbourne, Victoria.

DEWHA 2006. Threat Abatement Plan: Infection of amphibians with chytrid fungus resulting in chytridiomycosis. Department of Environment, water, Heritage and the Arts. Commonwealth of Australia, ACT.

DEWHA 2009. Significant impact guidelines for the vulnerable growling grass frog (*Litoria raniformis*. Nationally threatened species and ecological communities EPBC Act policy statement 3.14. Department of Environment, Water, Heritage and the Arts. Commonwealth of Australia, Canberra.

Ecology and Heritage Partners 2021. Existing Ecological Conditions: Northern and Western Geelong Growth Areas, Victoria.

Ecology and Heritage Partners 2024. Preliminary Documentation: Proposed development at 200 Geelong-Ballan Road, Moorabool.

Ecology Australia 2006. Sub-regional conservation Strategy for the Growling Grass Frog, Victoria. Ecology Australia Pty Ltd for Department of Primary Industries.

EPA 2009. *Sampling and analysis of waters, wastewaters, soils and wastes*, Publication Number: IWRG701, Environmental Protection Agency, Victoria.

EPA 2018. State Environment Protection Policy: Water for Victoria. Environment Protection Authority Victoria, Melbourne.

GbLA 2022. Cowies Creek Landscape MasterPlan (Draft). GlBA Landscape Architects, Victoria

Heard, G., Scroggie, M., Clemann, N., and Ramsey, D. In press. Wetland characteristics influence disease risk for a threatened amphibian. Ecological Applications. http://dx.doi.org/10.1890/13-0389.1

Hale, J.M., Heard, G.W., Smith, K.L., Parris, K.M., Austin, J.J., and Melville, J. 2013. Structure and fragmentation of growling grass frog metapopulations. *Conservation Genetics* **14**: 313-322

Hamer, A.J., Lane, S.J. and Mahony, M. 2002. Management of freshwater wetlands for the endangered Green and Golden Bell Frog *Litoria aurea*: roles of habitat determinants and space. *Biological Conservation* **106**: 413-424.

Hamer, A.J. and Organ, A. 2006. Distribution, Habitat Use, Movement Patterns and Conservation Management of the Growling Grass Frog *Litoria raniformis* through the Pakenham area, Pakenham, Victoria. Unpublished report for the Department of Sustainability and Environment (Ecology Partners, Brunswick).

Heard, G.W., Robertson, P. and Scroggie, M. 2004. The ecology and conservation status of the Growling Grass Frog *Litoria raniformis* within the Merri Creek corridor. Wildlife Profiles Pty. Ltd. and Arthur Rylah Institute for Environmental Research.

Heard, G., Robertson, P. and Scroggie, M.P. 2008. Microhabitat preferences of the endangered Growling Grass Frog *Litoria raniformis* in southern Victoria. Australian Zoologist **34(3):** 414-425.

Heard, G.W. 2010. Pattern, process and the conservation of threatened amphibian metapopulations. PhD thesis, La Trobe University, Melbourne.

Heard, G.W., Scroggie, M.P. and Clemann, N., 2010. Guidelines for managing the endangered Growling Grass Frog in urbanising landscapes. Technical Report Series 208. Arthur Rylah Institute for Environmental Research, Heidelberg.

Heard, G.W., Scroggie, M.P. and Clemann, N. 2012. Correlates and consequences of chytridiomycosis for populations of the Growling Grass Frog in peri-urban Melbourne. Report to the Victorian Department of Sustainability and Environment. Arthur Rylah Institute for Environmental Research, Heidelberg.

Hero, J.M., Littlejohn, M. and Marantelli, G. 1991. Frogwatch Field Guide to Victorian Frogs. Department of Conservation and Environment, East Melbourne.

Littlejohn, M.J. 1963. Frogs of the Melbourne area. Victorian Naturalist. **79**:296-304.

Littlejohn, M.J. 1982. Amphibians of Victoria. Victorian Yearbook. **85**:1-11.

Morgan, L.A. and Buttermer, W.A. 1996. Predation by the non-native fish *Gambusia holbrooki* on small *Litoria aurea* and *L. dentata* tadpoles. *Australian Journal of Zoology* **30**:143-149.

Murray, K., Skerratt, L., Marantelli, G., Berger, L., Hunter, D., Mahony, M. and Hines, H. 2011. Hygiene protocols for the control of diseases in Australian frogs. A report for the Australian Government Department of Sustainability, Environment, Water, Population and Communities.

Organ A. 2002. Warty Bell Frog *Litoria raniformis* ecological advice for the proposed Edgars Road extension, Epping Victoria. Unpublished report prepared for VicRoads (Biosis Research Pty Ltd.)

Organ A. 2003. Conservation strategy for the Warty Bell Frog *Litoria raniformis* at the proposed Edgars Road extension, Epping, Victoria. Unpublished report prepared for VicRoads (Biosis Research Pty Ltd.)

Organ, A. 2010. Growling Grass Frog *Litoria raniformis* monitoring over the 2009/10 breeding period, Western Treatment Plant, Werribee, Victoria. Ecology and Heritage Partners Pty. Ltd. unpublished report for Melbourne Water Corporation.

Pyke, G.H. 2002. A review of the biology of the southern bell frog *Litoria raniformis* (Anura: Hylidae). Australian Zoologist **32**: 32748.

Rain Consulting 2024. Cowies Creek Stormwater Impacts: 200 Ballan Road, Moorabool.

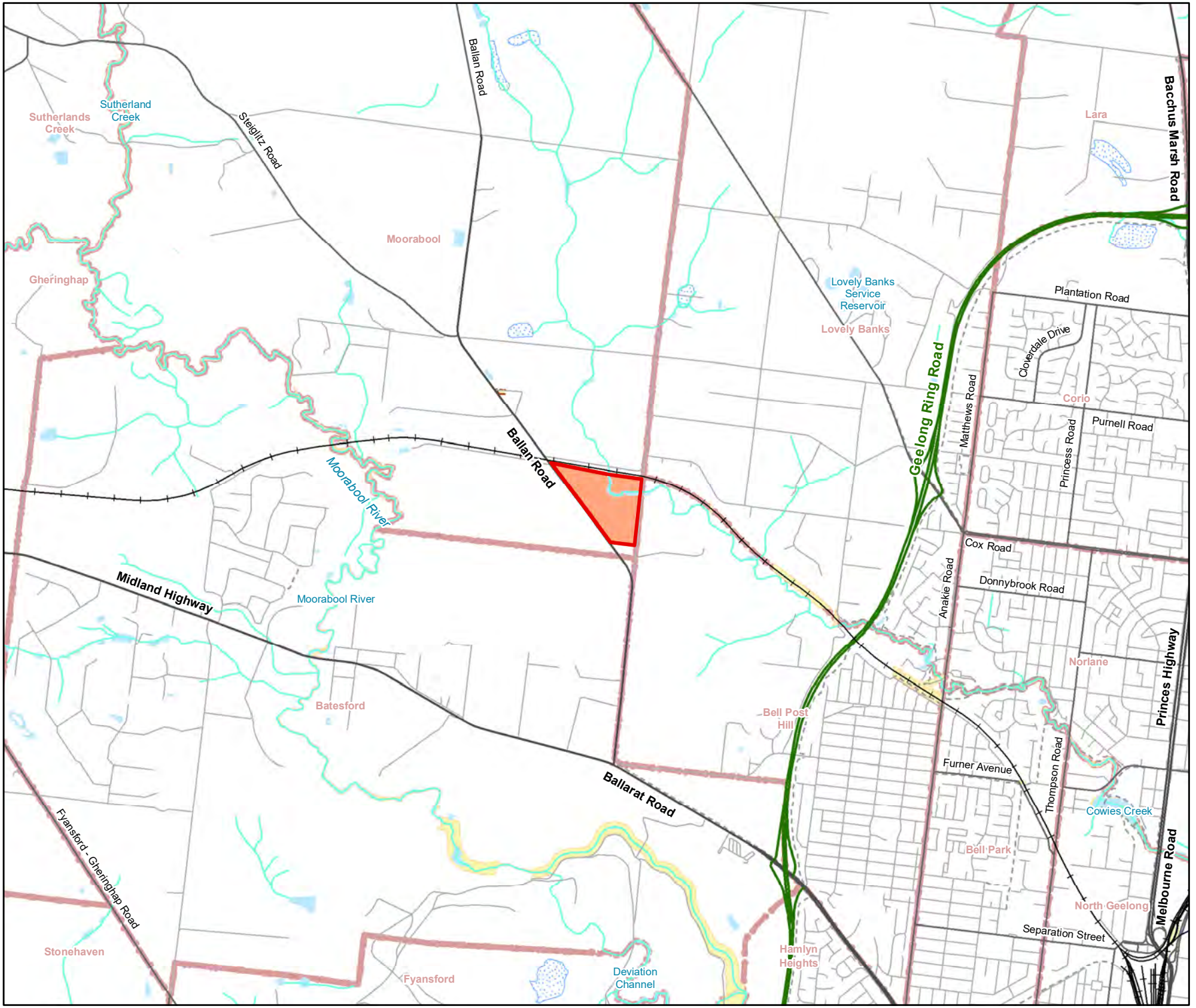
Robertson, P., Heard, G. and Scroggie, M. 2002. The Ecology and Conservation Status of the Growling Grass Frog *Litoria raniformis* within the Merri Creek Corridor. Interim Report: Distribution, Abundance and Habitat Requirements. Report produced for the Department of Natural Resources and Environment.

Tyler, M.J. 1997. The Action Plan for Australian Frogs. Wildlife Australia: Canberra

Wassens, S. 2005. The use of Space by the Endangered Southern Bell Frog *Litoria raniformis* in the Semi-Arid Region of New South Wales, Australia. PhD Thesis, Charles Sturt University, Wagga Wagga, NSW.

White A. W. & Pyke G.H. 1996. Distribution and conservation status of the green and golden bell frog *Litoria aurea* in New South Wales. *Australian Zoologist* **30**: 177-189.

FIGURES



Legend

- Study Area
- Railway
- Freeway
- Major Road
- Collector Road
- Minor Road
- Proposed Road
- Minor Watercourse
- Permanent Waterbody
- Land Subject To Inundation
- Commonwealth Land
- Crown Land
- Localities

Figure 1

Location of the study area

Growling Grass Frog Conservation Management Plan for 200 Geelong-Ballan Road, Moorabool

N

0 450 900

Metres

Map Scale: 1:40,000 @ A4
Coordinate System: GDA 1994 MGA Zone 55

ecology & heritage partners

17861_Fig01_StudyArea 1/02/2024 dvaladares

Legend

- Study Area
- Growling Grass Frog habitat
- 50m buffer around Cowies Creek
- Cowies creek coridor
- Residential development

Survey locations

- Growling Grass Frog
- Other species
- Call playback

Figure 2

Growling Grass Frog survey results

Growling Grass Frog Conservation Management Plan for 200 Geelong-Ballan Road, Moorabool

DRAFT

N

0 50 100

Metres

Map Scale: 1:3,500 @ A4
Coordinate System: GDA 1994 MGA Zone 55

ecology & heritage partners

17861_Fig02_GGFResults 27/11/2024 Melsley

Aerial source: Nearmap 2023

ATTACHMENTS

ATTACHMENT A - INDUCTION PAMPHLET

Wildlife Management Information: Growling Grass Frog

The Growling Grass Frog is commonly known by several other names; Warty Bell Frog, Southern Bell Frog, Warty Swamp Frog and Green and Golden Frog. The species is listed as endangered in Victoria and vulnerable nationally. It is also listed as a vulnerable taxon under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* and the Victorian *Flora and Fauna Guarantee Act 1988*. Overall the species is of national conservation significance.

This species is largely associated with permanent or semi-permanent still or slow flowing waterbodies (i.e. streams, lagoons, farm dams and old quarry sites). Frogs can also use temporarily inundated waterbodies for breeding purposes providing they contain water over the breeding season.

Growling Grass Frog is a bright emerald to dull olive green, with brown and/or gold blotches on a warty back, approximately 55-100 mm in length. Its call is a growling call similar to a far-off motorcycle – Crawark-crawark-crok-crok.

Growling Grass Frog *Litoria raniformis*
(© Ecology Partners Pty. Ltd.)

Growling Grass Frog *Litoria raniformis* (juvenile)
(© www.frogs.org.au.)

Who is responsible?

Specific measures have been put in place to protect the Growling Grass Frog. The proponent has responsibilities to ensure that the specific measures are implemented fully and appropriately.

The following government departments may scrutinise the works to ensure that the specific measures are implemented fully and appropriately:

- Victorian Department of Energy, Environment and Climate Action; and
- Commonwealth Department of Climate Change, Energy, the Environment and Water

What to do if you find a Growling Grass Frog

If a Growling Grass Frog is detected during pre-clearing and/or construction works, works are to be suspended in that area until the project herpetologist/zoologist of Ecology and Heritage Partners Pty Ltd is contacted to remove and relocate the animal(s) in accordance with the guidelines outlined in the Conservation Management Plan for Growling Grass Frog.

After the animal has been removed, construction activities may recommence under supervision of an ecologist from Ecology and Heritage Partners Pty Ltd.

Contacts at Ecology and Heritage Partners Pty Ltd:

Alex Wilkinson, Consultant Zoologist, ph 03 9377 0100 or 0447 025 323

Jeremy Coyne, Natural Heritage Team Leader / Zoologist, ph 03 9377 0100 or 0407 364 001

Aaron Organ, Director, ph 03 9940 1411 or 0425 873 159

ATTACHMENT B - FROG HANDLING KIT FACT SHEET

Emergency Growling Grass Frog (GGF) Handling Kit and Instructions

Growling Grass Frogs are only to be captured and placed in to the container provided if it is in harm's way and/or if the project zoologist has instructed you to do so.

Step 1 Is it a GGF?

Is it a bright emerald to dull green frog, with brown to gold blotches and a warty back?

Is it between 55 – 100 mm?

Does it look something like this?

Step 2 Call the project zoologist

Ecology and Heritage Partners Pty Ltd 03 9377 0100; Callum Luke 0447 051 647 or Aaron Organ, 0425 873 159

Step 3 Capture the GGF

Put on a new pair of disposal gloves.

Take the plastic holding container provided with you.

Capture the frog and immediately place it in the holding container.

Place the lid on the holding container, if possible, place a small amount of plant material from where you captured the frog into the container.

Step 4 Store the GGF

Place the container with the frog in a cool, dark environment, completely out of harm, until the zoologist arrives.

Do not store the frog for any greater than 2 hours.

Step 5 Dispose equipment

Dispose of the gloves and the plastic holding container used.

Ensure that there are enough provisions for another event.

Inventory of the Handling Kit

At least 3 plastic holding containers, 20x20 centimetres in size, sealable but with adequate aeration (i.e. several holes in the lid of the container to provide some air flow).

A box of disposal latex gloves.

This laminated fact sheet of how to handle and store the frog.

ATTACHMENT C - WETLAND VEGETATION SPECIES

Table C1: Species List of Recommended Plants for Revegetation

Botanical Name	Common Name
Fringing and emergent	
Calystegia sepium	Large Bindweed
Carex appressa	Tall Sedge
Carex fascicularis	Tassel Sedge
Carex gaudichaudiana	Fen Sedge
Crassula helmsii	Swamp Crassula
Epilobium billardierianum	Smooth Willow-herb
Glyceria australis	Australian Sweet-grass
Lachnagrostis filiformis	Common Blown-grass
Lycopus australis	Australian Gypsywort
Melaleuca ericifolia	Swamp Paperbark
Poa labillardierei var. *labillardierei*	Common Tussock-grass
* *Potamogeton ochreatus*	Blunt Pondweed
Ranunculus amphitrichus	Running Marsh Flower
Emergent	
Alisma plantago-aquatica	Water Plantain
Amphibromus fluitans	River Swamp Wallaby-grass
Baumea articulata	Jointed Twig-sedge
Cladium procerum	Leafy Twig-sedge
* *Eleocharis acuta*	Common Spike-sedge
Juncus amabilis	Hollow-rush
Juncus gregiflorus	Green Rush
Juncus procerus	Tall Rush
Juncus sarophorus	Broom Rush
Persicaria decipiens	Slender Knotweed
Persicaria praetermissa	Spotted Knotweed
Persicaria subsessilis	Hairy Knotweed
Ranunculus inundatus	River Buttercup
Schoenoplectus tabernaemontani	River Club-sedge
Submergent	
Ceratophyllum demersum	Hornwort

Botanical Name	Common Name
Myriophyllum caput-medusae	Coarse Water-milfoil
Myriophyllum crispatum	Upright Water-milfoil
Myriophyllum simulans	Amphibious Water-milfoil
Potamogeton crispus	Curly Pondweed
Floating Submergent	
Carex gaudichaudiana	Fen Sedge
Hydrocotyle sibthorpioides	Shining Pennywort
Lythrum salicaria	Small Loosestrife
Neopaxia australasica	White Purslane
* *Ottelia ovalifolia*	Swamp Lily
Potamogeton ochtreatus	Blunt Pondweed
Potamogeton pectinatus	Fennel Pondweed
Rumex bidens	Mud Dock
* *Triglochin procerum*	Water Ribbon (emergent form)
* *Vallisneria americana*	Ribbon-weed
Villarsia reniformis	Running Marsh Flower

* Indicates highly desirable vegetation for Growling Grass Frog

\# Limit use of this species, as it may become invasive

ATTACHMENT D - BEST PRACTICE GUIDELINES FOR THE MANAGEMENT OF CHYTRID FUNGUS (MURRAY *ET.AL*. 2011)

Australian Government
Department of Sustainability, Environment, Water, Population and Communities

JCU JAMES COOK UNIVERSITY

A REPORT FOR THE AUSTRALIAN GOVERNMENT DEPARTMENT OF SUSTAINABILITY, ENVIRONMENT, WATER, POPULATION AND COMMUNITIES

Hygiene protocols for the control of diseases in Australian frogs

June 2011

Prepared by:

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Cover photo: *Taudactylus eungellensis* – Eungella day frog. K. Murray

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> Murray, K., Skerratt, L., Marantelli, G., Berger, L., Hunter, D., Mahony, M. and Hines, H. 2011. Hygiene protocols for the control of diseases in Australian frogs. A report for the Australian Government Department of Sustainability, Environment, Water, Population and Communities.

Table of Contents

Hygiene protocols for the control of diseases in Australian frogs

1. Who should use this document?

- This protocol is intended for use nationally by conservation agencies, zoos, scientific research staff, industry organisations (e.g., the pet industry), wildlife consultants, fauna surveyors, students, frog keepers, wildlife rescue and carer groups, frog interest groups/societies and other key interest groups who regularly deal with or are likely to encounter frogs.

- This protocol outlines the expectations of the Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC) regarding precautionary procedures to be employed when working with frogs in Australia. The protocols were developed in collaboration with recognised experts in the fields of wildlife health, husbandry, research and conservation. The intention is to promote implementation of hygiene procedures by all individuals working with Australian amphibians.

- DSEWPaC recognises that some variation from the protocol may be appropriate for particular research and frog handling activities. Such variation should accompany any licence applications or renewals submitted to the relevant regulatory bodies for independent consideration. Variations should follow a risk analysis process which broadly involves hazard identification, risk assessment, risk management and risk communication.

Where *ex-situ* activities are proposed, these guidelines should be used in conjunction with the "**Guidelines for captive breeding, raising and restocking programs for Australian frogs**", which can be found here: http://www.environment.gov.au/biodiversity/invasive/projects/index.html#threat-10-11**.**

2. Objectives

The objectives of the hygiene protocols are to:

- Improve the control of diseases in Australian frogs
- **Improve preparedness for an emergency response** to new amphibian disease incursions in Australia
- **Recommend best-practice procedures** for personnel, researchers, consultants and other frog enthusiasts or individuals who handle frogs
- **Suggest workable strategies** for those regularly working or considering working in the field with frogs or where frogs may exist
- **Provide background information** and guidance to people who provide advice or supervise frog related activities
- **Inform regulatory bodies and animal care and ethics committees** for their consideration when granting permit approvals

3. Introduction

Amphibians have declined globally. In the first global amphibian assessment, at least 43% of amphibian species with sufficient data were found to have declined in recent decades, 34 species were extinct and a further 88 were possibly extinct (Stuart et al. 2004). In 2010, approximately 30% of amphibians were threatened globally (http://www.iucnredlist.org/documents/summarystatistics/2010_4RL_Stats_Table_1.pdf).

Diseases are responsible for many amphibian declines and extinctions and their risk needs to be addressed. Laurance et al. (1996) first proposed the 'epidemic disease hypothesis' to account for Australian amphibian declines. Shortly after, an unknown chytridiomycete fungus was seen infecting the skin of sick and dying frogs collected from montane rain-forests in Queensland and Panama during mass mortality events associated with significant population declines (Berger et al. 1998; Longcore et al. 1999). The fungus was subsequently found to be highly pathogenic to amphibians in laboratory trials by inducing development of skin pathology, morbidity and mortality similar to that seen in the wild frogs. The disease was called chytridiomycosis and the fungus described as a new species *Batrachochytrium dendrobatidis* (Bd), also known as the amphibian chytrid fungus.

Bd has been found infecting over 350 species in two amphibian orders (Anura and Caudata) from all continents where amphibians occur (http://www.bd-maps.net/). Sixty-three (~28%) of Australia's 223 (as listed by IUCN 2008) amphibian species are now known to be wild hosts for Bd (Murray et al. 2010a; Murray et al. 2010b), and over half of Australia's species may be naturally susceptible to Bd in the wild (Murray et al. 2011; Murray and Skerratt in press).

While the discovery of chytridiomycosis has sparked renewed appreciation for the role that diseases can play in threatening wildlife populations and species, it is not the only disease currently affecting amphibians, nor is it likely to be the last. Ranavirus, for example, has been observed to induce mass mortality events in frog and salamander populations in the UK and North America. In response to these global threats, the World Organisation for Animal Health (OIE) has listed both chytridiomycosis and ranavirus as "notifiable" diseases to help control their spread. Similarly, numerous conferences and reports have been assembled to produce standards in managing diseases in wild and captive amphibian populations. Together, these measures highlight the importance of developing **agreed hygiene protocols for the control of diseases in Australian frogs**. This document fulfils this role.

4. Key disease issues in amphibian populations

Here we review the most significant diseases of amphibians, including some that have zoonotic potential and some that have not been detected in Australia. There are many described diseases of amphibians but only a few are known to be an important threat to wild amphibians or other taxa including humans. Some become an issue in captive amphibian populations where management is inadequate. As research on this topic is limited, there are also likely to be many unknown diseases of amphibians which may pose a risk. Disinfection methods have not been validated for all pathogens. Any risk management strategy to minimise the impact of diseases of amphibians should take into account this uncertainty. For detailed reviews see Hemingway et al. (2009) and Berger et al (2009) for diseases in wild populations and Wright and Whitaker (2001) that also includes diseases in captivity.

4.1. Fungi

4.1.1. *Batrachochytrium dendrobatidis*

Batrachochytrium dendrobatidis (Bd) is a fungal pathogen capable of driving amphibian species to perilously low numbers or extinction. In Australia, the oldest record of Bd is from a museum frog specimen collected in south-east Queensland near Brisbane in 1978 (Department of the Environment and Heritage 2006a), which coincides with sudden frog declines in a number of species and two species extinctions in the region (Berger et al. 1998; Hines et al. 1999). Subsequent amphibian declines in central coastal Queensland (1985-86) and the Wet Tropics (1990-95) suggest that *B. dendrobatidis* spread north to its current northern limit at Big Tableland near Cooktown (Laurance et al. 1996; Berger et al. 1999; Skerratt et al. 2010). In southern Australia, the spread of *B. dendrobatidis* is poorly documented but its distribution extends down the entire east coast to Tasmania (first detected in 2004) (Obendorf and Dalton 2006; Pauza and Driessen 2008). Two separate foci occur in other states, one in southwest Western Australia, where the earliest record dates to 1985, and another around Adelaide in South Australia (earliest record 1995) (Murray et al. 2010a). The Northern Territory is currently considered amphibian chytrid free (Skerratt et al. 2008; Skerratt et al. 2010; Murray et al. 2011).

In the majority of infected animals for most of the time, clinical signs of chytridiomycosis are absent. The period of showing signs is typically short and mostly limited to those amphibians that die. Central nervous system signs predominate, including behavioural change, slow and uncoordinated movement, abnormal sitting posture, tetanic spasms, loss of righting reflex and paralysis. Skin changes associated with chytridiomycosis are typically microscopic and not detectable at the clinical level with any degree of confidence, although abnormal skin shedding occurs (skin shed more frequently and in smaller amounts) and erythema (tissue reddening) of ventral surfaces and digits may be seen. For what to do if you encounter a sick or dead amphibian in Australia, see section 6.7. below. For a detailed factsheet about chytridiomycosis, see the Australian Wildlife Health Network website (http://www.wildlifehealth.org.au/AWHN/FactSheets/Fact_All.aspx).

4.1.2. *Mucor amphiborium*

This fungus is an important cause of morbidity and mortality in platypus in Tasmania and amphibians are a potential reservoir host (Gust et al. 2009). Amphibian mucormycosis is a systemic disease caused by the fungus, *Mucor amphibiorum*. Severely infected amphibians have fungi disseminated through their internal organs and skin. The fungi incite formation of granulomas that consist of inflammatory cells and fibrous tissue. At postmortem, the liver contains small pale nodules up to about 5 mm in diameter and usually in massive numbers. These nodules can also be seen in other organs such as the kidney, lung, mesentery, urinary bladder, subcutaneous sinuses and skin. The microscopic fungi are found inside these nodules. *M. amphibiorum* is a primary pathogen and can infect normal amphibians, but in the wild it appears to cause only sporadic infections. Possibly the usual inoculating dose in the wild is not high enough to cause epidemic disease. In captivity it can cause fatal outbreaks in collections. For more information on mucormycosis, see http://www.jcu.edu.au/school/phtm/PHTM/frogs/mucor/mucoramphibiorum.htm.

4.1.3. Oomycetes

Water moulds (family Saprolegniaceae, phylum Oomycota) are ubiquitous in surface water. High levels of infection with *Saprolegnia ferax* caused mortality of Western toad (*Bufo boreas*) egg masses in northwestern United States and were sufficient to affect local populations (Kiesecker et al. 2001). Epidemics may be associated with fish stocking or environmental cofactors.

4.2. Viruses

There are a number of viruses that are known to cause disease and mortality in amphibians, including ranaviruses, frog erythrocytic virus, Lucké tumor herpesvirus, herpes-like virus of skin, calicivirus and leucocyte viruses (Hemingway et al. 2009). In Europe and America the most important of these for their ability to cause mass mortalities and potentially population declines are the ranaviruses (Hyatt et al. 2000). Ranaviruses have been identified in a range of ectothermic vertebrates, including fish, amphibians (frogs, toads, salamanders) and reptiles (lizards, turtles, snakes). Some species can infect a broad host range across all these taxa.

Ranaviral disease is an emerging infectious disease overseas as it is being detected over an increasing geographic range and in more species (Hemingway et al. 2009). While ranaviral disease in wild amphibians has not been frequently observed in Australia, antibodies to ranaviruses have been detected widely (NSW, Qld, NT) in cane toads (*Bufo marinus*) (Zupanovic et al. 1998). Bohle iridoviris (BIV) was first found causing death in wild caught metamorphs of *Limnodynastes ornatus* and has since been detected in wild, moribund adult *Litoria caerulea* from Townsville and captive juvenile *Pseudophryne coriacea* from Sydney (Speare et al. 2001; Cullen and Owens 2002). Laboratory studies in Australia have also shown that cane toads (*Bufo marinus*) and a range of native frogs are susceptible to BIV (Speare et al. 2001). Tadpoles appear the most susceptible, while juvenile frogs were more susceptible than adults. Data on the geographical origin and time of emergence or introduction of ranaviruses in Australia is not known. Ranaviruses not currently found in Australia can cause disease in native Australian amphibians in experimental challenges; for example, Venezuelan Guatopo virus was able to kill *Litoria caerulea* in experimental trials (http://www.jcu.edu.au/school/phtm/PHTM/frogs/otherdiseases-viruses.htm). We need to prevent the introduction of pathogenic ranaviruses into Australia.

Clinical signs of acute ranaviral disease may be seen in tadpoles, metamorphs, juveniles and adults. In general, amphibians infected with ranavirus may show decreased activity, ascites (accumulation of fluid in the peritoneal cavity), anasarca (accumulation of serous fluid in various tissues and cavities of the body), skin ulceration, focal and systemic haemorrhages and death. For what to do if you encounter a sick or dead amphibian in Australia, see section 6.7. below. For a detailed factsheet about ranaviral disease, see the Australian Wildlife Health Network website (http://www.wildlifehealth.org.au/AWHN/FactSheets/Fact_All.aspx).

4.3. Bacteria

The range of bacteria reported as causing disease in amphibians is small. Bacterial septicaemia can cause significant disease in captivity. Infection with Aeromonas spp., non-haemolytic group B Streptococcus, Flavobacteria and chlamydia have caused outbreaks in captive amphibians and Mycobacteria can cause chronic problems. Another group of bacteria can be carried by amphibians with minimal effect and are potentially capable of causing

infections in humans (zoonotic diseases). Salmonella and Leptospira are in this category and are a potential risk to humans, livestock and domestic pets, see below.

4.4. Myxozoa

Myxosporean parasites (*Myxidium* spp.) in the brain and liver of declining Australian frogs, the Green and Golden Bell frog (*Litoria aurea*) and the Southern Bell frog (*Litoria raniformis*), have recently been reported to be associated with disease and may have a significant impact on wild frogs (Hartigan et al. 2011).

4.5. Mesomycetozoa

Ichthyophonus sp. occurs the USA where it is often an incidental finding in tadpoles, frogs and salamanders but may cause morbidity and mortality. It infects muscles and adult frogs with massive infections become lethargic and emaciated. Massive acute lethal infections with numerous mortalities occur infrequently in ranid larvae (D. Green, unpubl., Mikaelian et al. 2000)

4.6. Alveolates

A *Perkinsus*-like organism is a major cause of mortality events in tadpoles in the US. Occurs predominantly in tadpoles of *Rana* spp. and may cause mortality rates of 80-99% in a pond over the course of 2-6 weeks (Davis et al. 2007). Weakly swimming, bloated and floating tadpoles are found.

4.7. Zoonotic Diseases

Guidelines for preventing human exposure to amphibian disease are available at the Centre for Disease Control website- http://www.cdc.gov/healthypets/animals/reptiles.htm

4.7.1. *Salmonella*

Amphibians may carry pathogenic *Salmonella* species, but rarely show signs of disease (Anver and Pond 1984). Prevalence of salmonellas isolated in clinically normal amphibians is generally greater than 10% and bacterial levels can be high (Sharma et al. 1974). In Australia, *Salmonella* were isolated from 12.7% (19/150) of *B. marinus* collected from the wild and 9 serotypes were identified. All nine had previously been isolated in Australia from humans and livestock (O'Shea et al. 1990). An outbreak of gastroenteritis in humans near Rockhampton possibly originated from green tree frogs (*Litoria caerulea*) contaminating drinking water in rainwater tanks (Taylor et al. 2000). Some strains of salmonellae are cosmopolitan while others are not found in Australia, but could be imported.

4.7.2. *Leptospira*

Leptospira are spirochaetal bacteria that usually invade the kidney of vertebrates and are excreted in the urine. Humans and domestic animals are susceptible to various strains of *Leptospira* usually from the species *Leptospira interrogans*. Serious acute and chronic disease occasionally with death can result. Little is known about the occurrence of *Leptospira* in amphibians, and on their significance as reservoir hosts for leptospirosis in humans. No studies appear to have been done on leptospires in amphibians in Australia. However in

Barbados, toads (*Bufo marinus*) and frogs (*Eleutherodactylus johnstonei*) were found to be reservoirs for serovars of *Leptospira* pathogenic to humans (Gravekamp 1991).

4.7.3. *Spirometra erinacei*

The adult stage of the tape worm *Spirometra erinacei* inhabits the small intestine of carnivores such as the cat, dog, fox and dingo. The first larval stage occurs in copepods and the second larval stage (spargana) are long, flat white worms that can infect amphibians and other vertebrates in muscles and under the skin. Sparganosis occurs in around 5% of Australian frogs and heavy burdens are associated with severe disease (Berger et al. 2009). Sparganosis is a public health problem in Asia, usually occurring as subcutaneous or intramuscular infections. Humans become infected by drinking water with infected copepods, eating undercooked frogs, and the worms can also migrate from frog flesh into skin wounds

5. National and border biosecurity

Unregulated trade in animals, as well as unintentional shipment, is suspected to have been a major contributor to the spread of emerging infectious diseases such as chytridiomycosis (Skerratt et al. 2007). There are numerous bodies and regulatory levels that attempt to provide guidance about how to minimise the risk of pathogen spread and transmission in amphibians.

5.1. World Organisation for Animal Health (OIE)

The World Organisation for Animal Health (OIE) lists key diseases as "notifiable" to promote the reporting and management of diseases among member countries. Preventing the spread of amphibian diseases across international borders is important, and both chytridiomycosis (Article 8.1.1) and ranavirus (Article 8.2.1:) are now listed as notifiable diseases in the OIE Aquatic Animal Health Code (http://web.oie.int/eng/normes/fcode/). To access these codes, follow these links:

- **Chytridiomycosis**: http://web.oie.int/eng/normes/fcode/en_chapitre_1.8.1.pdf
- **Ranavirus**: http://web.oie.int/eng/normes/fcode/en_chapitre_1.8.2.pdf

The codes outline recommendations for the "**Importation or transit of *aquatic animals and aquatic animal products* for any purpose from a country, zone or compartment"**:

- **Provided commodities are treated in a manner that inactivates the disease agent (Bd or ranaviruses),** Competent Authorities should not require any disease conditions when authorising the above activities, regardless of the disease status of the exporting country
- However, in cases where it could otherwise reasonably be expected that commodities pose a risk of Bd or ranavirus transmission, a risk assessment should be carried out in accordance with the recommendations in the Aquatic Code. The exporting country would then be notified of the outcome of the risk assessment before trade commences.

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Where commodities do not meet this condition and/or a reasonable risk remains, there are additional requirements that depend on the disease status of the country, zone or compartment.

Freedom from disease:

Importation of live aquatic animals from a country, zone or compartment declared free from disease (Bd or ranavirus) requires an **international aquatic animal health certificate** issued by the Competent Authority confirming disease free status.

- A country may make a **self declaration of freedom from disease** (Bd or ranaviruses) if one of the following conditions is met:

    1. It has no amphibians or other susceptible species AND basic biosecurity conditions have been continuously met for a period of 2 years
    2. There has been no observed occurrence of the disease for at least the past 10 years despite conditions that are conducive to its clinical expression AND basic biosecurity conditions have been continuously met for a period of 10 years
    3. Targeted surveillance has been in place for at least the past 2 years without detection of disease (Bd or ranaviruses) AND basic biosecurity conditions have been continuously met for a period of 2 years
    4. For a country that previously made a self declaration of freedom from disease, it may regain that status after detection of the disease if the affected area was declared an infected zone and a protection zone was established AND infected populations have been destroyed or removed from the infected zone by means that minimise the risk of further spread of the disease AND the appropriate disinfection procedures have been completed AND if the conditions of 3.) above are met.

- A zone or compartment may also be declared free from disease by the Competent Authority if it meets similar conditions to the above. Where a zone or compartment extends over more than one country, declarations must be made by all the Competent Authorities involved.

- A disease free status can be maintained if basic biosecurity conditions are continuously maintained. Targeted surveillance may be discontinued provided conditions that are conducive to clinical expression of disease exist. However, in infected countries and in all other cases where conditions are not conducive to clinical expression of disease, zones or compartments can only maintain a disease free status if targeted surveillance is maintained.

Unknown or known infected country, zone or compartment:

For the importation of live aquatic animals and aquatic animal products for any purpose (e.g., aquaculture, processing for human consumption, use in animal feed, agricultural, laboratory, zoo, pet trade, industrial or pharmaceutical use):

In general, the Competent Authority of the importing country should

- require an **international aquatic animal health certificate** stating the commodities have been appropriately treated to inactivate disease agents
- OR undertake a risk assessment and apply appropriate risk mitigation measures

The risk assessment and risk mitigation measures will vary with purpose of the importation or transit of commodities. Please see the Aquatic Code at the links provided above for more details.

5.2. AUSVETPLAN and AQUAVETPLAN

In Australia, management of animal disease emergencies normally defaults to protocols outlined in the Australian Veterinary Emergency Plan (AUSVETPLAN - http://www.animalhealthaustralia.com.au/programs/eadp/ausvetplan/ausvetplan_home.cfm) or the Australian Aquatic Veterinary Emergency Plan (AQUAVETPLAN - http://www.daff.gov.au/animal-plant-health/aquatic/aquavetplan). However, few of the diseases for which specific plans have been developed concern diseases of free-ranging wildlife. No amphibian diseases are currently included in AUSVETPLAN or AQUAVETPLAN.

5.3. Key Threatening Process and Threat Abatement Plan (TAP)

Chytridiomycosis was listed as a Key Threatening Process in Australia in 2002. A Threat Abatement Plan (TAP) for infection of amphibians with chytrid fungus resulting in chytridiomycosis was subsequently prepared by representatives of the Commonwealth Government. These documents can be accessed here:

- **Key Threatening Process:** http://www.environment.gov.au/biodiversity/threatened/ktp/frog-fungus.html
- **TAP:** http://www.environment.gov.au/biodiversity/threatened/publications/tap/chytrid.html
- **TAP Background document:** http://www.environment.gov.au/biodiversity/threatened/publications/tap/pubs/chytrid-background.pdf

Recommendation 1.1.3 of the TAP proposes that a risk-based approach be used for chytridiomycosis using AUSVETPLAN as a model (Department of the Environment and Heritage 2006b). However, this has not progressed. Nation-wide mapping protocols and disease risk models have been developed as suggested in the TAP and should serve as the basis for cost-sharing arrangements between states and for setting research and management priorities (Skerratt et al. 2008; Murray et al. 2010a; Murray et al. 2010b; Skerratt et al. 2010; Murray et al. 2011). Implementing this step remains a priority.

5.4. Biosecurity Australia

Risk analysis performed by Biosecurity Australia in **"Quarantine requirements for the importation of amphibians or their eggs into zoological facilities"** and **"Quarantine requirements for the importation of amphibians or their eggs for laboratory purposes"** (Animal Biosecurity Policy Memorandum 2003/26) does not list chytridiomycosis as a risk since it is endemic in Australia. However, this disregards the risk of importation into chytrid free areas or the introduction of novel strains. Although chytridiomycosis is not specifically mentioned, the general hygiene strategies recommended should still prevent the release of imported strains of *B. dendrobatidis* during the initial two years. After two years the amphibians can be released without testing for *B. dendrobatidis*. However, if being released into a chytrid free area, the same requirements imposed on Australian bred amphibians under the Threat Abatement Plan would apply.

Risk analysis performed by Biosecurity Australia in **"Quarantine requirements for the importation of amphibians or their eggs into zoological facilities"** and **"Quarantine requirements for the importation of amphibians or their eggs for laboratory purposes"** (Animal Biosecurity Policy Memorandum 2003/26) mentions ranaviruses:

- "The veterinary certificate must… certify that… for both live amphibians or amphibian eggs…, as far as can be determined, no case of ranavirus infection (including frog virus 3, Redwood Park virus, Regina ranavirus), or ranid herpesviruses has been diagnosed at the premises of origin during the 12 months prior to certification."

Importation of amphibians must meet the requirements of two Commonwealth departments, 1) Department of Agriculture, Fisheries and Forestry (DAFF) and 2) the DSEWPaC. The relevant documents can be accessed here:

- **DAFF:**
  Zoological facilities - http://www.jcu.edu.au/school/phtm/PHTM/frogs/aqis/2003-26a.pdf
  Laboratory purposes - http://www.jcu.edu.au/school/phtm/PHTM/frogs/aqis/2003-26b.pdf
- **DSEWPaC:** http://www.environment.gov.au/biodiversity/wildlife-trade/index.html. This site also has the requirements for export of amphibians from Australia.

6. Hygiene management

Hygiene management issues can be broadly classed into *in-situ* (field based) and *ex-situ* (facility based) categories. While general **isolation and disinfection** hygiene management principles apply to both, greater detail on '**Guidelines for captive breeding, raising and restocking programs for Australian frogs'** can be found here: http://www.environment.gov.au/biodiversity/invasive/projects/index.html#threat-10-11.

6.1. In-situ (site) hygiene management

Individuals studying frogs often travel and collect samples of frogs from multiple sites. Numerous hygiene guidelines for handling wild frogs exist, including Daszak et al. (2001), NSW NPWS (2008), NWHC (2001), Speare et al. (2004) and CCADC (2008). Most recently, Phillott et al. (2010) provide a detailed review and synthesis of hygiene considerations that aim to minimise the risk of exposure of amphibians to pathogens in field studies.

It is important to recognise that humans may aid in the:

- **transmission** (passing of disease from an infected to an uninfected individual), and
- **spread** (movement of disease geographically)

of diseases, within and among amphibian populations For researchers working with amphibians or within areas where amphibians may occur, the risk of disease transmission within these habitats and the spread of disease among populations may be increased due to:

- **movement** of frogs or personnel between isolated areas of habitat or between captive husbandry and laboratory facilities and the field
- **handling** of amphibians

It is therefore essential that personnel working with amphibians or within amphibian habitats take care to minimise disease transmission and spread. In order to do this, it is important that frog workers recognise the boundaries between sites/populations.

This is especially important where **rare, geographically restricted or threatened amphibian species** are concerned and when the spread of diseases can have serious consequences for species survival.

Phillott et al. (2010) recommend that field researchers evaluate their activities to determine the relative risk of pathogen transmission and spread compared with background levels (i.e., the risk posed by other mechanisms of disease transmission or pathogen dispersal) and implement appropriate strategies to minimise this risk during field studies. For a **hygiene protocol checklist and suggested field kit** see section 7. The risk of transmission and spread should also be evaluated by researchers, animal ethics committees and government agencies issuing permits.

6.1.1. Defining a site

Defining the boundary of a site may not be straightforward. In some places, the boundary between sites will be obvious but in others it may not. Undertaking work at a number of sites or conducting routine monitoring at a series of sites within walking distance creates obvious difficulties with boundary definitions. It is likely that defining the boundary between sites will differ among localities.

In general:

- watershed and geographical barriers should be used to designate separate sites
- river/stream tributaries should be considered separate sites
- wetlands, ponds, lakes etc. separated by dry land should be considered separate sites
- upstream locations separated by considerable distance (e.g., 500 m) should be considered separate sites
- any obvious break, barrier or change in habitats should be treated as separate sites, particularly if there is no known interchange of frogs between sites

6.1.2. Determining the order of visitation of multiple field sites

When a field trip encompasses several field sites, or a number of locations are being visited in succession, the order of visitation should be determined according to the presence of known pathogens and diseases.

- **Areas known to be absent of disease should be visited first, followed by areas of unknown status, followed by known infected areas**

6.1.3. On-site hygiene

When travelling from site to site it is recommended that the following hygiene precautions be taken to minimise the possibility of transfer of disease from personnel, footwear, equipment and/or vehicles. A list of suitable disinfectants, their required concentrations and exposure times for various purposes is summarised by Phillott et al. (2010) and is reproduced in Table 1 below.

Personnel

- **Hands, arms, knees etc. should be cleaned to remove debris and washed** or wiped with a suitable disinfectant. It is preferable to do this before entering the vehicle or moving to another site.

Footwear and clothing

- **Footwear must be thoroughly cleaned and disinfected** at the commencement of fieldwork and between each sampling site. This can be achieved by initially scraping boots clear of mud and standing the soles in a disinfecting solution. The remainder of the boot should be rinsed or sprayed with a disinfecting solution. Clothing that has significant contact with frogs and the environment should also be subjected to changing or cleaning

Disinfecting solutions should be prevented from entering any water bodies. Several changes of footwear/clothing bagged between sites might be a practical alternative to on-site cleaning. In high value sites, dedicated equipment and clothing stored at the entry to the site may be desirable. (e.g., in a lockbox)

Equipment

- Equipment such as nets, balances, callipers, bags, scalpels, headlamps, torches, wetsuits and waders etc. that are used at one site must be **cleaned and disinfected** before re-use at another site
- Disposable items should be used where practical/possible

Non-disposable equipment should be used only once during a particular field exercise and disinfected later or disinfected at the site between uses using procedures outlined below in Table 1.

Vehicles

Transmission of disease from vehicles is generally unlikely to be a problem. However, if a vehicle is used to traverse a known frog site and could result in mud and water being transferred to other bodies of water or frog sites, then wheels and tyres should be cleaned and disinfected. This is particularly important where vehicles are used in areas not normally frequented by other vehicles. Disinfection should be carried out at a safe distance from water bodies to minimise the risk of chemical contamination.

6.1.4. Principles of cleaning and disinfection

Designing an effective disinfection protocol requires understanding of the properties of disinfectants and target pathogens, and practical consideration of the equipment or processes requiring disinfection. As well as understanding the efficacy of various disinfecting processes, it is important to consider the safety of any disinfection protocol to the environment and the animals on which they will be used. Key distinctions include:

- **Cleaning**: The physical removal of all visible organic and inorganic debris from items
- **Disinfection:** A physical (e.g., UV light) or chemical (e.g., bleach) process to reduce the numbers and/or viability of microorganisms (e.g., bacteria, fungi or viruses) on an object, surface or material
- **Sterilization:** A physical or chemical process that removes all microorganisms from an object, surface or material

Thorough cleaning and disinfection reduces most of the risk of transferring amphibian pathogens. Sterilization of objects is labour intensive and less practical for most routine applications.

Cleaning alone does not render an object free of pathogens. However, it is important to thoroughly clean objects prior to disinfection or sterilization.

- Thorough cleaning physically removes many or most pathogens that are trapped in organic debris
- Thorough cleaning makes successful disinfection more likely
- Cleaning allows disinfectants to directly contact the surfaces of an object
- Warm or hot water improves the ability to remove organic materials from objects
- Regular cleaning of all items used should be performed
- Use of detergents aid cleaning by loosening organic material from the surface of objects and help to break apart biofilms of microorganisms that can resist disinfection
- Thorough rinsing of detergents from objects is essential after cleaning

Disinfection of an item by application of an appropriate chemical agent after cleaning reduces pathogen numbers and viability and minimises potential for disease transmission. Things to consider include:

- **Efficacy of the disinfectant and the type of pathogens that must be eliminated.** For example, some microorganisms such as Mycobacterium spp. or Cryptosporidium spp. are very resistant to most common disinfectants
- **The potential for toxicity to amphibians that are exposed to the disinfectant.** Amphibians are very sensitive to some disinfectant residues and thorough rinsing of all disinfectants is required after use
- **Concerns about human exposure to disinfectants and about discharge of disinfectants into the environment**
- **Safety for use on different materials.** Some disinfectants may be corrosive to materials or tools used in amphibian facilities
- **Ease of use and disposal**
- **Cost**

Table 1. Disinfection strategies suitable for killing *Batrachochytrium dendrobatidis, Mucor amphibiorum* and ranaviruses in field studies. From Phillott et al. (2010) and Webb et al. (submitted).

Application	Disinfectant	Strength	Time	Target pathogen
Surgical equipment and other instruments (e.g. scales, callipers)	Benzalkonium chloride	1 mg ml–1	1 min	*B. dendrobatidis*
	Ethanol	70%	1 min	*B. dendrobatidis* Ranaviruses
Collection equipment and containers	Sodium hypochlorite (bleach contains 4% sodium hypochlorite)	1%	1 min	*B. dendrobatidis*
		3%	1 min	Ranaviruses
	Path X or quaternary ammonium compound 128	1 in 500 dilution	0.5 min	*B. dendrobatidis*
		1 in 100 dilution	10 min	*M. amphibiorum*
	Trigene	1 in 5000 dilution	1 min	*B. dendrobatidis*
	F10	1 in 1500 dilution	1 min	*B. dendrobatidis*
	Virkon	2 mg ml–1	1 min	*B. dendrobatidis*
		1%	1 min	Ranaviruses
	Nolvasan	0.75%	1 min	Ranaviruses
	Potassium permanganate	1%	10 min	*B. dendrobatidis*
	Complete drying		>3 h	*B. dendrobatidis*
	Heat 60°C		30 min	*B. dendrobatidis* Ranaviruses
	Heat 37°C		8 h	*B. dendrobatidis*
	Sterilising UV light		1 min	Ranaviruses only
Footwear	Sodium hypochlorite (bleach contains 4% sodium hypochlorite)	1%	1 min	*B. dendrobatidis*
		3%	1 min	Ranaviruses
	Path X or quaternary ammonium compound 128	1 in 500 dilution	0.5 min	*B. dendrobatidis*
		1 in 100 dilution	10 min	*M. amphibiorum*
	Trigene	1 in 5000 dilution	1 min	*B. dendrobatidis*
	F10	1 in 1500 dilution	1 min	*B. dendrobatidis*
	Phytoclean (30% benzalkonium chloride)	0.075%	1 min	*B. dendrobatidis*
		5%	1 min	*M. amphibiorum*
	Complete drying		>3 h	*B. dendrobatidis*
Cloth (e.g. carry bags, clothes)	Hot wash 60°C or greater		30 min	*B. dendrobatidis* Ranaviruses

6.2. Handling of frogs in the field

The spread of pathogens may occur as a result of handling frogs. In addition to spreading disease among captured frogs, handling may stress animals making them more susceptible to infection from other sources or more likely to succumb to infection.

- **Capture, handling and housing of wild amphibians should be minimised or avoided where possible**
- Where handling is necessary, care must be taken to ensure individuals do not have their exposure to pathogens elevated over their background exposure levels.

Direct transfer of pathogens during capture and handling of successive adult amphibians can be reduced by using:

- **single-use gloves** (latex, nitrile or vinyl), and/or
- **single-use lightweight plastic bags**
- **adequate cleaning of hands and handling equipment**

Many researchers use disposable plastic bags to catch and/or restrain frogs followed by handling/processing with disposable gloves. As some tadpoles may suffer lethal effects when exposed to latex, nitrile or vinyl gloves (Cashins et al. 2008), researchers should only use gloves that have been proven or rendered safe (e.g., by rinsing with water) for the study species.

In situations **where gloves are not available or suitable:**

- hand washing with 70% ethanol (allowing hands to dry) between handling individual frogs is acceptable (note, repeated use on human skin is not recommended). Alcohol is toxic to frogs so hands must be washed thoroughly in water after treatment with alcohol
    - If 70% ethanol is not available or suitable, the minimum treatment is hand-washing in the water to which the amphibian is normally exposed.

In situations **where amphibians must be held temporarily:**

- Individuals should be housed in **single-use containers (e.g. plastic bags) or in containers disinfected** between each animal
- Adults should not be held in groups
- Tadpoles from the same water body may be housed for short periods in a common container, although overcrowding should be avoided

Longer holding times (>60 min) will require changes to water and the provision of appropriate food (>24 h). Tadpoles should always be treated with care to prevent damage on capture and with movement of water within holding containers. If animals must be removed from the field for greater periods and later returned, it should always be to the same site.

6.3. Housing frogs and tadpoles

- **Frogs and tadpoles should only be removed from a site when absolutely necessary.**

Detailed **'**Guidelines for captive breeding, raising and restocking programs for Australian frogs' can be found at: http://www.environment.gov.au/biodiversity/invasive/projects/index.html#threat-10-11. See also 'A Manual for Control of Infectious Diseases in Amphibian Survival Assurance Colonies and Reintroduction Programs**'** (Pessier and Mendelson 2010) at: http://www.cbsg.org/cbsg/workshopreports/26/amphibian_disease_manual.pdf#search=%22amphibian%22

When frogs or tadpoles are to be collected and held for a period of time, the following measures are recommended:

- Isolate animals obtained at different sites
- Aquaria set up to hold frogs should not share water, equipment or any filtration system. Splashes of water from adjacent enclosures or drops of water on nets may transfer pathogens between enclosures
- Ensure that tanks, aquaria and any associated equipment are disinfected prior to housing frogs or tadpoles
- Tanks and equipment should be cleaned, disinfected and dried after frogs/tadpoles are removed

6.4. Marking, invasive and surgical procedures

Strict hygiene standards must be maintained during amphibian marking procedures including implanting internal radio transmitters, passive integrated transponder (PIT) tags, visible implant alphanumeric (VIA) tags, visible implant elastomer (VIE) tags and toe tipping or clipping.

Due to the high permeability of amphibian skin, special disinfectants are required.
The **only suitable, commercially available preparation for disinfecting wounds** is:

- **Bactine®** spray (active ingredient 0.14% w/w benzalkonium chloride and 2.6% w/w lidocaine hydrochloride in a non-alcohol base)
- **Chlorhexidine** (0.75% diluted from 2% Nolvasan®) is also suitable for surgical disinfection
- Alcohol, phenol and iodine based disinfectants **should not be used** because they are potentially toxic and can destroy mucus and wax that prevent dehydration and microbial infection of amphibian skin. Contrary to the recommendations of previous hygiene protocols, Betadine® or other povidone-iodine products are not recommended for use as disinfectants for amphibians until species-specific toxicity has been determined (Phillott et al. 2010).

Toe tipping (removal of most distal phalange) or toe clipping (amputation of a greater proportion of the digit):

- should occur through the **interphalangeal joints**

- Scissors should be **sterilised in 70% ethanol** and dried before use on frogs in the field
- For studies in which diagnostic testing of disease is important, the diagnostic test step (e.g., swabbing for Bd) should be undertaken before any other processing step to minimise the potential for false-positives due to cross contamination

PIT, VIE and VIA tags should be inserted with a **sterile, single-use applicator**.

6.4.1. Sealing wounds

- A c**ryanoacrylate** compound such as Vetbond® (active ingredient n-butyl cryanoacrylate) as a tissue adhesive after toe tipping or clipping is recommended. Vetbond® can also be used to seal incisions made during subdermal injection of VIA, VIE and PIT tags
- A disinfectant such as **Bactine**® should be applied before the adhesive to avoid trapping microbes
- Less expensive industrial adhesives ('superglues') should not be used as a replacement for surgical tissue glues

However, this procedure may only be possible in larger amphibians. In smaller animals, it can be difficult to isolate toes for application and internal marking devices such as PIT tags may be unsuitable. Moisture can interfere with setting times and adhesion so care must be taken to ensure setting has occurred before release. Problems may be experienced in their application to stream- or pond-dwelling amphibians, but can be avoided by using a small piece of sterile absorbent dressing to draw surplus water from the wound before application of the adhesive (Phillott et al. 2010).

6.4.2. Equipment

- Equipment used in marking or surgery should be appropriately **disinfected**
- Disposable sterile instruments should be used where practical/possible
- Instruments should be disinfected or changed in between each frog
- All used **disinfecting solutions, gloves and other disposable items should be stored in a sharps or other waste container and disposed of or sterilised appropriately** at the completion of fieldwork
- Disinfecting solutions must not come into contact with frogs or be permitted to contaminate any water bodies

6.5. Return of captive animals to the wild

- In general, if wild frogs or tadpoles are housed for any period of time in a captive situation (e.g. laboratory, zoo or captive breeding facility), **they should not be returned to the wild**

Exceptions to this can occur if they have been kept in isolation, their captive history is free of undiagnosed morbidity or mortality and they have had rigorous pathogen screening before release. This is usually beyond the means of most studies.

Detailed **'**Guidelines for captive breeding, raising and restocking programs for Australian frogs' can be found at:

http://www.environment.gov.au/biodiversity/invasive/projects/index.html#threat-10-11. See also 'A Manual for Control of Infectious Diseases in Amphibian Survival Assurance Colonies and Reintroduction Programs' (Pessier and Mendelson 2010) at: http://www.cbsg.org/cbsg/workshopreports/26/amphibian_disease_manual.pdf#search=%22amphibian%22

6.6. Displaced frogs

- **Displaced frogs should be treated as if they are infected and should not be transported anywhere for release to the wild**

Displaced frogs are native frog species and introduced cane toads (*Bufo marinus*) that have been unintentionally transported from one place to another. This may typically occur with the transport of fresh produce and landscaping supplies. 'Banana Box' frog is the term used to describe several native frog species (usually *Litoria gracilenta, L. fallax, L. caerulea, L. rubella, L. infrafrenata* and *L. bicolor*) commonly transported in fruit and vegetable shipments and landscaping supplies. There is risk of spread of disease if these frogs are transferred from place to place.

When encountering a displaced frog:

- Contact a **licensed wildlife carer** organisation to collect the animal. The frog may then undergo a quarantine period along with an approved disinfection treatment
- Post-quarantine, and dependant on local state legislation and policies, the frog may be transferred to a **licensed frog keeper** once permission from the relevant regulatory body has been received. Licensed carer groups are to record and receipt frogs obtained and disposed of in this way.
- Frogs held by licensed frog keepers are **not to be released to the wild** except with relevant regulatory body approval

Displaced frogs may also be made available to recognised institutions for research projects, display purposes or offered to a museum as scientific specimens once approval has been provided by the relevant regulatory body.

- **Frogs encountered on roads, around dwellings and gardens or in swimming pools should not be considered as displaced frogs unless they are of a species not local to the area**

Local frogs encountered in these situations should be assisted off roads, away from dwellings, or out of swimming pools preferably to the nearest area of vegetation or suitable habitat.

6.6.1. Cane toads

Cane toads are known amphibian disease carriers and should not be knowingly transported or released to the wild.

If a cane toad is discovered it should be humanely euthanized in accordance with the recommended Animal Welfare procedures. Care should be taken to avoid euthanasia of native species due to mistaken identity.

6.7. Sick and dead animals

Dead amphibians or live animals showing clinical signs of disease must be regarded as having a high infection risk to healthy animals and rigorous hygiene measures are required.

- **Sick and dead frogs should be collected and sent for disease diagnosis**

No effective and practical field treatment for chytridiomycosis has been demonstrated. Similarly, no treatment regimes for ranaviral infection of frogs have been described. The collection of sick and dead frogs for expert diagnosis may improve disease surveillance activities, which can help detect disease introduction and enable emergency responses. It is also useful to assess the risk of pathogen transmission to other individuals or spread to other populations. A procedure for the preparation and transport of a sick or dead frog is given below. Adherence to this procedure will ensure the animal is maintained in a suitable condition for pathological examination and assist determining the extent of the disease and the number of species affected. For more information about sick and dead amphibians, see http://www.jcu.edu.au/school/phtm/PHTM/frogs/pmfrog.htm.

Collection:

- Do not use bare hands to handle sick or dead frogs
- Disposable gloves should be worn when handling sick or dead frogs
- New gloves and a clean plastic bag should be used for each frog specimen to prevent cross-contamination
- If the frog is dead, keep the specimen cool and preserve as soon as possible to avoid decomposition

Preserving specimens:

- Specimens can be **preserved/fixed in 70% ethanol or 10% buffered formalin**
- Cut open the belly and place the frog in about 10 times its own volume of preservative
- Where no preservative is available, **specimens can also be frozen**. If numerous frogs are collected, some should be preserved and some should be frozen. Portions of a dead frog can also be sent for analysis (e.g., a preserved foot, leg or a portion of abdominal skin)

Transportation:

- **If the frog is alive and likely to survive transportation**, place the frog into either a moistened cloth bag with some damp leaf litter or into a plastic bag with damp leaf litter and partially inflated before sealing
- Remember to **keep all frogs separated** during transportation
- **If the frog is alive but unlikely to survive transportation** (death appears imminent), euthanize the frog and place the specimen in a freezer or preservative. Once frozen/preserved the specimen is ready for shipment
- **All containers should be labelled** showing at least the species (if known), date and collection location
- Preserved samples can be sent in jars or wrapped in wet cloth, sealed in bags and placed inside a padded box
- Send frozen samples in an esky with dry ice

- Place live or frozen specimens into a small Styrofoam esky. Seal esky with packaging tape before sending
- Send the package by courier and declare any hazardous or flammable contents (e.g., 70% ethanol)

7. Hygiene protocol checklist and field kit

The following checklist and field kit are designed to assist with minimising the risk of transferring pathogens between frogs and sites in field studies (follows NSW 2008)

Have you considered the following questions before handling frogs in the field:

- Has your proposed field trip been sufficiently well planned to consider hygiene issues?
- Have you considered the boundaries between sites (particularly where endangered species or populations at risk are known to occur)?
- Have footwear disinfection procedures been considered and a strategy adopted?
- Have you planned the equipment you will be using and developed a disinfection strategy?
- Are you are planning to visit sites where vehicle disinfection will be needed? If so, do you have a plan to deal with vehicle disinfection?
- Have handling procedures been planned to minimise the risk of frog to frog pathogen transmission?
- Do you have a planned disinfection procedure to deal with equipment, apparel and direct contact with frogs?

If you answered NO to any of these questions please re-read the relevant section of the *Hygiene Protocols for the Control of Disease in Australian Frogs* and apply a suitable strategy.

Field hygiene kit

When planning to survey frogs in the field a portable field hygiene kit should be assembled to assist with implementing the hygiene protocols. Recommended contents of a field hygiene kit would include:

- Plastic box to store field equipment
- Small Styrofoam esky
- Disposable gloves
- Disinfectant spray bottle (atomiser spray) and/or wash bottle for disinfectants
- Disinfecting solutions
- Scraper or scrubbing brush for cleaning mud off footwear, vehicles etc.
- Bucket for mixing disinfecting solutions and soaking
- Plastic bags, large and small for hygienic temporary animal handling/holding
- Sharps or other container for safe waste disposal
- Materials for dealing with sick and dead frogs (see section 6.7.)

Detailed 'Guidelines for captive breeding, raising and restocking programs for Australian frogs' can be found at: http://www.environment.gov.au/biodiversity/invasive/projects/index.html#threat-10-11. See also 'A Manual for Control of Infectious Diseases in Amphibian Survival Assurance Colonies and Reintroduction Programs' (Pessier and Mendelson 2010) at: http://www.cbsg.org/cbsg/workshopreports/26/amphibian_disease_manual.pdf#search=%22amphibian%22

8. Important Australian contacts

8.1. Sick and dead frogs

To arrange receipt and analyse sick and dead frogs, make contact with experts at any of the organisations below prior to dispatching package:

Australian Registry of Wildlife Health
Taronga Conservation Society,
Australia
PO Box 20
MOSMAN NSW 2088
Phone: 02 9978 4749

School of Public Health, Tropical Medicine and Rehabilitation Sciences
James Cook University
Douglas Campus
TOWNSVILLE QLD 4811
Phone: 07 4796 1735

School of Biological Sciences
University of Newcastle
CALLAGHAN NSW 2308
Phone: 02 4921 6014

9. References

Anver, M. R. and C. L. Pond (1984). Biology and diseases of amphibians. Laboratory Animal Medicine. B. J. C. J. G. Fox, F. M. Loew. New York, Academic Press**:** 427-447.

Berger, L., J. E. Longcore, R. Speare, A. Hyatt and L. F. Skerratt (2009). Fungal Diseases in Amphibians. Amphibian Biology, Volume 8 Amphibian Decline: Disease, Parasites, Maladies, and Pollution. H. Heatwole and J. W. Wilkinson, Surrey Beatty & Sons. NSW.

Berger, L., R. Speare, P. Daszak, D. E. Green, A. A. Cunningham, C. L. Goggin, R. Slocombe, M. A. Ragan, A. D. Hyatt, K. R. McDonald, H. B. Hines, K. R. Lips, G. Marantelli and H. Parkes (1998). "Chytridiomycosis causes amphibian mortality associated with population declines in the rain forests of Australia and Central America." Proceedings of the National Academy of Sciences of the United States of America 95(15): 9031-9036.

Berger, L., R. Speare and A. Hyatt (1999). Chytrid fungi and amphibian declines: Overview, implications and future directions. Declines and Disappearances of Australian Frogs. A. Campbell. Canberra, Environment Australia**:** 23-33.

Cashins, S., R. Alford and L. F. Skerratt (2008). "Lethal effect of latex, nitrile, and vinyl gloves on tadpoles." Herpetological Review 39: 298-301.

CCADC (2008). "Decontamination protocol to reduce the risk of spreading infectious amphibian diseases in freshwater systems. (California Centre for Amphibian Disease Control). www.ccadc.us/docs/DeconForProfessionals.pdf."

Cullen, B. R. and L. Owens (2002). "Experimental challenge and clinical cases of Bohle iridovirus (BIV) in native Australian anurans." Diseases of Aquatic Organisms 49(2): 83-92.

Daszak, P., A. A. Cunningham and H. A.D. (2001). Draft guidelines for international translocation of amphibians with respect to infectious diseases. Attachment 6. In: Speare R and Steering Committee of Getting the Jump on Amphibian Disease. Developing management strategies to control amphibian diseases: Decreasing the risks due to communicable diseases. School of Public Health and Tropical Medicine, James Cook University: Townsville. 2001: 150-156.

Davis, A. K., M. J. Yabsley, M. K. Keel and J. C. Maerz (2007). "Discovery of a novel alveolate pathogen affecting southern leopard frogs in Georgia: Description of the disease and host effects." Ecohealth 4(3): 310-317.

Department of the Environment and Heritage. (2006a). "Background document for the Threat Abatement Plan: Infection of amphibians with chytrid fungus resulting in chytridiomycosis." from http://www.environment.gov.au/biodiversity/threatened/publications/tap/chytrid/pubs/chytrid-background.pdf.

Department of the Environment and Heritage. (2006b). "Threat Abatement Plan: Infection of amphibians with chytrid fungus resulting in chytridiomycosis." 2007, from http://www.environment.gov.au/biodiversity/threatened/publications/tap/chytrid.html.

Gravekamp, C., Korver, H., Montgomery, J., Everard, C.O., Carrington, D., Ellis, W.A., Terpstra, W.J. (1991). "Leptospires isolated from toads and frogs on the Island of Barbados." Zentralblatt fur Bakteriologie 275: 403-411.

Gust, N., J. Griffiths, M. Driessen, A. Philips, N. Stewart and D. Geraghty (2009). "Distribution, prevalence and persistence of mucormycosis in Tasmanian platypuses (Ornithorhynchus anatinus)." Australian Journal of Zoology 57(4): 245-254.

Hartigan, A., I. Fiala, D. I, M. Jirků, B. Okimoto, K. Rose, D. N. Phalen and Š. J. (2011). "A suspected parasite spill-back of two novel Myxidium spp. (Myxosporea) causing

disease in Australian endemic frogs found in the invasive cane toad." PLoS One 6: e18871.
Hemingway, V., J. Brunner, R. Speare and L. Berger (2009). Viral and bacterial diseases of amphibians. Amphibian Biology, Volume 8 Amphibian Decline: Disease, Parasites, Maladies, and Pollution. H. Heatwole and J. W. Wilkinson, Surrey Beatty & Sons. NSW.
Hines, H., M. Mahony and K. McDonald (1999). An assessment of frog declines in wet subtropical Australia Declines and Disappearances of Australian Frogs. A. Campbell. Canberra, Environment Australia**:** 44-63.
Hyatt, A. D., A. R. Gould, Z. Zupanovic, A. A. Cunningham, S. Hengstberger, R. J. Whittington, J. Kattenbelt and B. E. H. Coupar (2000). "Comparative studies of piscine and amphibian iridoviruses." Archives of Virology 145(2): 301-331.
Kiesecker, J., A. R. Blaustein and C. L. Miller (2001). "Transfer of a pathogen from fish to amphibians." Conservation Biology 15: 1064-1070.
Laurance, W., K. McDonald and R. Speare (1996). "Catastrophic declines of Australian rain forest frogs: support for the epidemic disease hypothesis." Conservation Biology 10: 406-413.
Longcore, J. E., A. P. Pessier and D. K. Nichols (1999). "*Batrachochytrium dendrobatidis gen et sp nov*, a chytrid pathogenic to amphibians." Mycologia 91(2): 219-227.
Mikaelian, I., M. Ouellet, B. Pauli, J. Rodrigue, J. C. Harshbarger and D. M. Green (2000). "Ichthyophonus – like infection in wild amphibians from Québec, Canada." Diseases of Aquatic Organisms 40: 195-201.
Murray, K. A., R. Retallick, K. McDonald, D. Mendez, K. Aplin, P. Kirkpatrick, L. Berger, D. Hunter, H. B. Hines, R. Campbell, M. Pauza, M. Driessen, R. Speare, S. J. Richards, M. Mahony, A. Freeman, A. D. Phillott, J.-M. Hero, K. Kriger, D. Driscoll, A. Felton, R. Puschendorf and L. F. Skerratt (2010a). "The distribution and host range of the pandemic disease chytridiomycosis in Australia spanning surveys from 1956 to 2007." Ecology 91(5): 1557.
Murray, K. A., R. W. R. Retallick, R. Puschendorf, L. F. Skerratt, D. Rosauer, H. McCallum, L. Berger, R. Speare and J. VanDerWal (2011). "Assessing spatial patterns of disease risk to biodiversity: implications for the management of the amphibian pathogen, *Batrachochytrium dendrobatidis*." Journal of Applied Ecology 48(1): 163-173.
Murray, K. A., D. Rosauer, H. McCallum and L. F. Skerratt (2010b). "Integrating species traits with extrinsic threats: closing the gap between predicting and preventing species declines." Proceedings of the Royal Society B-Biological Sciences Published online October 27 2010(doi:10.1098/rspb.2010.1872).
Murray, K. A. and L. F. Skerratt (in press). "Predicting wild hosts for amphibian chytridiomycosis: integrating host life-history traits with pathogen environmental requirements." Human and Ecological Risk Assessment.
NSW, N. P. a. W. S. (2008). Hygiene protocol for the control of disease in frogs. Threatened Species Management**:** Information Circular No. 6. 200: p 218.
NWHC (2001). "Toe-clipping of frogs and toads standard operating procedure no. 110. NWHC (National Wildlife Health Center), Madison, WI www.nwhc.usgs.gov/publications/amphibian_research_procedures/toe_clipping.jsp.".
O'Shea, P., R. Speare and A. D. Thomas (1990). "Salmonellas from the cane toad, Bufo marinus." Australian Veterinary Journal 67: 310.
Obendorf, D. and A. Dalton (2006). "A survey for the presence of the amphibian chytrid fungus (*Batrachochytrium dendrobatidis*) in Tasmania." Papers and Proceedings of the Royal Society of Tasmania 140: 25-29.
Pauza, M. and M. Driessen (2008). Distribution and potential spread of amphibian chytrid fungus *Batrachochytrium dendrobatidis* in the Tasmanian Wilderness World Heritage

Area, Biodiversity Conservation Branch, Department of Primary Industries and Water, Tasmania.
Pessier, A. and J. R. Mendelson (2010). A manual for control of infectious diseases in amphibian survival assurance colonies and reintroduction programs. Apple Valley, MN, IUCN/SSC Conservation Breeding Specialist Group: .
Phillott, A. D., R. Speare, H. B. Hines, E. Meyer, L. F. Skerratt, K. R. McDonald, S. D. Cashins, D. Mendez and L. Berger (2010). "Minimising exposure of amphibians to pathogens during field studies." Diseases of Aquatic Organisms.
Sharma, V. K., Y. K. Kaura and I. P. Singh (1974). "Frogs as carriers of Salmonella and Edwardsiella." Antonie von Leeuwenhoek 40: 171-175.
Skerratt, L. F., L. Berger, H. B. Hines, K. R. McDonald, D. Mendez and R. Speare (2008). "Survey protocol for detecting chytridiomycosis in all Australian frog populations." Diseases of Aquatic Organisms 80(2): 85-94.
Skerratt, L. F., L. Berger, R. Speare, S. Cashins, K. R. McDonald, A. D. Phillott, H. B. Hines and N. Kenyon (2007). "Spread of chytridiomycosis has caused the rapid global decline and extinction of frogs." Ecohealth 4(2): 125-134.
Skerratt, L. F., K. R. McDonald, H. B. Hines, L. Berger, D. Mendez, A. Phillott, S. D. Cashins, K. A. Murray and R. Speare (2010). "Validation of the mapping protocol for *Batrachochytrium dendrobatidis* in Queensland, Australia " Diseases of Aquatic Organisms 92: 117-129.
Speare, R., L. Berger, L. F. Skerratt, R. Alford, D. Mendez, S. Cashins, N. Kenyon, K. Hauselberger and J. Rowley (2004). Hygiene Protocol for handling amphibians in field studies. A. D. Group. Townsville, James Cook University**:** 4.
Speare, R., o. G. t. J. o. A. D. Core Working Group and o. G. t. J. o. A. Steering Committee (2001). Developing Management Strategies to Control Amphibian Diseases: Decreasing the Risks Due to communicable Diseases. S. C. o. G. t. J. o. A. D. (eds Speare R. Townsville, School of Public Health and Tropical Medicine, James Cook University.
Stuart, S. N., J. S. Chanson, N. A. Cox, B. E. Young, A. S. L. Rodrigues, D. L. Fischman and R. W. Waller (2004). "Status and trends of amphibian declines and extinctions worldwide." Science 306(5702): 1783-1786.
Taylor, R., D. Sloan, T. Cooper, B. Morton and I. Hunter (2000). "A waterborne outbreak of Salmonella Saintpaul." Communicable Diseases Intelligence 24: 336-340.
Webb, R., A. Philips, L. Berger, J. Connolly and R. Speare (submitted). "Controlling the spread of wildlife diseases: In vitro efficacy of disinfectants against the pathogenic fungi Batrachochytrium dendrobatidis and Mucor amphibiorum." Diseases of Aquatic Organisms.
Wright, K. M. and B. R. Whitaker (2001). Amphibian Medicine and Captive Husbandry. Malabar, Florida, Krieger Publishing.
Zupanovic, Z., G. Lopez, A. D. Hyatt, B. Green, G. Bartran, H. Parkes, R. J. Whittington and R. Speare (1998). "Giant toads Bufo marinus in Australia and Venezuela have antibodies against 'ranaviruses'." Diseases of Aquatic Organisms 32(1): 1-8.

ATTACHMENT E - SITE PHOTOGRAPHS

Photograph E1 – Overview of the study area from Geelong-Ballan Road.

Photograph E2 – Inundated areas charaterised predominantly by pasture grasses, adjacent to Cowies Creek.

Photograph E3 – Saltmarsh in drainage line running north-south through the study area.

Photograph E4 – Juncus sp. among fringing vegetation along Cowies Creek in the study area.

Photograph E5 – Very little floating and emergent vegetation is present within the Cowies Creek habitat corridor.

Photograph E6 – Fencing is present along the creekline preventing damage from livestock

APPENDIX 2 – COWIES CREEK STORMWATER IMPACTS

Engineering + Creativity = Better Water Outcomes

3/05/2022

David Liao
Manager
Yih-Sheng Investments Pty Ltd
Via email

Dear David,

200 Ballan Road, Moorabool: Cowies Creek Stormwater Impacts
Rain Reference 197_01_m01v01_200_ballan_rd

1 Introduction

The proposed Creamery Road Precinct Structure Plan (PSP) area is located in the West Geelong Growth Area. A section of Cowies Creek is located in the PSP area. This has been identified as containing the Growling Grass Frog (GGF) which is a federally protected species. Cowies Creek is understood to be a suitable location for GGF habitat preservation and/or enhancement. Figure 1-1 shows the location of the proposed Creamery Road PSP area, along with current land boundaries.

Figure 1-1 Creamery Road PSP Area

Work is currently being undertaken to inform a Federal referral under the EPBC Act, this will be informed by information about the impacts of the proposed development, this includes hydrological impacts.

Matters to be addressed to inform the Federal referral area are as follows:

- Stormwater modelling is required to understand what (if any) changes to the hydrology of Cowies Creek will occur as a result of the proposed development.
- The stormwater modelling should be based on the expected maximum development scenario and provide a comparison against current conditions.
- Specifically, the following scenarios and parameters should be modelled:
    - Current hydrological conditions of Cowies Creek including flow rates, flow volumes, seasonality of flows and water quality parameters (incl. salinity, turbidity, nutrient inputs).
    - Expected hydrological conditions of Cowies Creek following development including flow rates, flow volumes, seasonality of flows and water quality parameters (incl. salinity, turbidity, nutrient inputs) based on a 100 m buffer along Cowies Creek.
    - The model for expected hydrological conditions should be based on the maximum developable area being proposed to be able to present a 'worst case scenario' for Cowies Creek.
        - Turbidity cannot be modelled in MUSIC, but Total Suspended Solids can and will be. Others may draw conclusions between the changes in TSS loads and how that may correlate with turbidity.
        - Salinity cannot be modelled in MUSIC. Others may draw conclusions between the flow rates/volumes and expected changes to salinity.
- The stormwater modelling report will need to provide discussion and interpretation of the modelling outputs and include consideration of the following:
    - Are there likely to be changes in the existing patterns of flow rate, flow volume or seasonality of flows in Cowies Creek as a result of the development of the PSP? If so, what is the nature and scale of the change?
    - Are there likely to be any changes to the nutrients inputs or other pollutants received by Cowies Creek as a result the proposed development? If so, what is the nature and scale of the change?
    - If there are likely to be changes to the current hydrology of Cowies Creek, how can these be avoided or mitigated? (i.e., how can the proposed development be designed to avoid potential impacts?).

2 Subject of this Report

This report pertains to the development of the property at 200 Ballan Road, Moorabool. Yih-Sheng Investments Pty Ltd control this land. The subject site is shown in Figure 2-1.

Figure 2-1 Subject Site

3 Hydrological and Water Quality Modelling

3.1 RORB Modelling

The City of Greater Geelong provided a RORB model of the broader Cowies Creek catchment for use in this study. A schematic of the model is shown in Figure 3-1. Key configuration parameters were set by others and adopted for use in this study.

The RORB model was used to:

- Obtain peak 1% AEP flows for the creek; and
- Set sub-catchment areas, fractions impervious and catchment connectivity for existing conditions for the MUSIC modelling.

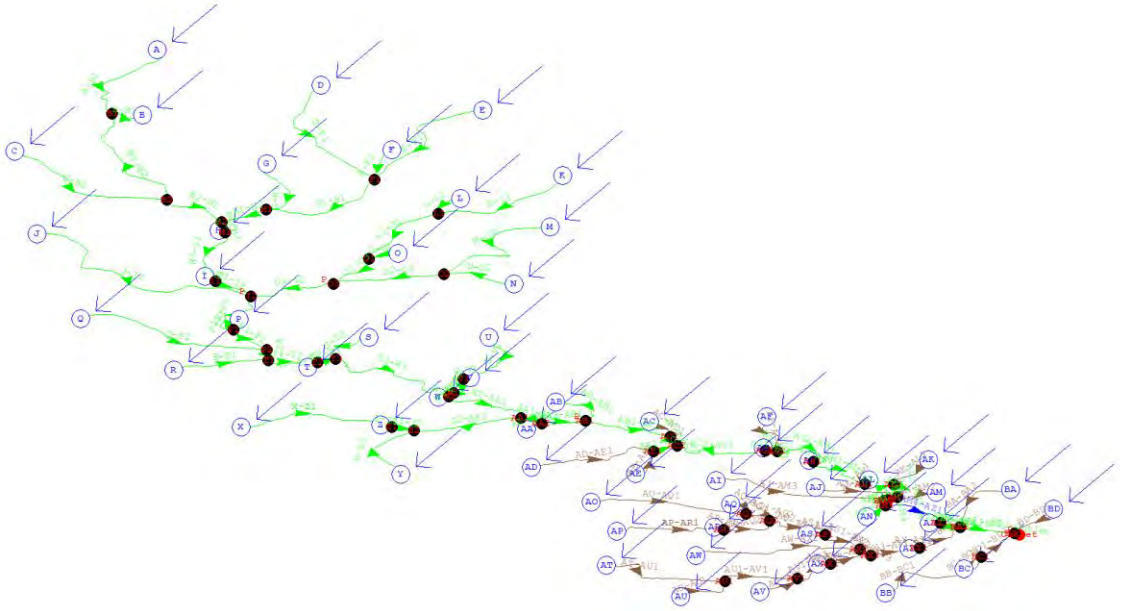


Figure 3-1 RORB layout – existing conditions

3.2 MUSIC Modelling

Long term hydrology including rates, volumes and seasonality, and water quality including Total Suspended Solids, Total Phosphorus, Total Nitrogen and Gross Pollutants were modelled using MUSIC. The City of Greater Geelong provided a MUSIC model of the Creamery Road PSP area for consideration in this study. That model was considered in setting the MUSIC parameters as part of this work. The following key assumptions were used following this and the *MUSIC Guidelines* (Melbourne Water, 2018):

- Source nodes - Mixed
- Soil Storage Capacity – 120 mm
- Field Capacity – 50 mm
- Meteorological data - Geelong North gauge 1971-1980 6 minute infilled

- Fractions Impervious (FI) – as recommended Yih-Sheng Investments. Set to 0.8 for entire developable area (20.35 ha). An additional 3.98 ha is set to represent the creek buffer in the parcel. Developer assumes this is a conservative assumption in lieu of final layout plan. 0.8 correlates to development of the style of a 'Mixed Use Zone' (mix of residential, commercial, industrial and hospitals) when comparing to assumptions for FI from the *MUSIC Guidelines*. FI's were adopted from the RORB model for all other areas.

Current (existing) conditions were modelled by adopting catchment areas, fractions impervious (which represent development levels and soil conditions) and catchment alignments from the supplied RORB model for consistency. Note the catchments adopted from RORB were AB and AA and all upstream catchments (AB and AA (refer Figure 3-1) are the most downstream catchments to contribute to Cowies Creek flows adjacent to the proposed Creamery Rd PSP area – all other downstream catchments were not modelled as they are irrelevant to this study). The existing conditions MUSIC layout is shown in Figure 3-2, while Figure 3-3 zooms in over the subject site showing its source nodes and key reporting junctions.

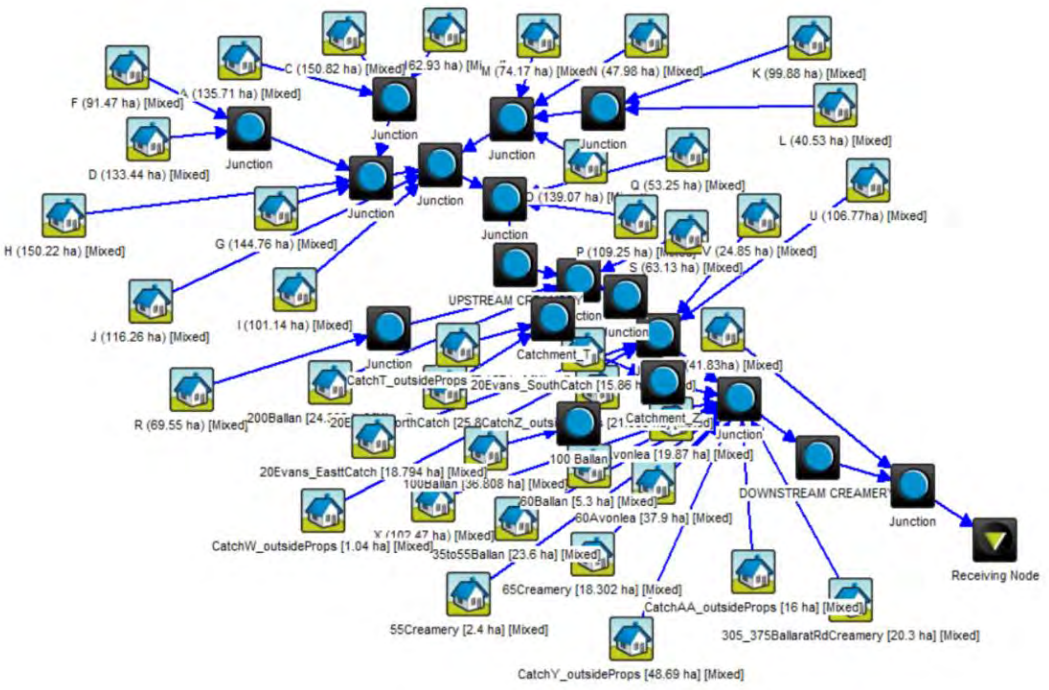


Figure 3-2 MUSIC model – existing conditions

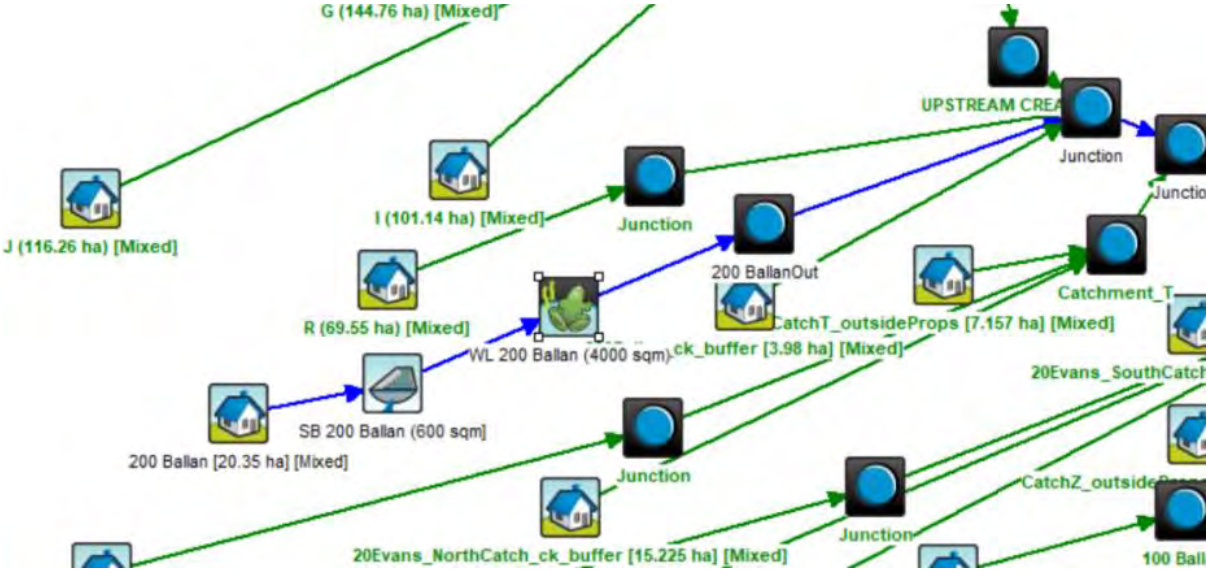


Figure 3-3 MUSIC model – existing conditions – close up of 200 Ballan Road and reporting junctions

Developed conditions were modelled by modifying the source node for the developing parcel, with 20.35 ha of the area of that parcel modelled as developed (adopting an impervious fraction of 0.8) for the purposes of this report, to ascertain the impact of the development of that parcel. Development levels were set for a conservative assumption (i.e. higher fraction impervious). The remaining 3.98 ha of the parcel was set to existing FI to represent the 50 m creek buffer.

Water quality treatments have been assumed to be standard and were represented as standard in the MUSIC modelling (i.e. water treated to Best Practice Environmental Management Guidelines (BPEMG)). This was via the inclusion of sediment basins and wetlands to simulate treatment to BPEMG and sized using high-level hand calculations. It is considered that all developed conditions flows up to the 3 month ARI will be treated, either on the subject site or downstream of it on a nearby site within the proposed PSP area. It is noted that in the MUSIC modelling provided by Council, assets were designed with very high bypass flow values which may lead to under-estimation of asset sizes required in that work when compared to this work. The modelling completed in this study includes indicative treatment rates only, and in reality, the placement of treatment assets may be on other sites within the PSP area to treat stormwater runoff from multiple parcels. It is a fair assumption that the site runoff would be treated at some point prior to entering Cowies Creek.

4 Results – Hydrological Conditions

4.1 Peak Flows

The Cowies Creek RORB model supplied by Council (30087_CowiesCreek_003.catg) was edited for this project to add a print location on Cowies Creek immediately upstream of the Creamery Road precinct. The model was then re-run adopting all run parameters and losses as provided.

The 1% AEP peak median flow for current conditions (from the RORB modelling) is 35.76 m^3/s on Cowies Creek immediately upstream of the Creamery Road precinct. This is seen in the 12-hour duration storm event. Figure 4-1 shows that the peak flow occurs at around the 9-hour mark, with most of the peak having passed the site by the 20-hour mark.

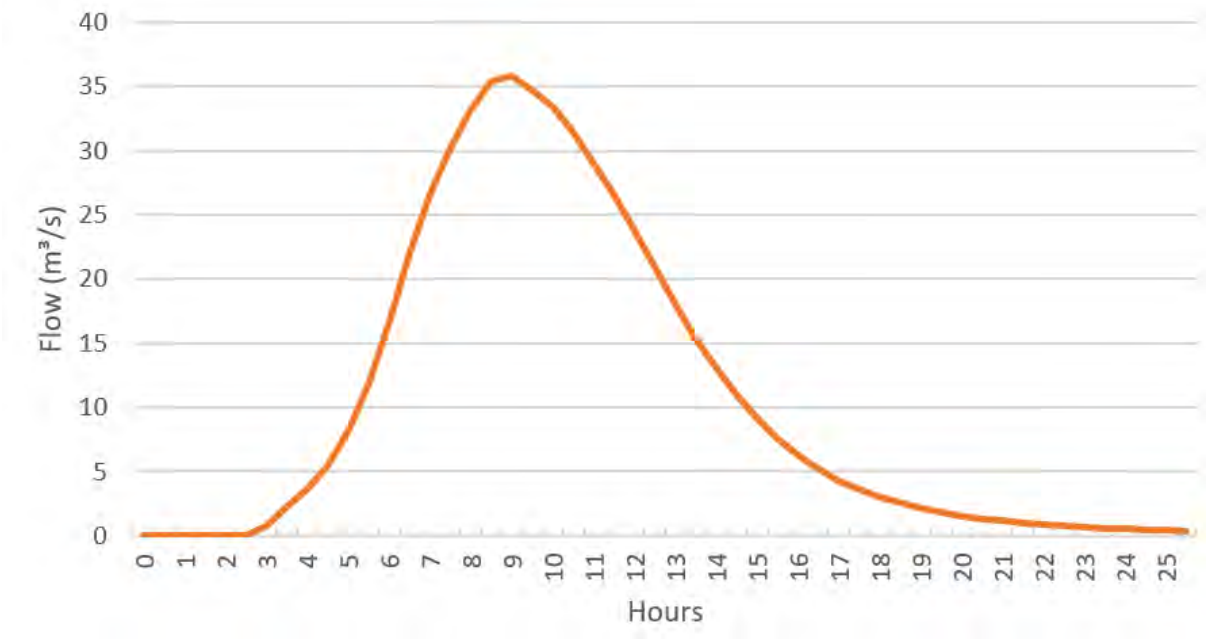


Figure 4-1 Peak 1% AEP flow immediately upstream of Creamery Road

In developed conditions, there is a requirement to retard any excess stormwater runoff to the same peak flow rate as current conditions, therefore it can be assumed that this retardation will occur as routine for the development, and so the developed conditions peak flow rate will be the same as for current conditions for the 1% AEP flood event.

A Rational Method estimate was completed to determine the likely 1% AEP runoff in developed conditions on the subject site assuming pre-development levels (assuming appropriate flow retardation has taken place).

- 200 Ballan Road: Approximately 0.63 m^3/s

Based on the above, flows from the subject site will contribute to around 1.75% of the peak 1%AEP flow in Cowies Creek if the peak 1% AEP flow of the subject site was to meet the peak 1% AEP flow of the upstream catchment. The travel time from the

subject site to Cowies Creek will likely be much quicker than the travel time of the peak from upstream. In pre-developed conditions, the travel time for each catchment is estimated to be around 20-30 minutes (calculated via Adam's Method). This indicates that in existing conditions, peak flows would pass through the site and into Cowies Creek well before the peak from upstream reaches.

In post-developed conditions, retardation back to pre-developed levels is likely. As a general indication, once a retarding basin is introduced, peaks are retarded (delayed) to 1.5 – 2 times the initial storm duration of the inflow. It could be assumed that the peak storm duration will be less than the 1-hour duration, indicating that the peak from any basin would occur before 2-hours after the storm commencement. It is hence suggested that, although the peak leaving the site would be delayed and extended, the peaks from any retarding basin would enter Cowies Creek before the upstream peak arrives. Although the overall volume entering Cowies Creek would increase (given no mitigation), it can be assumed that there will be no increase in peak 1% AEP flows experienced in Cowies Creek due to the development.

With any development, the increase in hard surface reduces soil infiltration and other catchment losses. With development, regardless of whether a retardation basin is in place, the frequency of flows would be expected to increase as a result of development.

4.2 Long-term Flow Rates, Volumes and Seasonality

The results in this section are from the MUSIC modelling. MUSIC does not perform flow routing; hence flow results are indicative and for comparative (existing versus developed) purposes only.

The model results are reported at two reporting points, detailed below and indicated in Figure 4-2:

- Creek Reporting Location: At the junction with Cowies Creek, where inflow from the site would combine with adjacent and upstream flows where it enters the creek.
    - This provides an estimate of flows within Cowies Creek itself at the approximate location at which the site runoff would enter the creek. The creek at this point has a significant upstream contributing catchment area, being the broader Cowies Creek catchment.
    - Using these results simulates rainfall occurring across the entire Cowies Creek catchment in the long-term modelling.
- Site Reporting Location: At the outlet of the parcel itself ('site outlet'), prior to the runoff entering Cowies Creek.
    - This provides a comparison of existing versus developed conditions runoff from the site itself before those site flows combine with larger creek flows from upstream or any other local catchment flows.

- This shows treatment rates only, and in reality, the placement of treatment assets may be on other sites within the PSP area to treat stormwater runoff from multiple parcels. Therefore, runoff leaving the parcel in developed conditions may potentially remain untreated and unretained until a point further downstream closer to Cowies Creek.

Figure 4-2 MUSIC reporting points

4.2.1 At the Junction with Cowies Creek

The average annual flow rate (m^3/day) across all modelled years for existing (blue) and developed (grey) conditions is shown in Figure 4-3. This is representative of possible flows within Cowies Creek itself, inclusive of potential flows from the greater upstream catchment area and the site itself.

There is an approximate 4% increase in average daily flow volume in the creek (where it combines with flows from the site) across all modelled years when comparing existing with developed site conditions, from 3,727 m^3/d to 3,866 m^3/d.

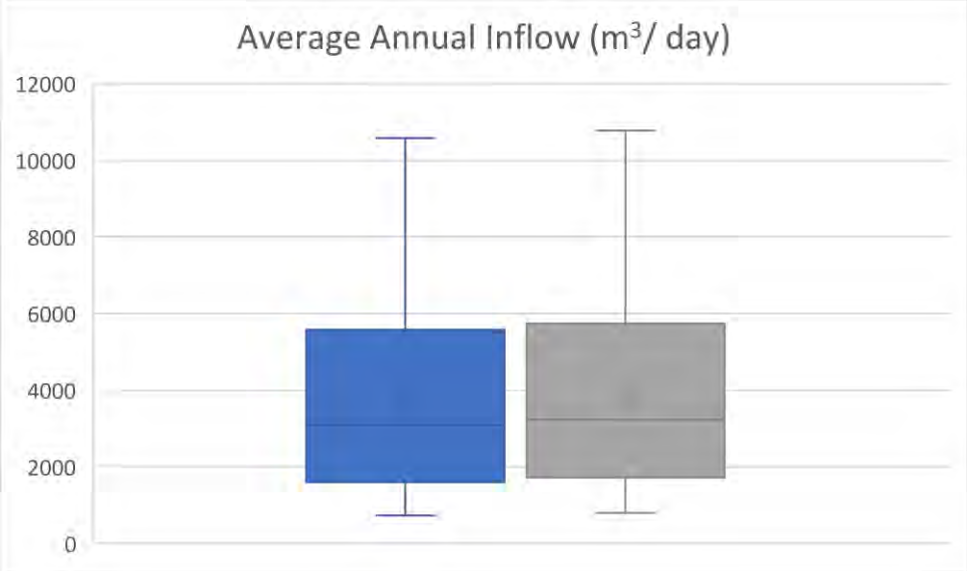


Figure 4-3 Average annual inflow for existing (blue) and developed (grey) conditions.

Corresponding box and whisker plots for flows in the creek for each season across all modelled years are presented in Appendix A, with summary seasonal statistics presented in Table 4-1.

Daily average flow volumes in the creek are likely to be lowest in Autumn and highest in Winter for current conditions, with this seasonal pattern likely to be maintained in developed conditions, albeit with higher flow volumes experienced in developed conditions. Highest maximums are experienced in Summer, reflecting the larger storm events generally experienced in summer. Daily maximums may be reduced in developed conditions with any onsite flood storage (retarding basins) which are not modelled in the MUSIC models.

Seasonal daily flow volumes in Cowies Creek (averaged across all years) could be expected to increase as a result of the development of the site, with the scale of the increase being lowest in Winter and highest in Autumn (for average inflow volumes).

Table 4-1 Seasonal inflows

		Inflow (m^3/day)		
		Current	**Developed**	**% Change**
Summer	Average	2,914	3,036	4%
	Maximum Average	61,434	64,680	5%
Autumn	Average	2,133	2,271	6%
	Maximum Average	32,561	34,739	7%
Winter	Average	5,988	6,101	2%
	Maximum Average	24,027	25,106	4%
Spring	Average	3,857	4,040	5%
	Maximum Average	40,024	43,196	8%

4.2.2 At the Site Outlet

This shows treatment rates only, and in reality, the placement of treatment assets may be on other sites within the PSP area to treat stormwater runoff from multiple parcels. Therefore, runoff leaving the parcel in developed conditions may potentially remain untreated and unretained until a point further downstream closer to Cowies Creek.

The average annual flow rate (m^3/d) across all modelled years for existing (blue) and developed (grey) conditions is shown in Figure 4-4. This reporting point is representative of flows immediately leaving the site, before they intersect with any other runoff, or the creek flows themselves.

There is an increase in average daily flow volume leaving the site (before combining with flows from Cowies Creek) across all modelled years when comparing existing with developed conditions, from 40.5 m^3/d to 179.8 m^3/d. This equates to an average an additional 139.3 m^3 of additional runoff leaving the site and eventually entering Cowies Creek in developed conditions on a daily basis.

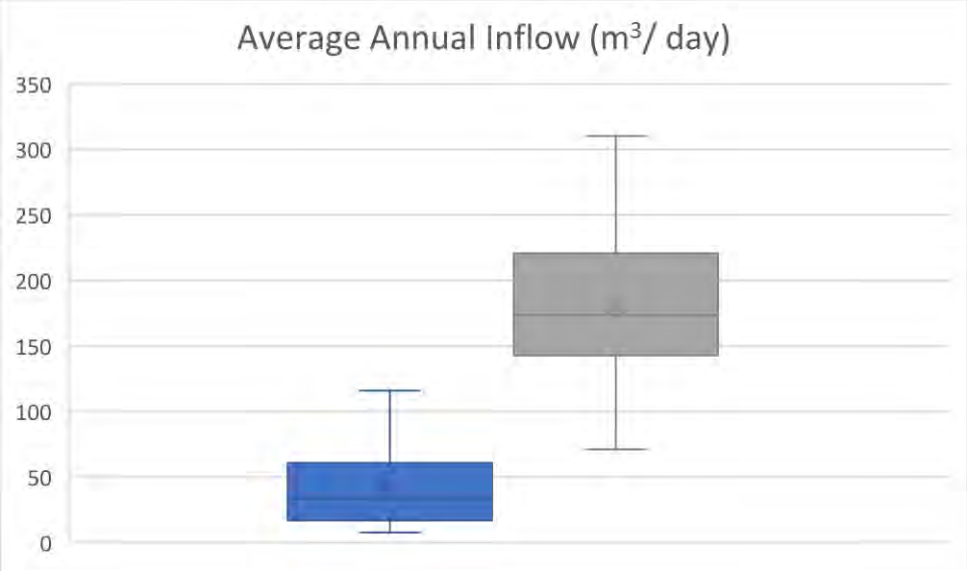


Figure 4-4 Average annual inflow for existing (blue) and developed (grey) conditions.

Corresponding box and whisker plots for each season are presented in Appendix B, with summary seasonal statistics presented in Table 4-2.

Daily average flow volumes leaving the site are likely to be lowest in Autumn and highest in Winter for current conditions. Highest maximums are experienced in summer, reflecting the larger storm events generally experienced in Summer.

Seasonal flows leaving the site could be expected to increase as a result of the development of the site, with the increases being lowest in Winter and highest in Autumn. While the scale of the change in site runoff is large, the dilution effect of flows within Cowies Creek when these flows reach the creek itself should be taken into consideration (see previous section).

Table 4-2 Seasonal inflows

		Inflow (m³/day)	
		Current	**Developed**
Summer	Average	32	154
	Maximum Average	662	4,335
Autumn	Average	23	162
	Maximum Average	346	2,729
Winter	Average	66	179
	Maximum Average	257	1,547
Spring	Average	42	225
	Maximum Average	426	3,715

4.3 Long-term Nutrients and Pollutants

The results in this section are from the MUSIC modelling. It should be noted that MUSIC incorporates standard loading rates for nutrients and gross pollutants given the type of development. The MUSIC Guidelines have been followed and all upstream catchments set to 'Mixed' in lieu of additional information regarding loading rates. It is probable that the current (existing) conditions may have higher nutrient loads than have been modelled as there is a significant amount of farmland present. Hence any increases in pollutant loads as a result of development are likely to be overstated.

Pollutants are treated to BPEMG levels through this section of the report through the use of a sediment pond and wetland for each outlet of the site. Per standard practices, the conceptual sediment ponds and wetlands have been modelled with flows larger than the 3-month flow bypassing the system. That means, that in events greater than the 3-month recurrence interval, flows will not be treated. This is reflected partially in the seasonal results. Within the rainfall period, average rainfall (mm/day) is greatest in Spring, followed by Winter, Autumn, and Summer. Summer sees the most intense rainfall, followed by Spring, Autumn, and Winter. It is hence likely that more bypass would occur more often in Spring and Summer.

4.3.1 At the Junction with Cowies Creek

For all nutrients and pollutants reported at the junction with Cowies Creek, the results are representative of possible loads within Cowies Creek itself, inclusive of potential nutrient/pollutant loads from the greater upstream catchment area and the site itself.

Box and whisker plots for seasonal averages for each of the nutrients and pollutants are presented in Appendix A.

The average annual Total Phosphorus loading rate (kg/d) across all modelled years for existing (blue) and developed (grey) conditions is shown in Figure 4-5.

There is an approximate 1% increase in average daily TP loads in the creek (where it combines with loads from the site) across all modelled years when comparing existing with developed site conditions, from 1.03 kg/d to 1.04 kg/d (an average increase of 0.01 kg/d).

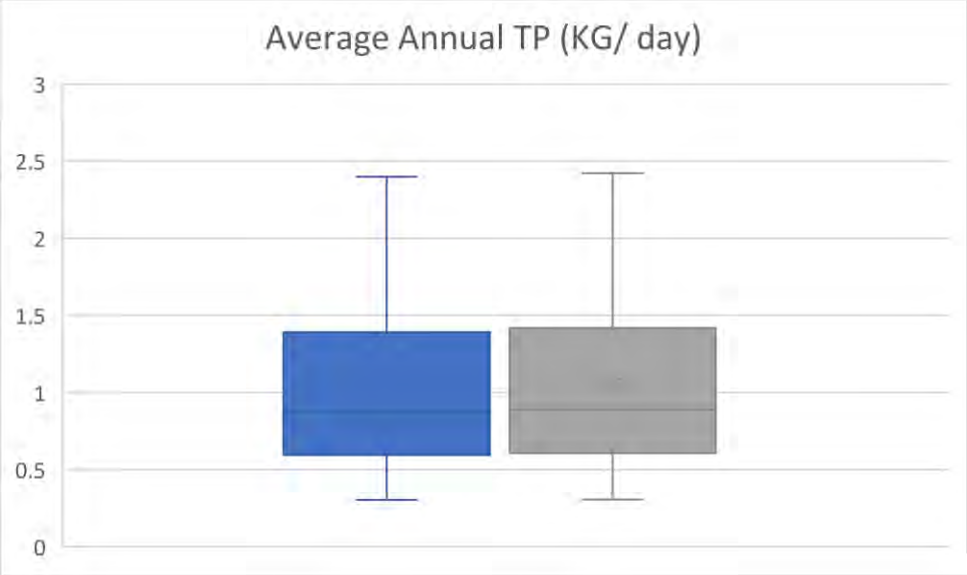


Figure 4-5 Average annual TP loading rate for existing (blue) and developed (grey) conditions

Summary seasonal statistics are presented in Table 4-3. Seasonally averaged daily TP loads in Cowies Creek (averaged across all years) could be expected to increase as a result of the development of the site, with the increases being lowest in Winter and the highest increases in Summer and Autumn.

Daily average TP loads in the creek are likely to be lowest in Autumn and highest in Winter for current conditions, with this seasonal pattern likely to be maintained in developed conditions, albeit with higher loads experienced in developed conditions. Highest maximums are experienced in Summer, reflecting the larger storm events generally experienced in Summer.

Table 4-3 Seasonal TP loading rate

		TP (kg/day)		
		Current	**Developed**	**% Change**
Summer	Average	0.90	0.92	2%
	Maximum Average	24.89	25.83	4%
Autumn	Average	0.73	0.74	2%
	Maximum Average	13.74	14.38	5%
Winter	Average	1.35	1.36	0%
	Maximum Average	8.89	9.14	3%
Spring	Average	1.14	1.16	1%
	Maximum Average	15.96	16.87	6%

The average annual Total Suspended Solids (TSS) loading rate (kg/d) across all modelled years for existing (blue) and developed (grey) conditions is shown in Figure 4-6.

There is an approximate 1% increase in average daily TSS loads in the creek (where it combines with loads from the site) across all modelled years when comparing existing with developed site conditions, from 366.33 kg/d to 369.76 kg/d (an average increase of 3.43 kg/d).

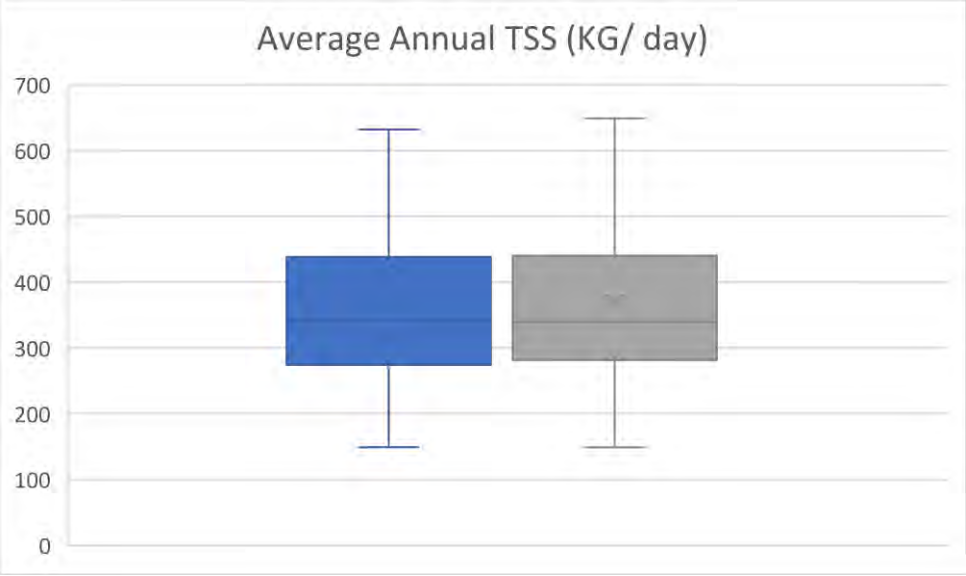


Figure 4-6 Average annual TSS loading rate for existing (blue) and developed (grey) conditions

Summary seasonal statistics are presented in Table 4-4. Daily average TSS loads in the creek are likely to be lowest in Autumn and highest in Spring for current

conditions, with this seasonal pattern likely to be maintained in developed conditions, albeit with higher loads experienced in developed conditions.

Seasonally averaged daily TSS loads in Cowies Creek (averaged across all years) could be expected to increase as a result of the development of the site, with the increases being lowest in Summer (0% increase) and consistent across the remaining seasons (1% increase).

Table 4-4 Seasonal TSS loading rate

		TSS (kg/day)		
		Current	**Developed**	**% Change**
Summer	Average	360.85	361.23	0%
	Maximum Average	12,134.35	12,560.83	4%
Autumn	Average	314.85	317.97	1%
	Maximum Average	6,653.33	6,761.56	2%
Winter	Average	355.07	359.94	1%
	Maximum Average	4,149.74	4,316.72	4%
Spring	Average	435.16	440.50	1%
	Maximum Average	7,803.54	8,055.62	3%

The average annual Total Nitrogen (TN) loading rate (kg/d) across all modelled years for existing (blue) and developed (grey) conditions is shown in Figure 4-7.

There is an approximate 2% increase in average daily TN loads in the creek (where it combines with loads from the site) across all modelled years when comparing existing with developed site conditions, from 9.27 kg/d to 9.47 kg/d (an average increase of 0.20 kg/d).

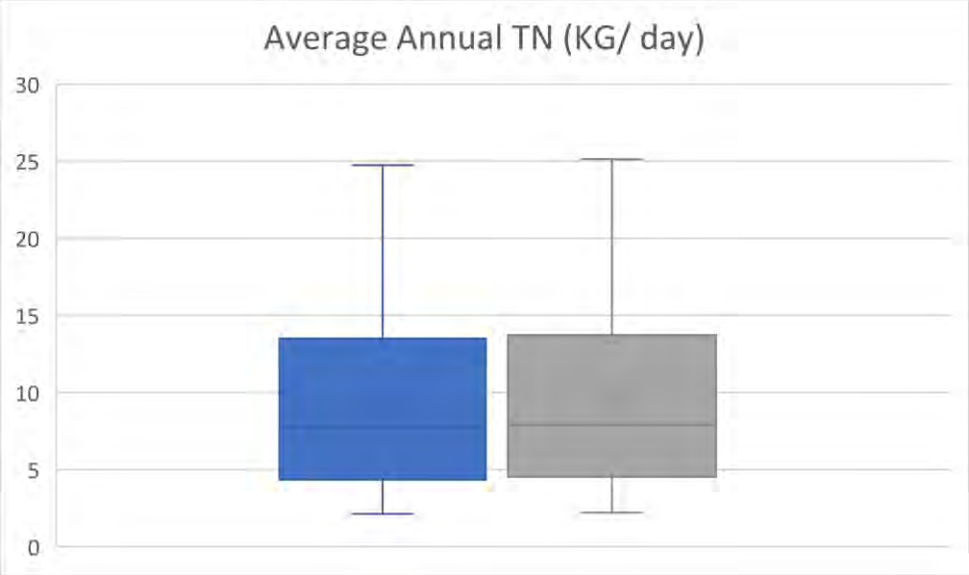


Figure 4-7 Average annual TN loading rate for existing (blue) and developed (grey) conditions

Summary seasonal statistics are presented in Table 4-5. Daily average TN loads in the creek are likely to be lowest in Autumn and highest in Winter for current conditions, with this seasonal pattern likely to be maintained in developed conditions, albeit with higher loads experienced in developed conditions.

Seasonally averaged daily TN loads in Cowies Creek (averaged across all years) could be expected to increase as a result of the development of the site, with the increases being lowest in Winter (1% increase) and consistent across the remaining seasons (3% increase).

Table 4-5 Seasonal TN loading rate

		TN (kg/day)		
		Current	**Developed**	**% Change**
Summer	Average	7.51	7.73	3%
	Maximum Average	175.04	182.88	4%
Autumn	Average	5.70	5.88	3%
	Maximum Average	93.95	99.13	6%
Winter	Average	14.03	14.13	1%
	Maximum Average	66.74	69.24	4%
Spring	Average	9.80	10.09	3%
	Maximum Average	113.92	122.42	7%

The average annual Gross Pollutants (GP) loading rate (kg/d) across all modelled years for existing (blue) and developed (grey) conditions is shown in Figure 4-8.

There is an approximate 0.02 % decrease in average daily GP loads in the creek (where it combines with loads from the site) across all modelled years when comparing existing with developed site conditions, from 65.15 kg/d to 65.13 kg/d (an average decrease of 0.02 kg/d).

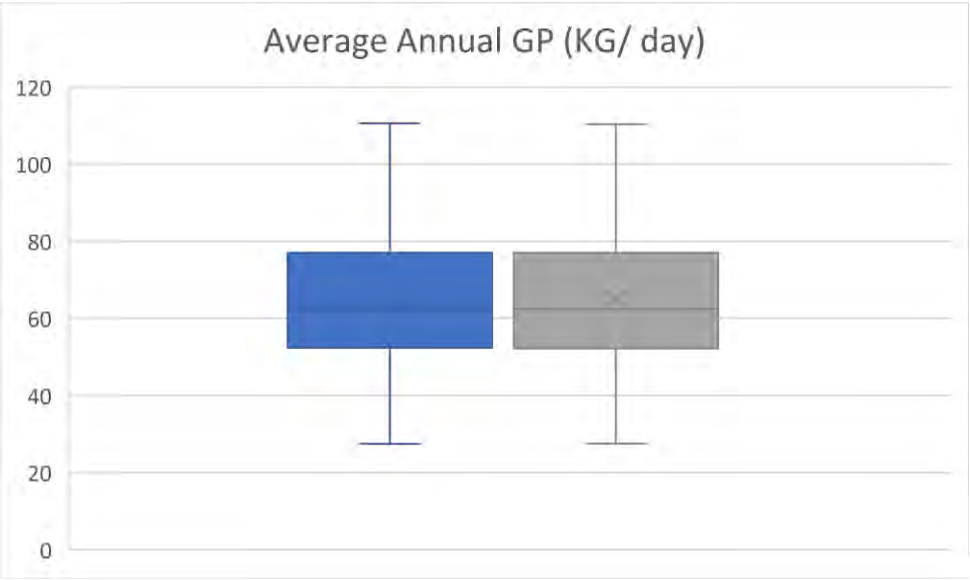


Figure 4-8 Average annual GP loading rate for existing (blue) and developed (grey) conditions

Summary seasonal statistics are presented in Table 4-6.

Daily average GP loads in the creek are likely to be lowest in Winter and highest in Spring for current conditions, with this seasonal pattern likely to be maintained in developed conditions, albeit with higher loads experienced in developed conditions.

Seasonally averaged daily GP loads in Cowies Creek (averaged across all years) could be expected to decrease as a result of the development of the site, with the decreases being low across all seasons (approximately 0.0 % to 0.2 %).

Table 4-6 Seasonal GP loading rate

		GP (kg/day)		
		Current	**Developed**	**% Change**
Summer	Average	62.84	62.98	0.2%
	Maximum Average	1,914.47	1,907.48	-0.4%
Autumn	Average	61.48	61.43	-0.1%
	Maximum Average	1,534.20	1,529.14	-0.3%
Winter	Average	53.71	53.72	0.0%
	Maximum Average	1,028.86	1,023.26	-0.5%
Spring	Average	82.70	82.54	-0.2%
	Maximum Average	1,686.17	1,667.67	-1.1%

4.3.2 At the Site Outlet

This shows treatment rates only, and in reality, the placement of treatment assets may be on other sites within the PSP area to treat stormwater runoff from multiple parcels. Therefore, runoff leaving the parcel in developed conditions may potentially remain untreated and unretained until a point further downstream closer to Cowies Creek.

Box and whisker plots for seasonal averages for each of the nutrients and pollutants are presented in Appendix B.

The average annual Total Phosphorus loading rate (kg/d) across all modelled years for existing (blue) and developed (grey) conditions is shown in Figure 4-9.

There is an increase in average daily TP loads leaving the site (before combining with flows from Cowies Creek) across all modelled years when comparing existing with developed conditions, from 0.011 kg/d. to 0.026 kg/d. This equates to an average an additional 0.015 kg of additional load leaving the site and eventually entering Cowies Creek in developed conditions on a daily basis.

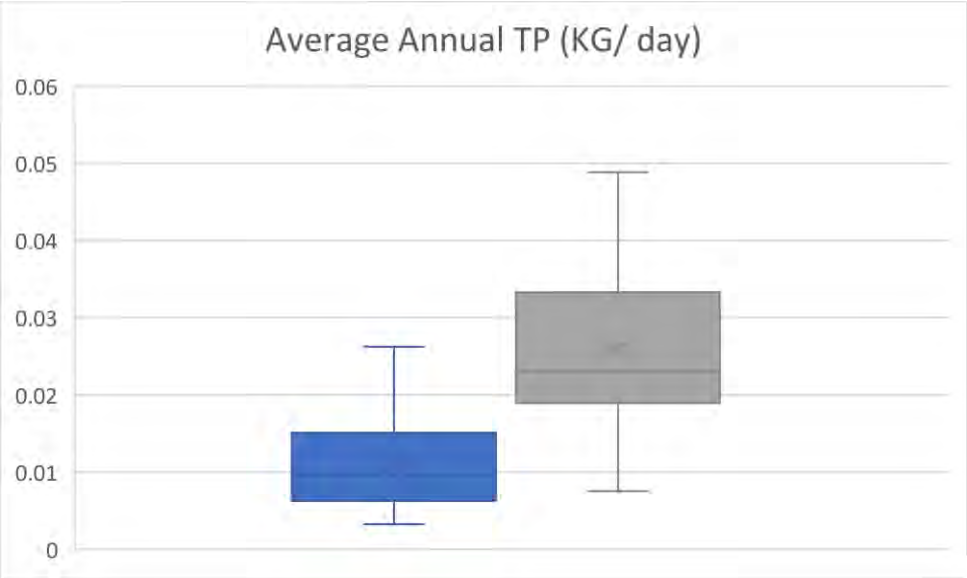


Figure 4-9 Average annual TP loading rate for existing (blue) and developed (grey) conditions

Summary seasonal statistics are presented in Table 4-7. Daily average loads leaving the site are lowest in Autumn (0.008 kg/d) and highest in Winter (0.015 kg/d) for current conditions. Highest maximums are experienced in Summer, reflecting the larger storm events generally experienced in Summer.

Seasonal loads leaving the site could be expected to increase as a result of the development of the site, with the increases being lowest in Winter and highest in Summer. Any flow events greater than the 3-month recurrence interval were set to bypass the treatment. Therefore, generally larger changes occur in seasons with generally higher flow events (represented by the maximums).

The dilution effect of flows within Cowies Creek when these flows reach the creek itself should be taken into consideration (see previous section).

Table 4-7 Seasonal TP loading rate (kg/day)

		TP (kg/day)	
		Current	**Developed**
Summer	Average	0.010	0.032
	Maximum Average	0.287	1.433
Autumn	Average	0.008	0.023
	Maximum Average	0.155	0.780
Winter	Average	0.015	0.017
	Maximum Average	0.097	0.339
Spring	Average	0.012	0.032
	Maximum Average	0.172	1.090

The average annual Total Suspended Solids (TSS) loading rate (kg/d) across all modelled years for existing (blue) and developed (grey) conditions is shown in Figure 4-10.

There is an increase in average daily loads leaving the site (before combining with flows from Cowies Creek) across all modelled years when comparing existing with developed conditions, from 3.88 kg/d. to 7.97 kg/d. This equates to an average an additional 4.09 kg of additional load leaving the site and eventually entering Cowies Creek in developed conditions on a daily basis.

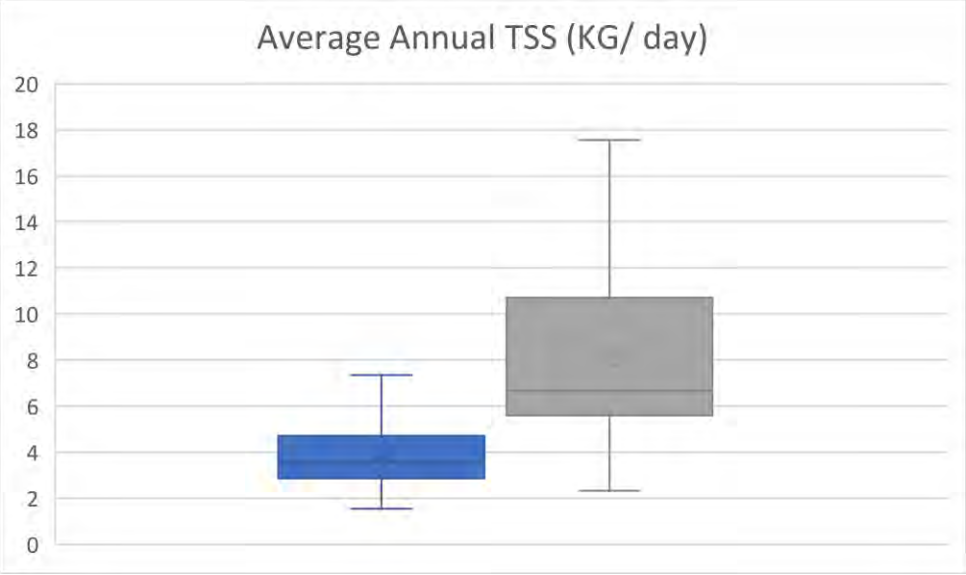


Figure 4-10 Average annual TSS loading rate for existing (blue) and developed (grey) conditions

Summary seasonal statistics are presented in Table 4-8. Daily average loads leaving the site are lowest in Autumn (3.24 kg) and highest in Spring (4.66 kg) for current conditions. Highest maximums are experienced in Summer, reflecting the larger storm events generally experienced in Summer.

Seasonal loads leaving the site could be expected to increase as a result of the development of the site, with the increases being lowest in Winter and highest in Summer. Any flow events greater than the 3-month recurrence interval were set to bypass the treatment. Therefore, generally larger changes occur in seasons with generally higher flow events (represented by the maximums).

The dilution effect of flows within Cowies Creek when these flows reach the creek itself should be taken into consideration (see previous section).

Table 4-8 Seasonal TSS loading rate (kg/day)

		TSS (kg/day)	
		Current	**Developed**
Summer	Average	3.78	10.76
	Maximum Average	128.24	533.10
Autumn	Average	3.24	7.22
	Maximum Average	65.90	355.07
Winter	Average	3.84	4.31
	Maximum Average	48.09	170.92
Spring	Average	4.66	9.66
	Maximum Average	85.31	418.80

The average annual Total Nitrogen (TN) loading rate (kg/d) across all modelled years for existing (blue) and developed (grey) conditions is shown in Figure 4-11.

There is an increase in average daily loads leaving the site (before combining with flows from Cowies Creek) across all modelled years when comparing existing with developed conditions, from 0.100 kg/d. to 0.304 kg/d. This equates to an average an additional 0.204 kg of additional load leaving the site and eventually entering Cowies Creek in developed conditions on a daily basis.

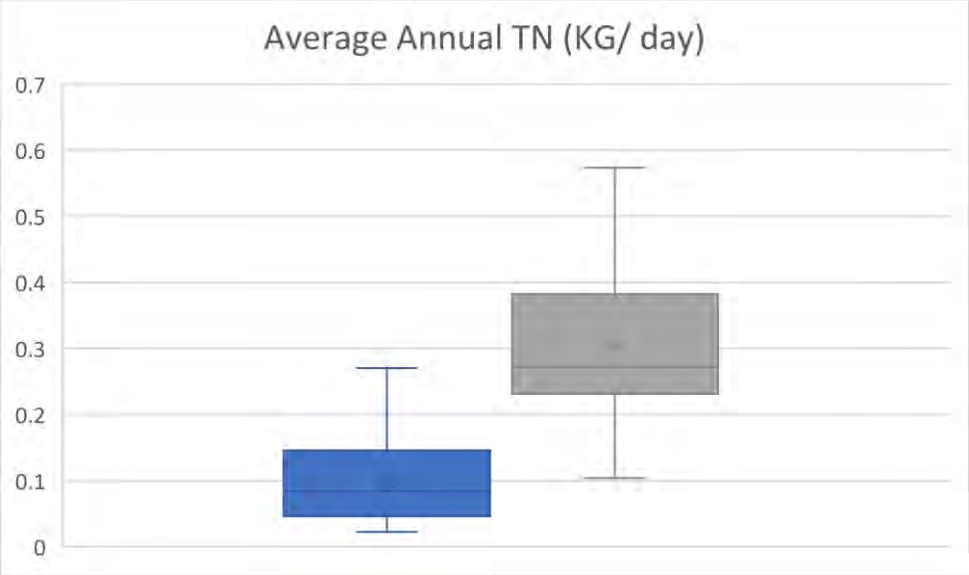


Figure 4-11 Average annual TN loading rate for existing (blue) and developed (grey) conditions

Summary seasonal statistics are presented in Table 4-9. Daily average loads leaving the site are lowest in Autumn (0.06 kg) and highest in Winter (0.15 kg) for current conditions. Highest maximums are experienced in Summer, reflecting the larger storm events generally experienced in Summer.

Seasonal loads leaving the site could be expected to increase as a result of the development of the site, with the increases being lowest in Winter and highest in Autumn when considering percentage increase. Any flow events greater than the 3-month recurrence interval were set to bypass the treatment.

The dilution effect of flows within Cowies Creek when these flows reach the creek itself should be taken into consideration (see previous section).

Table 4-9 Seasonal TN loading rate (kg/day)

		TN (kg/day)	
		Current	**Developed**
Summer	Average	0.08	0.32
	Maximum Average	1.90	11.78
Autumn	Average	0.06	0.27
	Maximum Average	0.94	7.24
Winter	Average	0.15	0.24
	Maximum Average	0.70	3.62
Spring	Average	0.11	0.39
	Maximum Average	1.25	10.31

The average annual Gross Pollutants (GP) loading rate (kg/d) across all modelled years for existing (blue) and developed (grey) conditions is shown in Figure 4-12.

There is a decrease in average daily loads leaving the site (before combining with flows from Cowies Creek) across all modelled years when comparing existing with developed conditions, from 0.461 kg/d. to 0.445 kg/d. This equates to an average reduction of 0.016 kg of GP leaving the site and eventually entering Cowies Creek in developed conditions on a daily basis.

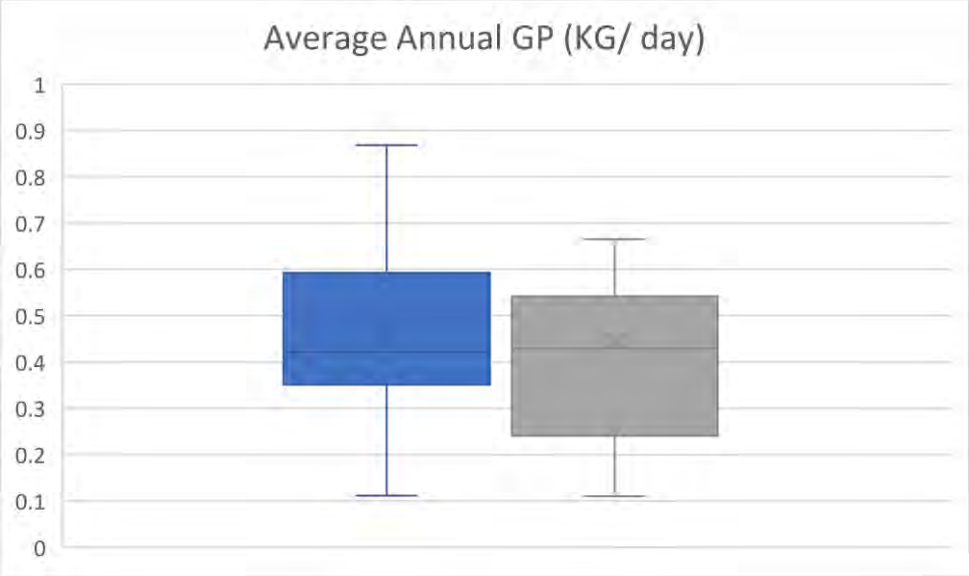


Figure 4-12 Average annual GP loading rate for existing (blue) and developed (grey) conditions

Summary seasonal statistics are presented in Table 4-10.

Daily average loads leaving the site are lowest in Winter (0.19 kg) and highest in Summer (0.61 kg) for current conditions. Highest maximums are experienced in Summer, reflecting the larger storm events generally experienced in Summer.

Seasonal loads leaving the site could be expected to fluctuate depending on season as a result of the development of the site. Any flow events greater than the 3-month recurrence interval were set to bypass the treatment. The scale of increases are largest in Summer, while decreases are largest in Spring. This is due to the way MUSIC calculates GP loading non-linearly with greater loads generated as a percentage of flows in smaller events than compared to larger events.

The dilution effect of flows within Cowies Creek when these flows reach the creek itself should be taken into consideration (see previous section).

Table 4-10 Seasonal GP loading rate (kg/day)

		GP (kg/day)	
		Current	**Developed**
Summer	Average	0.61	0.75
	Maximum Average	30.79	31.98
Autumn	Average	0.47	0.43
	Maximum Average	23.70	26.41
Winter	Average	0.19	0.20
	Maximum Average	9.93	11.16
Spring	Average	0.57	0.41
	Maximum Average	25.54	17.17

5 Summary

RORB and MUSIC models were analysed for the site to make the inferences within this report. The developable area (20.35 ha) of the site parcel was assumed to be developed, with a fraction impervious of 0.8 applied in developed conditions. The developer assumes this is a conservative assumption in lieu of final layout plan. 0.8 correlates to development of the style of a 'Mixed Use Zone' (mix of residential, commercial, industrial and hospitals) when comparing to assumptions for FI from the MUSIC Guidelines. FI's were adopted from the RORB model for all other areas and for existing conditions. The FI of the Cowies Creek buffer (3.98 ha of the parcel area) was retained as per the existing conditions RORB model.

The provided RORB model provided showed that the 1% AEP event peak flows from Cowies Creek would pass the site's inflow point to the Creek after the site-derived runoff has passed through that point of the Creek in both existing and developed conditions. It is therefore unlikely that the development of the site would have an impact on design peak flows in Cowies Creek. With any development, the increase in hard surface reduces soil infiltration and other catchment losses. With development, regardless of whether a retardation basin is in place, the frequency of flows would be expected to increase as a result of development. Through the expected inclusion of retarding basin/s, peak flows would not be expected to increase in the design event. The total volume entering the Creek will increase with a longer period of peak flow leaving the basin.

MUSIC modelling indicates that there is possibly 3,727 m^3/day of average inflow in Cowies Creek immediately downstream of the site in current conditions (across the modelled period). Results suggest an approximate 4% increase in average daily flow volume in the Creek where it combines with flows from the site across all modelled years when comparing existing with developed site conditions. Developed condition average daily flow volume was 3,866 m^3/d.

Daily average flow volumes in the Creek are likely to be lowest in Autumn and highest in Winter for current conditions. This overall seasonal pattern is likely to be maintained in developed conditions, albeit with higher flow volumes experienced across all seasons in developed conditions (2-6% increase across the seasons). Highest maximums are experienced in Summer, reflecting the larger storm events generally experienced in Summer.

TP, TN, TSS and GP were modelled using standard MUSIC loading rates per Melbourne Water's MUSIC Guidelines. The site runoff may contain other contaminants outside of these depending on the nature of development proposed, however these are unable to be modelled in MUSIC and are currently unknown. Results indicate treatment rates only, and in reality, the placement of treatment assets may be on other sites within the PSP area to treat stormwater runoff from multiple parcels. Therefore, runoff leaving the parcel in developed conditions may

potentially remain untreated and unretained until a point further downstream closer to Cowies Creek.

There is an approximate 1% increase in average daily TP loads in the creek (where it combines with loads from the site) across all modelled years when comparing existing with developed site conditions, from 1.03 kg/d to 1.04 kg/d (an average increase of 0.01 kg/d). There is an approximate 1% increase in average daily TSS loads in the creek (where it combines with loads from the site) across all modelled years when comparing existing with developed site conditions, from 366.33 kg/d to 369.76 kg/d (an average increase of 3.43 kg/d). There is an approximate 2% increase in average daily TN loads in the creek (where it combines with loads from the site) across all modelled years when comparing existing with developed site conditions, from 9.27 kg/d to 9.47 kg/d (an average increase of 0.20 kg/d). There is an approximate 0.02% decrease in average daily GP loads in the creek (where it combines with loads from the site) across all modelled years when comparing existing with developed site conditions, from 65.15 kg/d to 65.13 kg/d (an average decrease of 0.02 kg/d).

The increase in volume (m^3) or load (kg) is the same whether considered at the outlet of the site (inland from the Creek) or in the Creek itself. However, the scale of change is greater when comparing at the site outlet point as the flows at that point have not yet combined with the much greater flows in Cowies Creek. Results are presented throughout this report.

It is important to note that pollutants and nutrients will be transported and settle on their transport journey depending on the flow rates and other factors. It is not expected that all of the modelled pollutants would accumulate at the model outlet but rather be transported downstream as well once combined with larger upstream flows, nutrients and pollutants from Cowies Creek.

There is unlikely to be changes in peak flow rates in the design event, however overall volumes of flow will increase. the primary method for mitigation would be to develop a reliable stormwater harvesting reuse scheme within the development. Potential mitigation options are further addressed in section 6.

6 Mitigation

This section discusses avoidance or mitigation of any changes to the current hydrology of Cowies Creek. It provides general commentary around how any hydrological impacts may be mitigated using standard approaches. The advice is subject to concept/functional design investigations and feasibility assessments.

- While the analysis of 1% AEP peak flows showed that peaks from the development site would pass prior to upstream peaks, retardation basins within the site will assist in preventing downstream impacts due to more frequent higher peaks.

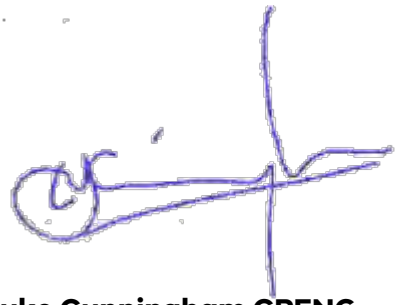
- The analysis has shown that flow and water quality markers in the long-term assessment spike at times where it is likely that the high-flow bypass around the treatment train is occurring. Harvesting of stormwater upstream of the treatment trains will assist here if demands can be guaranteed. Interventions can be lot-scale (e.g. rainwater tanks on individual properties), street scale (e.g. passive irrigation of street trees) or at a larger scale, storing and reusing stormwater for public facilities.
- Fraction impervious values adopted in this analysis are conservatively high. Any efforts to reduce the imperviousness of the catchment will assist in reducing impacts. The use of more permeable materials is recommended where possible.

7 Further Key Assumptions and Limitations

- RORB has been used to calculate peak flows in the 1%AEP event. It can be used to calculate flows in other AEP events (all theoretical events). To be able to get an indication of seasonality, we've modelled via MUSIC the reference years available – the "average" 20-year period. Flow rates have been reported from the MUSIC models at a daily timestep. The maximum flow rates are indicative only and shouldn't be used for design work and are to be used as a comparative discussion of potential differences in flows.
- The assessment is limited to the accuracy of the MUSIC and RORB modelling approaches.
- MUSIC modelling does not route flows and hence is high level comparison of potential flow and pollutants off the development areas in existing and future developed conditions.
- This shows treatment rates only, and in reality, the placement of treatment assets may be on other sites within the PSP area to treat stormwater runoff from multiple parcels. Therefore, runoff leaving the parcel in developed conditions may potentially remain untreated and unretained until a point further downstream closer to Cowies Creek.
- The supplied RORB model has not been reviewed by us or Council, and neither Rain Consulting nor Council accept liability for its use.
- As the focus was on long-term flow implications, retarding basins were not simulated in the MUSIC or modelling.
- There may be differences in water quality treatment attained in final developed conditions.
- Groundwater interactions have not been considered.
- Turbidity cannot be modelled in MUSIC, but Total Suspended Solids can and will be. Others may draw conclusions between the changes in TSS loads and how that may correlate with turbidity.
- Salinity cannot be modelled in MUSIC. Others may draw conclusions between the flow rates/volumes and expected changes to salinity.

- No commentary can be provided by us on any other pollutants (other than TSS, TP, TN and Gross Pollutants) that may be expected, as it will be dependent on the type of industry that ends up in the development.
- Whenever our work is presented by others in any form, we expect our work to be represented truthfully, accurately, and ethically.

Kind Regards



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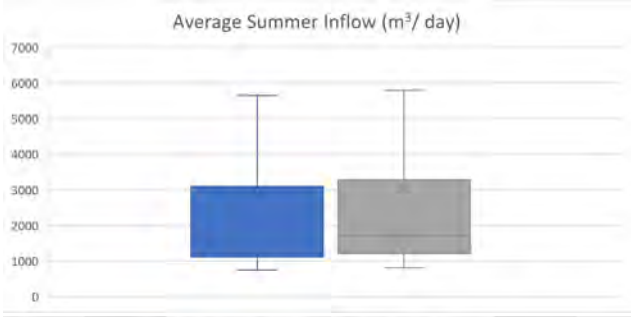
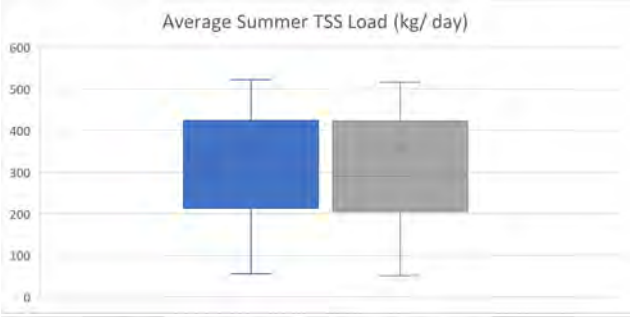
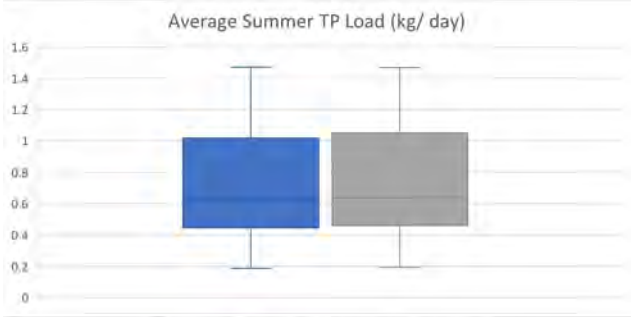
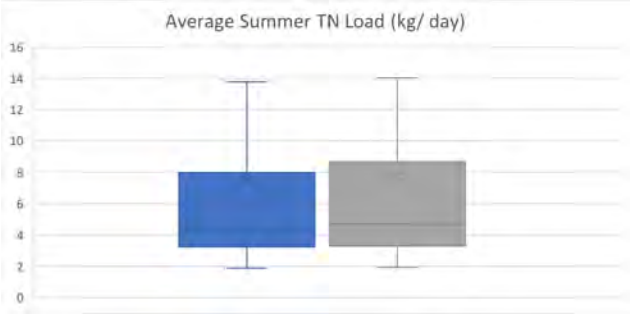
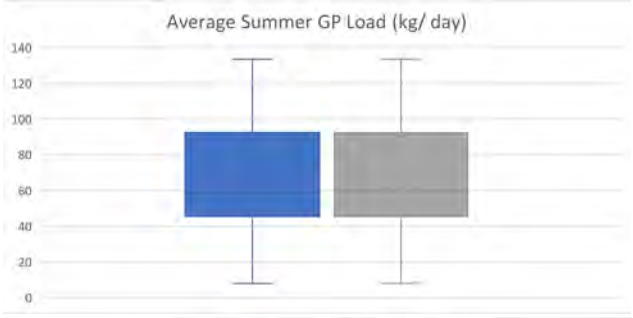
Appendix A: Seasonal Box and Whisker Plots – Flows, Nutrients and Pollutants at the Junction with Cowies Creek

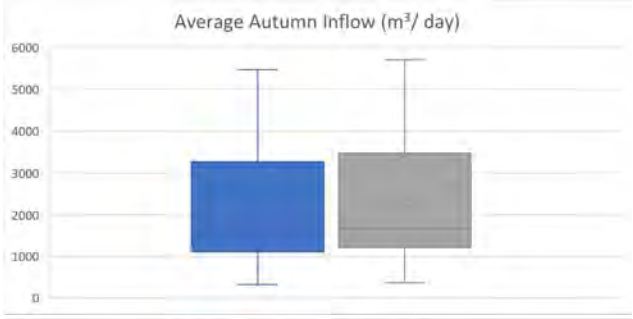

Average Summer Inflow (m³/ day)
7000
6000
5000
4000
3000
2000
1000
0

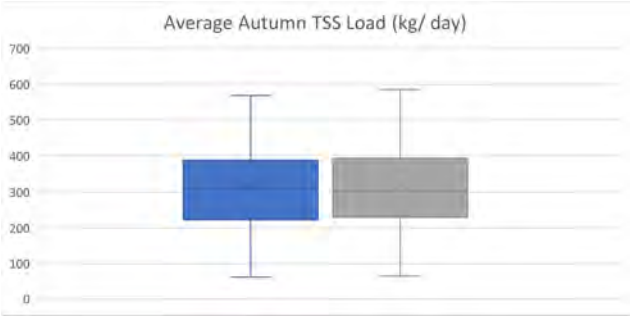

Average Summer TSS Load (kg/ day)
600
500
400
300
200
100
0

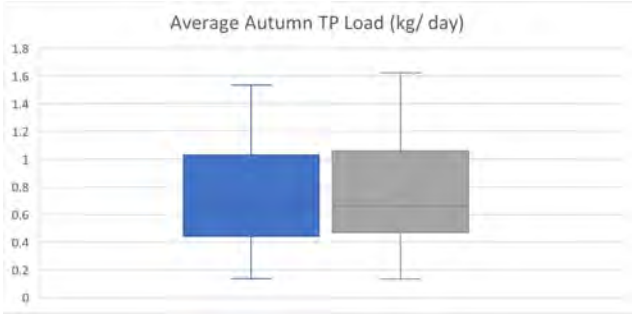

Average Summer TP Load (kg/ day)
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0

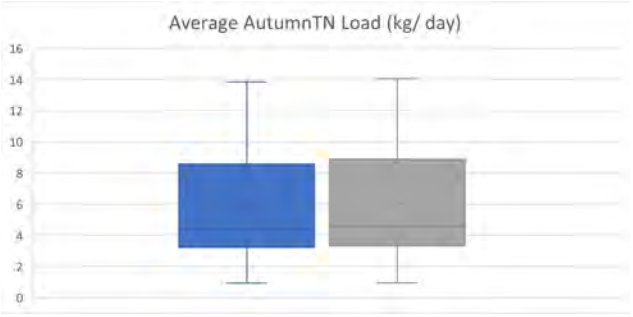

Average Summer TN Load (kg/ day)
16
14
12
10
8
6
4
2
0

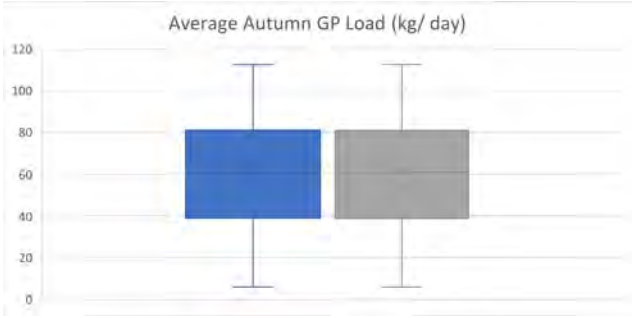

Average Summer GP Load (kg/ day)
140
120
100
80
60
40
20
0


Average Autumn Inflow (m³/ day)
6000
5000
4000
3000
2000
1000
0

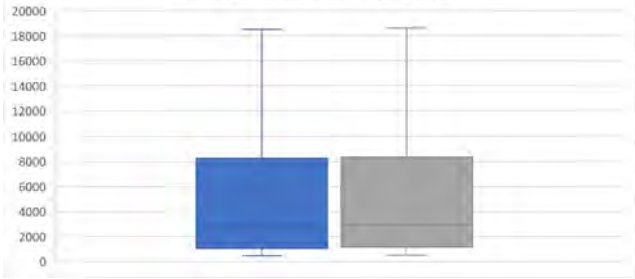

Average Autumn TSS Load (kg/ day)
700
600
500
400
300
200
100
0


Average Autumn TP Load (kg/ day)
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0

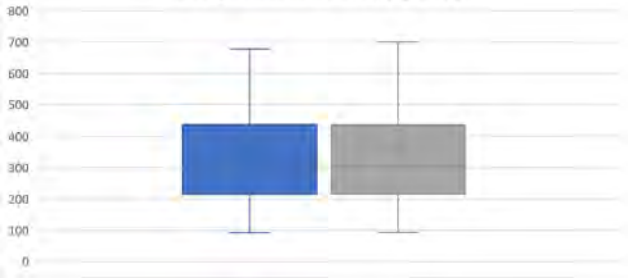

Average AutumnTN Load (kg/ day)
16
14
12
10
8
6
4
2
0


Average Autumn GP Load (kg/ day)
120
100
80
60
40
20
0

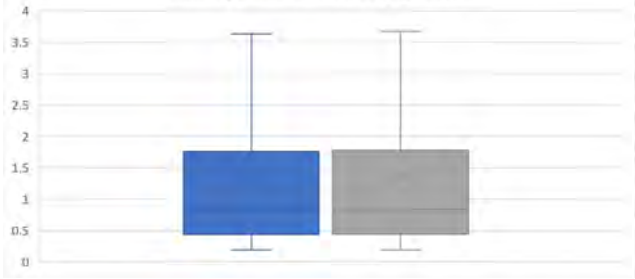
Average Winter Inflow (m^3/ day)



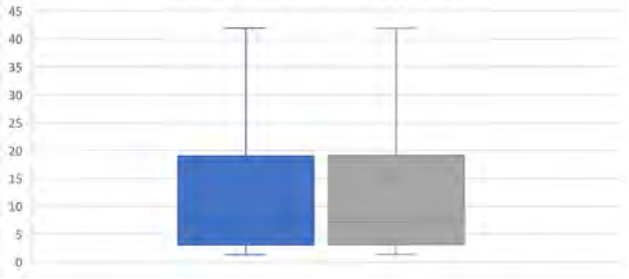
Average Winter TSS Load (kg/ day)



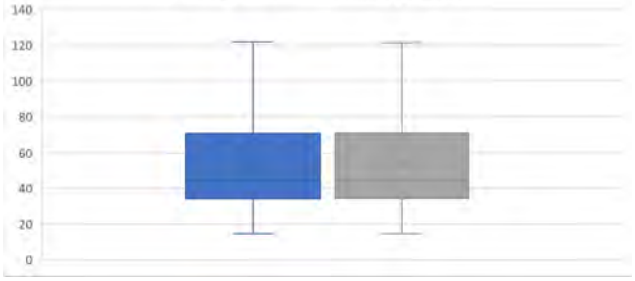
Average Winter TP Load (kg/ day)



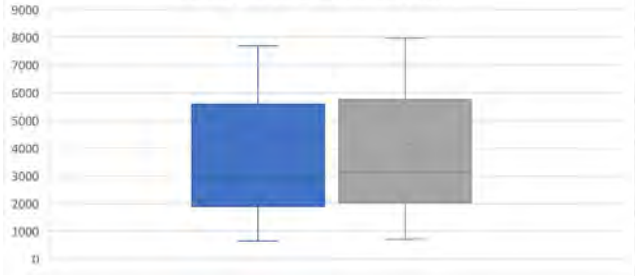
Average Winter TN Load (kg/ day)



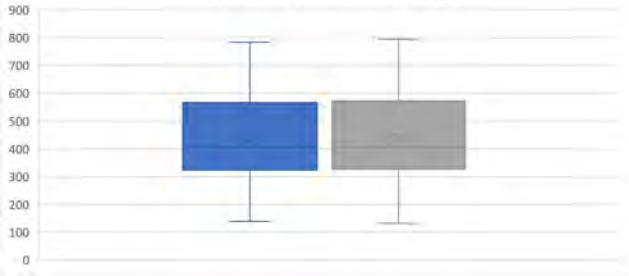
Average Winter GP Load (kg/ day)



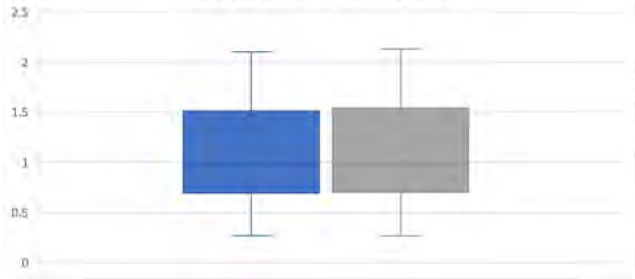
Average Spring Inflow (m^3/ day)



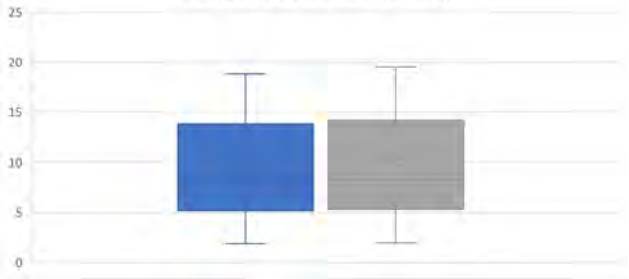
Average Spring TSS Load (kg/ day)



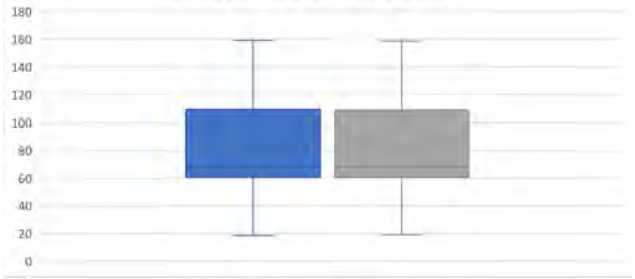
Average Spring TP Load (kg/ day)



Average SpringTN Load (kg/ day)

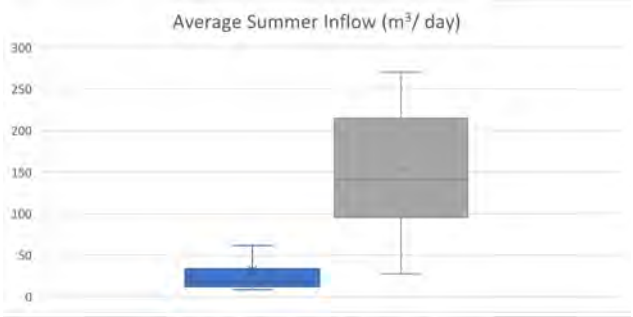


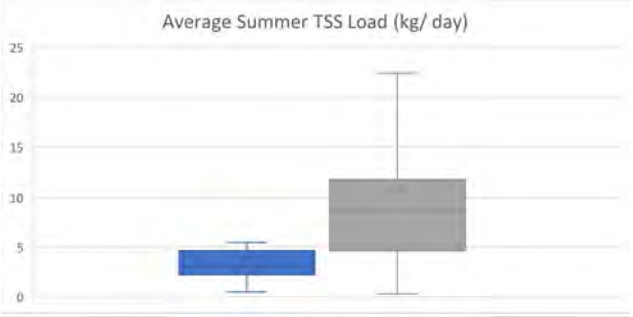
Average Spring GP Load (kg/ day)

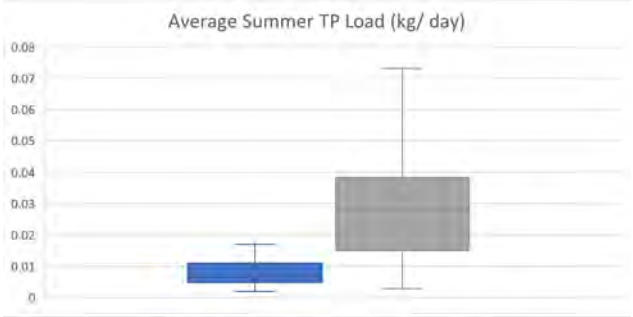


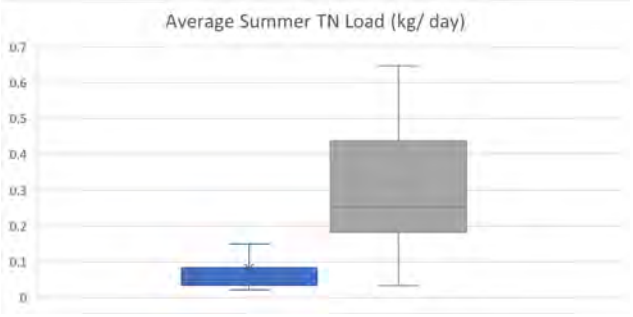
Engineering + Creativity = Better Water Outcomes

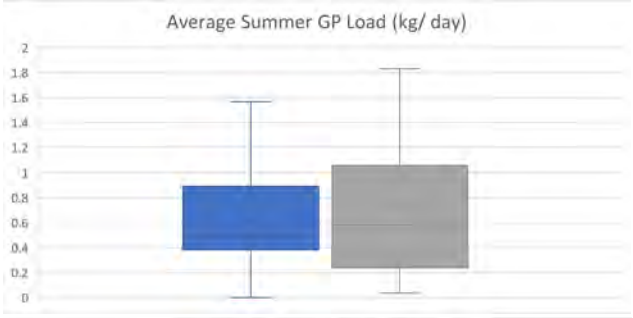
Appendix B: Seasonal Box and Whisker Plots – Flows, Nutrients and Pollutants at the Site Outlet

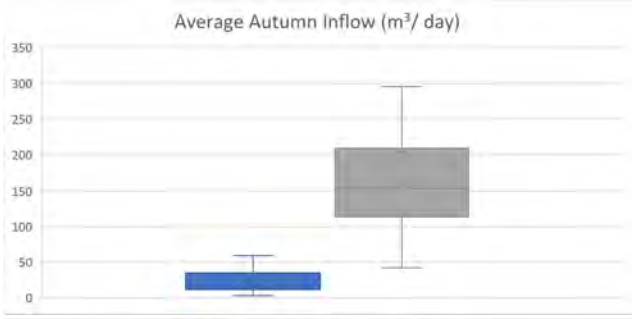

Average Summer Inflow (m³/ day)
300
250
200
150
100
50
0

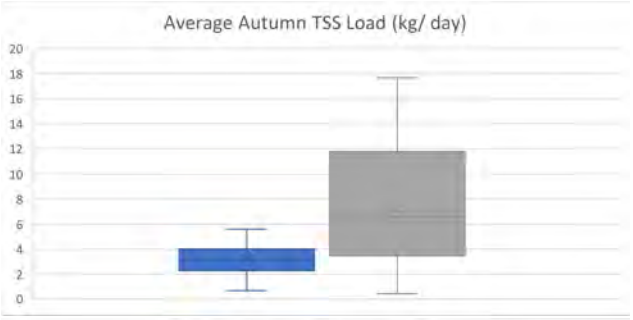

Average Summer TSS Load (kg/ day)
25
20
15
10
5
0

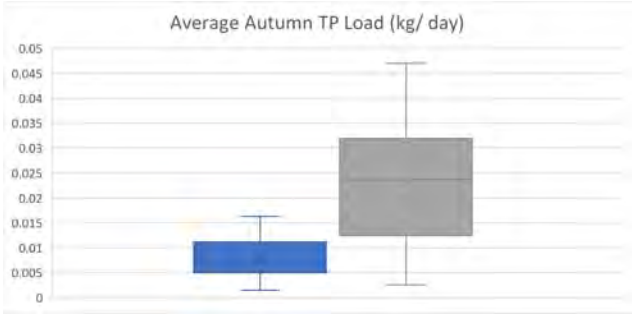

Average Summer TP Load (kg/ day)
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0

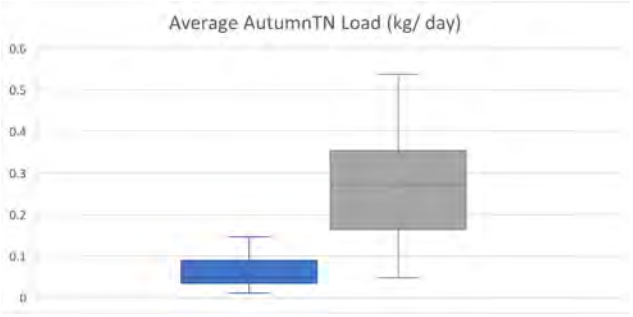

Average Summer TN Load (kg/ day)
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0

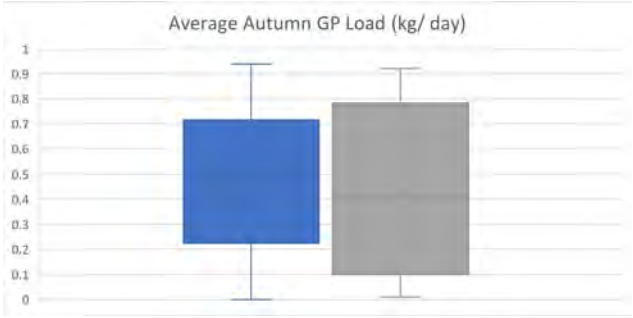

Average Summer GP Load (kg/ day)
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0

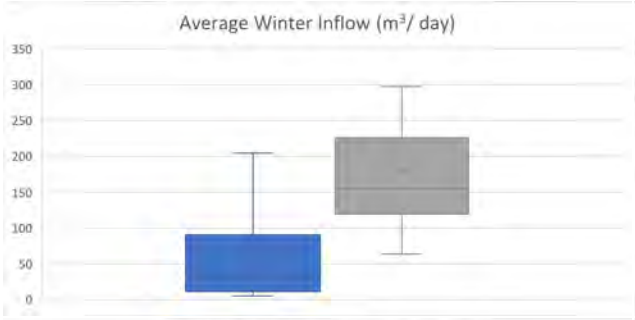

Average Autumn Inflow (m³/ day)
350
300
250
200
150
100
50
0

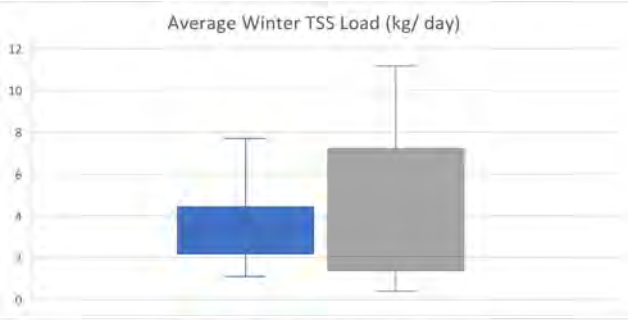

Average Autumn TSS Load (kg/ day)
20
18
16
14
12
10
8
6
4
2
0

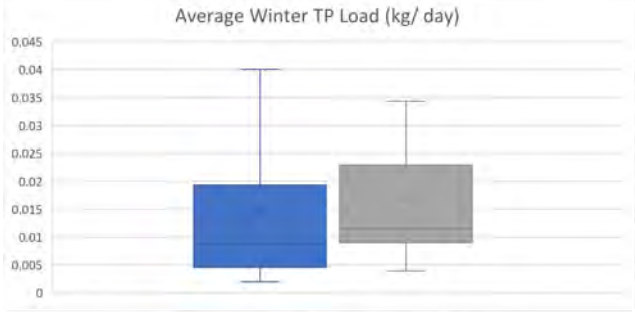

Average Autumn TP Load (kg/ day)
0.05
0.045
0.04
0.035
0.03
0.025
0.02
0.015
0.01
0.005
0

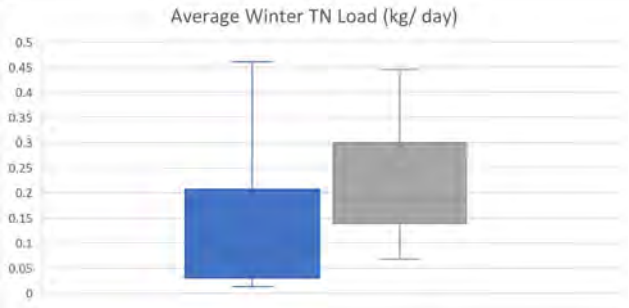

Average AutumnTN Load (kg/ day)
0.6
0.5
0.4
0.3
0.2
0.1
0

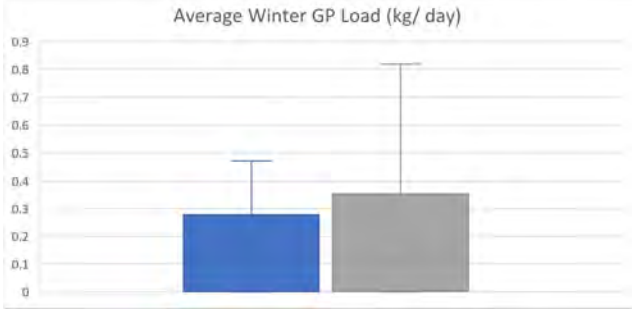

Average Autumn GP Load (kg/ day)
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0

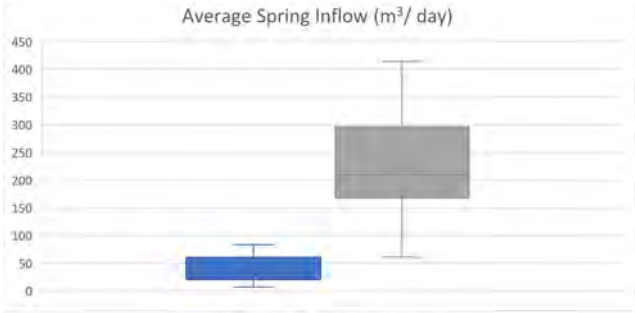

Average Winter Inflow (m³/ day)
350
300
250
200
150
100
50
0

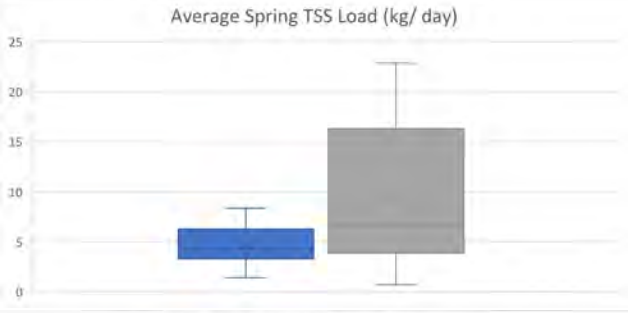

Average Winter TSS Load (kg/ day)
12
10
8
6
4
2
0

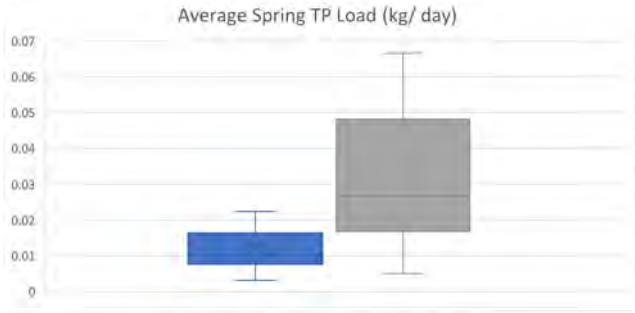

Average Winter TP Load (kg/ day)
0.045
0.04
0.035
0.03
0.025
0.02
0.015
0.01
0.005
0

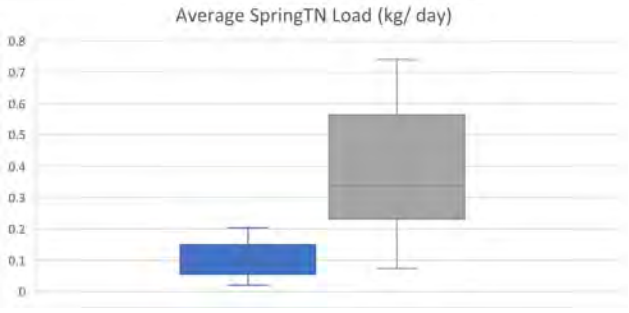

Average Winter TN Load (kg/ day)
0.5
0.45
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0

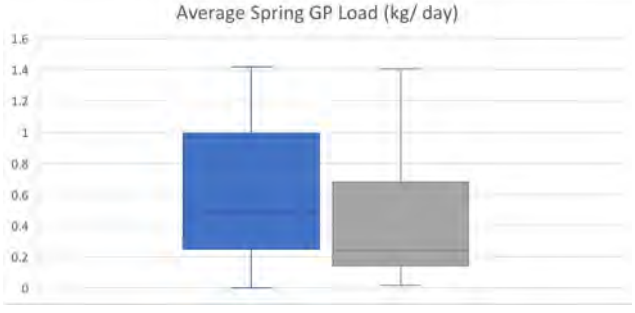

Average Winter GP Load (kg/ day)
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0


Average Spring Inflow (m³/ day)
450
400
350
300
250
200
150
100
50
0

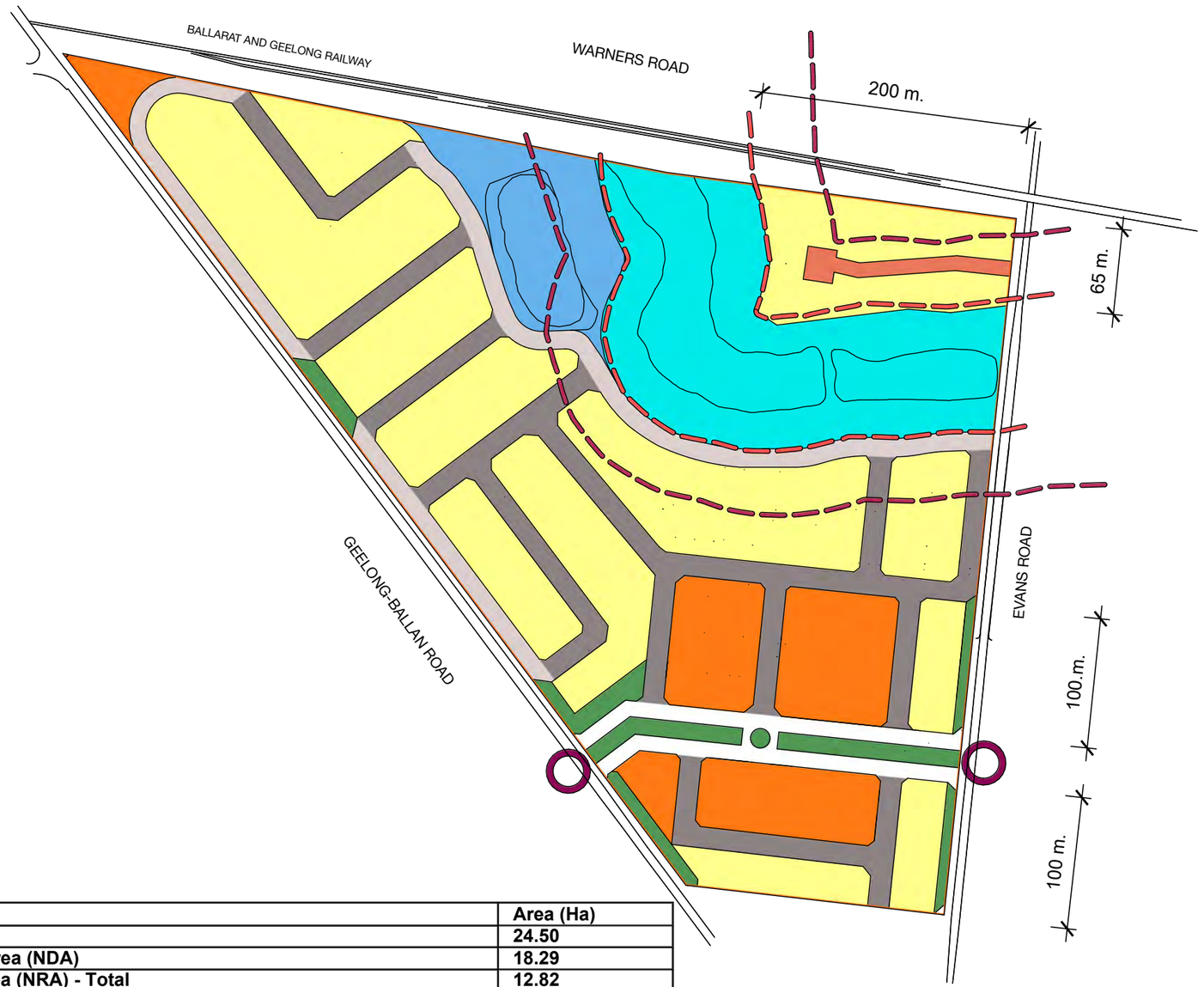

Average Spring TSS Load (kg/ day)
25
20
15
10
5
0


Average Spring TP Load (kg/ day)
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0


Average SpringTN Load (kg/ day)
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0


Average Spring GP Load (kg/ day)
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0

APPENDIX 3 – DEVELOPMENT PLAN



Residential

Conventional Housing.

Medium Density Housing.

Roads

CCC. 35.6 width.

Roads 16 m.

Roads 14 m.

Signalised Intersection.

Landscapes / Environments

Cowies Creek Corridor.

Retarding Basin.

Reserves.

Land Budget	Area (Ha)
Total Site Area	**24.50**
Net Developable Area (NDA)	**18.29**
Net Residential Area (NRA) - Total	**12.82**
Residential (Conventional)	10.20
Residential (Medium Density)	2.62
Roads - Total	**5.47**
Internal Road Network	5.47
Landscape / Reserves - Total	**6.21**
Cowies Creek Corridor	3.97
Retarding Basin	1.39
Reserves (other)	0.85
Indicative Lot Yield (Conventional @ 15 Lots/Ha & MD @ 25 Lots/Ha)	Approx. 330-350

A Different City

Liao Land - Indicative Future Urban Structure.

12.06.2024 Prepared for Tango

APPENDIX 4 - Wetland Species

Table A1: Species List of Recommended Plants for Revegetation

Botanical Name	Common Name
Fringing and emergent	
Calystegia sepium	Large Bindweed
Carex appressa	Tall Sedge
Carex fascicularis	Tassel Sedge
Carex gaudichaudiana	Fen Sedge
Crassula helmsii	Swamp Crassula
Epilobium billardierianum	Smooth Willow-herb
Glyceria australis	Australian Sweet-grass
Lachnagrostis filiformis	Common Blown-grass
Lycopus australis	Australian Gypsywort
Melaleuca ericifolia	Swamp Paperbark
Poa labillardierei var. *labillardierei*	Common Tussock-grass
* *Potamogeton ochreatus*	Blunt Pondweed
Ranunculus amphitrichus	Running Marsh Flower
Emergent	
Alisma plantago-aquatica	Water Plantain
Amphibromus fluitans	River Swamp Wallaby-grass
Baumea articulata	Jointed Twig-sedge
Cladium procerum	Leafy Twig-sedge
* *Eleocharis acuta*	Common Spike-sedge
Juncus amabilis	Hollow-rush
Juncus gregiflorus	Green Rush
Juncus procerus	Tall Rush
Juncus sarophorus	Broom Rush
Persicaria decipiens	Slender Knotweed
Persicaria praetermissa	Spotted Knotweed
Persicaria subsessilis	Hairy Knotweed
Ranunculus inundatus	River Buttercup
Schoenoplectus tabernaemontani	River Club-sedge
Submergent	
Ceratophyllum demersum	Hornwort
Myriophyllum caput-medusae	Coarse Water-milfoil
Myriophyllum crispatum	Upright Water-milfoil
Myriophyllum simulans	Amphibious Water-milfoil
Potamogeton crispus	Curly Pondweed

Botanical Name	Common Name
Floating Submergent	
Carex gaudichaudiana	Fen Sedge
Hydrocotyle sibthorpioides	Shining Pennywort
Lythrum salicaria	Small Loosestrife
Neopaxia australasica	White Purslane
* *Ottelia ovalifolia*	Swamp Lily
Potamogeton ochtreatus	Blunt Pondweed
Potamogeton pectinatus	Fennel Pondweed
Rumex bidens	Mud Dock
* *Triglochin procerum*	Water Ribbon (emergent form)
* *Vallisneria americana*	Ribbon-weed
Villarsia reniformis	Running Marsh Flower

Notes: * Indicates highly desirable vegetation for Growling Grass Frog, # Limit use of this species, as it may become invasive