



Green and Golden Bell Frog Plan of Management

Arncliffe

Prepared for
Roads and Maritime Service

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Contents

1	Introduction	1
1.1	Background.....	1
1.2	Purpose of the Plan of Management.....	1
1.3	Objective of plan.....	2
2	Legislative context and related documents	5
2.1	Threatened Species Conservation Act 1995.....	5
2.2	Environment Protection and Biodiversity Conservation Act 1999.....	5
2.3	Secretary’s Environmental Assessment Requirements.....	5
2.4	Guidelines and related documents.....	5
3	Green and Golden Bell Frog	7
3.1	Description.....	7
3.2	Habitat.....	8
3.3	Species status and distribution.....	8
3.3.1	Sydney Key Populations.....	9
3.3.2	Arncliffe population.....	9
3.4	Key threatening processes.....	11
4	Impacts, mitigation and management measures	13
4.1	Description of impacts.....	13
4.2	Current management of existing habitat areas.....	13
4.3	Proposed management.....	15
4.4	Project specific mitigation measures.....	15
4.4.1	Construction mitigation measures.....	15
4.4.2	Habitat enhancement and management within adjacent habitat including the RTA ponds.....	22
4.4.3	Habitat creation at Marsh St and the establishment of a captive breeding population.....	25
5	Monitoring and Reporting	27
5.1	Monitoring implementation of mitigation strategies.....	27
5.1.1	Monitoring effectiveness of management and mitigation measures during construction.....	27
5.1.2	GGBF Population monitoring construction and operation.....	31
5.1.3	Population performance criteria during construction and operation.....	35
5.1.4	Goals and performance indicators for mitigation measures.....	35
5.1.5	Contingency measures and corrective actions for declines in the frog population.....	35
5.2	Evidence of consultation with OEH.....	36
5.3	Review of Plan of Management.....	36
5.4	Annual reporting of monitoring.....	36

References 37

Appendix A Unanticipated find procedure 39

Appendix B Consultation with OEH 40

Appendix C Hygiene protocol – Murray et al 2011..... 41

Appendix D Consultation with DP&E 42

List of figures

Figure 1: Proposed impact area and Green and Golden Bell Frog habitat.....	3
Figure 2: Maximum known number of adults between 2002/03 and 2014/15 at the RTA ponds (White unpubl. data).....	10
Figure 3: Frog exclusion fence design (indicative only)	21
Figure 4: Area proposed for habitat at Marsh Street.....	26

List of tables

Table 1: Proportion of male and female Green and Golden Bell Frogs from 2002/03 to 2014/15 (White unpubl. data).....	11
Table 2: Construction mitigation and management measures within the construction zone	16
Table 3: Habitat enhancement measures	22
Table 4: Monitoring requirements to assess effectiveness of mitigation measures during construction .	29
Table 5: Population monitoring and corrective actions for Green and Golden Bell Frog at Arncliffe.....	33

Abbreviations

Abbreviation	Description
CEMP	Construction and Environmental Management Plan
DotE	Commonwealth Department of the Environment
DP&E	NSW Department of Planning and Environment
ELA	Eco Logical Australia Pty Ltd
EPA Act	<i>Environmental Planning and Assessment Act 1979</i> (NSW)
EPBC Act	<i>Environmental Protection and Biodiversity Conservation Act 1999</i> (Commonwealth)
LEP	Local Environmental Plan
LGA	Local Government Area
MNES	Matters of National Environmental Significance
OEH	NSW Office of Environment and heritage
Roads and Maritime	NSW Roads and Maritime Services

SEARs	Secretary's Environmental Assessment Requirements
TSC Act	<i>Threatened Species Conservation Act 1995</i> (NSW)

Key roles and terms

Role	Description
Project Ecologist	The role would be engaged by the contractor. The role would involve ensuring the management actions and monitoring are carried out in accordance with this plan. The Project Ecologist would be suitably qualified and experienced especially in the implementation of mitigation measures at construction sites.
Project Herpetologist	The Project Herpetologist is a specialist role. For this Project, the Project Herpetologist must have extensive and direct experience in the handling and ecology of Green and Golden Bell Frogs. The project Herpetologist must have the necessary scientific licence and ethics permit. The Project Herpetologist may be engaged by the contractor or the proponent to carry out specific actions in this plan.
Project Manager	The Project Manager means the manager engaged by the contractor to ensure that this and other plans are being carried out. They would ensure that relevant notifications are made to the proponent and any relevant agencies regarding the measures set out in this plan.
Project Director	This role is a Roads and Maritime role. It is responsible for the engagement with parties such as adjacent landholders and to seek agreement from those landholders on access and management actions.
M5 East Asset Manager	This is a Roads and Maritime role. This role is required to ensure that actions are carried out in the RTA ponds in accordance with the 1998 Plan of Management.
M5 Asset Trustee Operational Contractor	This is a M5 Asset Trustee role following completion of the construction works. The M5AT Operational Contractor is responsible for managing the New M5 once it becomes operational as defined by the Ministers Conditions of Approval.
RMS New M5 Environment Manager	This is a Roads and Maritime role. The Environment Manager is responsible for overseeing the environmental performance of New M5 project
RMS internal herpetologist	This is a Roads and Maritime role. The RMS herpetologist is responsible for providing input and advice as required during construction and operation.

1 Introduction

1.1 Background

Roads and Maritime Services (Roads and Maritime) has gained approval to construct and operate the New M5 (the project), which comprises a new, tolled multi-lane road link between the existing M5 East Motorway, east of King Georges Road, and St Peters. The project also includes an interchange at St Peters and connections to the existing road network. The project is declared to be State Significant Infrastructure (SSI) and approval was sought under Part 5.1 of the NSW *Environmental Planning and Assessment Act 1979* (EP&A Act). In addition to State approval, the project is a controlled action under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

Construction activities associated with the project would affect habitat of *Litoria aurea* (Green and Golden Bell Frog) at the Arncliffe surface works area. There are expected to be direct and indirect impacts. Permanent road facilities are proposed on land owned by Roads and Maritime, adjacent to existing purpose built breeding ponds. The impacts to the breeding ponds relate to impacts arising from construction within approximately 32 metres of the ponds and will not arise from direct physical removal of habitat. Direct impacts do involve removal of around 7.82 hectares of foraging, sheltering and dispersal habitat on the Kogarah Golf Course.

Green and Golden Bell Frogs at this location form the Arncliffe key population, which is covered in *The Green and Golden Bell Frog Key Population of the Lower Cooks River Management Plan* (DECC 2008a). The plan addresses threats and issues affecting the conservation of the species in the Lower Cooks River, in accordance with the draft species Recovery Plan (DEC 2005).

Green and Golden Bell Frogs have been continuously recorded at the Arncliffe location for over 20 years (White 2015). The species has been breeding and foraging at this site, which contains both suitable terrestrial and aquatic habitat (White 2015). Purpose built breeding ponds for the species are currently located on Roads and Maritime land adjacent to Marsh Street and the Arncliffe surface works area. These breeding ponds are regularly managed through the manipulation of water levels to control vegetation and predators, including the Plague Minnow (*Gambusia holbrooki*), and Chytrid fungus (a specific frog fungal disease) through salt water flushing. The ponds are known as the 'RTA ponds' and referred to as the RTA ponds hereon.

The local population centres on the artificially created habitat at the RTA ponds. The RTA ponds are considered to be the key source for adult frogs for the local population, which disperse across the Kogarah Golf Course. It is unlikely that other ponds within the golf course provide suitable significant breeding habitat as they contain Plague Minnow. However, occasional breeding events in the golf course ponds have been recorded (Dr Arthur White pers. comm 2015).

1.2 Purpose of the Plan of Management

This Plan of Management has been prepared to support the Commonwealth and State environmental approvals process. The Plan has also been developed to provide a framework for the construction team to incorporate Green and Golden Bell Frog management actions in their Construction Environmental Management Plans (CEMP), and to ensure that any actions are consistent with relevant Roads and Maritime guidelines and the impact assessment process.

In particular, this Plan of Management outlines mitigation and management measures to be implemented prior to construction and in the event the species is found in the construction zone during

the proposed works. The Plan of Management also outlines management measures to enhance habitat adjacent to the RTA ponds within the Kogarah Golf Course for the duration of the construction activities. This Plan of Management does not address the management of the RTA ponds as measures to manage the RTA ponds are provided in the *Management Plan for the Green and Golden Bell Frogs (Litoria aurea) at Arncliffe* (White, 1998).

The project has attempted to avoid potential adverse impacts to the Green and Golden Bell Frog population. There are two main foci for management: provision of new habitat and an insurance population. The Plan of Management sets out strategies to create new artificial habitat on Roads and Maritime land at Marsh Street (south of the RTA ponds on the southern side of the M5 East Motorway) supported by a captive breeding program. These strategies are further detailed in a Habitat Creation and Captive Breeding Plan which has been prepared with the advice of independent expert ecologists. This strategy demonstrates that significant effort is being directed toward minimising risk to the population as a result of potential impacts associated with the project.

The Plan of Management has been considered in relation to available management guidelines and policies outlined in Section 2.

1.3 Objective of plan

This plan has the following objectives:

- Minimise or eliminate all avoidable construction impacts by removing and excluding frogs from the construction zone and implementing strict ongoing construction protocols and exclusions.
- Compensate for unavoidable construction impacts by augmenting existing foraging habitat
- Insure against stochastic impacts on RTA ponds by establishing a captive breeding colony and managing non construction related threats known to adversely impact the RTA ponds.
- At least double the availability of suitable habitat in the vicinity of the Kogarah Golf Course by creating new breeding habitat ponds on Marsh Street and re-instating habitat within Kogarah Golf Course where feasible post construction.

Together these objectives are designed to increase the security of the species at Arncliffe which is the ultimate aim of this management plan. Biologically meaningful key performance indicators (KPIs) have been developed to assess and monitor the effectiveness of all actions. These include the responses to not meeting KPIs (thresholds), the personnel responsible and reporting mechanisms. This plan will be subject to expert review by independent experts, with knowledge of the biology and ecology of Green and Golden Bell Frog, as well as the relevant agencies.



Figure 1: Proposed impact area and Green and Golden Bell Frog habitat

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2 Legislative context and related documents

2.1 Threatened Species Conservation Act 1995

The Green and Golden Bell Frog is listed as 'Endangered' under the NSW *Threatened Species Conservation Act 1995* (TSC Act). The TSC Act requires that a public authority take appropriate measures to implement actions included in a Recovery Plan for which they have agreed to be responsible. In addition, the TSC Act specifies that public authorities must not make decisions that are inconsistent with the provisions of the draft species Recovery Plan (DEC 2005).

Construction activities associated with the project, would affect habitat of the Green and Golden Bell Frog. The management of potential habitat and mitigation measures for the project is to be undertaken in a manner consistent with the TSC Act requirements and the draft species Recovery Plan. The project is consistent with the draft Recovery Plan because it provides for fully offset impacts. This is consistent with the objective of 'no net loss' of habitat.

2.2 Environment Protection and Biodiversity Conservation Act 1999

The Green and Golden Bell Frog is listed as 'Vulnerable' under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

The EPBC Act significant impact guidelines (DEWHA 2009) for this species consider that a significant impact is possible if actions result in the removal or degradation of terrestrial habitat within 200 metres of known habitat. The current project footprint proposes to remove known Green and Golden Bell Frog habitat on Kogarah Golf Course as part of the construction activities for permanent and temporary facilities. The project has been referred to the Commonwealth for approval under the EPBC Act and has been determined to be a controlled action on the basis of impacts to Green and Golden Bell Frog.

2.3 Secretary's Environmental Assessment Requirements

The NSW Secretary's Environmental Assessment Requirements (SEARs) for the project were issued on 5 March 2015 and a revised SEARs issued on 26 August 2015 and included a requirement to undertake an assessment of potential impacts of the project on biodiversity values. In addition, matters for further consideration were provided by the NSW Office of Environment and Heritage (OEH), which included specific consideration of the Green and Golden Bell Frog. In anticipation that additional conservation measures are likely to be required for impacts on this species, this plan sets out a targeted and detailed management strategy for this species at this location.

2.4 Guidelines and related documents

This Plan of Management has been considered in relation to available management guidelines and policies including:

- Draft Recovery Plan for the Green and Golden Bell Frog (DEC 2005).
- Plan of Management – Green and Golden Bell Frog Key Population of the Lower Cooks River (DECC 2008a).
- EPBC Act Policy Statement 3.19. Significant Impact Guidelines for the vulnerable green and golden bell frog *Litoria aurea* (DEWHA 2009).
- Best Practice Green and Golden Bell Frog Habitat Guide (DECC 2008b).
- Protecting and restoring Green and Golden Bell Frog habitat (DECC 2008c).

- Hygiene protocol for the control of disease in frogs (DECC 2008d).
- Environmental Impact Assessment Guidelines: Green and Golden Bell Frog (NPWS 2003).
- Species expert reports and annual monitoring at Kogarah Golf Course (White 2015).
- Biodiversity Guidelines – protecting and managing biodiversity on RTA projects (NSW Roads and Traffic Authority 2011).

In addition, this plan has been prepared with reference to:

- The Commonwealth EPBC Act Policy Statement – Translocation of listed threatened species – assessment under chapter 4 of the EPBC Act (SEWPaC, 2013).
- Policy and Procedure Statement No 9 – Policy for the translocation of threatened fauna in NSW (NPWS, 2001).

Approvals required implementing this plan

In anticipation that implementation of this plan, including the proposals to undertake habitat creation and captive breeding activities, would be part of the conditions of the planning approval under the EP&A Act, separate TSC Act licensing of these activities would not be required. The program and plans requires Animal Ethics Committee approval according to the “Code of practice for the care and use of animals in research in Australia” (National Health and Medical Research Council and Commonwealth Scientific and Industrial Research Organisation).

3 Green and Golden Bell Frog

3.1 Description

The Green and Golden Bell Frog is a relatively large dull olive to bright emerald green frog that can range in size from around 45 millimetres to 100 millimetres snout to vent length (Cogger 2000, OEH 2015). Its distinctive characteristics are a gold or creamish white stripe running along the side, extending from the upper eyelids almost to the groin, with a narrow dark brown stripe beneath it, from nostril to eye. It also has a blue or bluish-green colour on the inside of the thighs (OEH 2015). The Green and Golden Bell Frog can be distinguished from similar species by its wart-free skin, expanded finger and toe pads, and lack of spotting or marbling on the hind side of the thigh.

Tadpoles of the species are relatively large (65 – 100 millimetres at limb bud development stage) and juvenile frogs are smaller versions of the adults that metamorphose at around 25 – 30 millimetres snout to vent length (DEC 2005).



It is active by day and usually breeds in summer when conditions are warm. However, the breeding has been recorded from September to February, with a peak breeding period following heavy rains in the warmer January to February months. Breeding patterns are influenced by geography with southerly and higher altitude populations having a narrower window of opportunity for breeding than more northerly and lower altitude populations (DEC 2005, DoE 2015).

The species is known to be highly mobile, and may move among breeding sites with large distances travelled in a single day/night or up to 1-1.5 kilometres (Pyke and White 2001). Juvenile frogs are

especially mobile with dispersal rates of up to 90% experienced at breeding sites within Kooragang Island (Professor Michael Mahony *pers. comm* 2017). Male frogs call while floating in water and amongst fringing vegetation and females produce a raft of eggs that initially float before settling to the bottom of the water body (DEC 2005). Tadpoles are known to feed on algae and other plant-matter within the water body, while adult frogs are known to eat mainly insects, but may also eat other frogs.

3.2 Habitat

Green and Golden Bell Frogs can occupy a broad range of habitats, including natural, artificial and disturbed habitats, and breed in ephemeral ponds (Pyke & White 1996, DEC 2005). They have been recorded associated with coastal swamps, marshes, dune swales, lagoons, lakes and other estuarine wetlands as well as riverine floodplain wetlands and billabongs and constructed water bodies such as storm water detention basins, farm dams, bunded areas, drains and ditches (DEC 2005).

Green and Golden Bell Frog need various habitats for different aspects of their life cycle including foraging, breeding, sheltering, over-wintering and dispersal. They will also use different habitats or habitat components on a temporal or seasonal basis (DotE 2015). The species has been found in a wide range of water bodies except fast flowing streams (Pyke & White 1996) and has been associated with habitats such as marshes, dams and stream-sides, particularly those containing *Typha* spp. (Bullrushes) or *Eleocharis* spp. (Spikerushes).

Breeding habitat consists of water bodies that are still, shallow, ephemeral, unpolluted, unshaded, with aquatic plants present and free of Plague Minnow (*Gambusia holbrooki*) and other predatory fish. Breeding habitats also occur near terrestrial habitats containing grassy areas and vegetation no taller than woodlands for foraging and dispersal, and a range of diurnal shelter sites, such as rocks, logs, tussock forming vegetation and other cover for refuge (Pyke & White 1996, DotE 2015).

3.3 Species status and distribution

The Green and Golden Bell Frog is listed as 'Endangered' under the NSW TSC Act and as 'Vulnerable' under the Commonwealth EPBC Act.

The NSW Scientific Committee, when producing the original schedules for listing of the species as endangered stated that: “[the] Population [was] severely reduced over entire range; [and] severe threatening processes [operate].”

The Green and Golden Bell Frog has declined from a status where it was regarded as an extremely abundant species, with a widespread and almost continuous distribution between the north coast near Brunswick Heads, south along the coast to Victoria, to one where it now has only a fragmented distribution throughout this former range. It is currently considered to be absent from at least 90% of its former distribution (White and Pyke 1996; DEC 2005).

The Green and Golden Bell Frog occurs mainly along the coastal lowland areas of eastern NSW and Victoria. Its distribution now extends from Yuraygir National Park near Grafton on the North Coast of NSW, to the vicinity of Lake Wellington, just west of Lakes Entrance in south-eastern Victoria. The furthest inland record of the species is near Hoskinstown in the Southern Tablelands, just outside the ACT (DotE 2015).

At the time of the Recovery Plan production, there were 43 populations described as 'key' populations, known or considered likely to persist throughout the species range within NSW.

3.3.1 Sydney Key Populations

Sydney still contains some of the largest but also most disturbed and isolated populations of the Green and Golden Bell Frog, as a result of development and other human disturbances rather than a naturally patchy distribution.

Eight key populations exist within the greater Sydney Region, with other transient sites believed to also exist, consisting of small populations of migrating individuals. The Sydney based eight key populations are at:

- Kurnell
- Homebush Bay (Sydney Olympic Park lands)
- Greenacre
- Clyde/Rosehill (wetlands at the confluence of the Parramatta and Duck Rivers)
- Merrylands (Holroyd Gardens estate)
- Arncliffe (Marsh Street Wetlands) – this location
- St Marys
- Hammondville.

3.3.2 Arncliffe population

As part of the original M5 East project opened in 2001, Roads and Maritime provided breeding ponds for the Green and Golden Bell Frog on Roads and Maritime owned land occupied by Kogarah Golf Club in Arncliffe. The new frog habitats are known as the RTA ponds. This site is directly adjacent to planned construction activity for the New M5.

The RTA Ponds were purpose built and while they are permanent, they have the capability of being periodically emptied. Water levels are managed in response to particular triggers and in accordance with the "Management Plan for the Green and Golden Bell Frogs (*Litoria aurea*) at Arncliffe" (White 1998) prepared as part of the M5 East approval.

The two ponds were planted with emerging and fringing aquatic vegetation such as *Eleocharis* sp and *Schoenoplectus* sp. These species are rushes and sedges which are used by the frogs for basking. The areas surrounding the ponds were planted with native grasses such as *Rytidosperma* sp. (Wallaby Grass) and a few low shrubs. No trees were planted as these shade the ponds, which is less favourable for the frogs. A boulder field was constructed to provide basking or sheltering habitat. The entire site was fenced with cyclone mesh fencing to prevent access to the ponds. Maintenance of the RTA ponds is managed by the Roads and Maritime M5 East asset team in consultation with Dr Arthur White. Assistance is also provided by a frog and tadpole community group when required.

Formal monitoring of the frogs in the area started in November 2000.

Monitoring was initially confined to the remaining areas of the Marsh Street wetland and Eve Street wetlands, however, with the construction of the two frog ponds at Arncliffe and the partial loss of the Marsh Street wetland, monitoring focussed almost entirely on the RTA ponds, the Kogarah Golf Course and the remaining portion of the Marsh Street wetland. Monitoring gradually declined then ceased at Marsh Street and Eve Street wetlands due to lack of frogs present.

Monitoring has been ongoing with most survey work being carried out during the warmer months of the year (from August to May).

Surveys carried out over the summers of 1999-2000 and 2000/01 showed a progressive increase in the number of adult Green and Golden Bell Frogs found in the two RTA ponds at Arncliffe and a decrease in the number of frogs in the Marsh Street wetlands.

A graph showing the results of the monitoring effort between 2002/03 and 2014/15 is shown below (**Figure 2**). This graph demonstrates presumed recent declines in the size of the population. While no specific study of the reasons for decline has been undertaken, Dr Arthur White believes this could be due to a range of factors including:

- excessive plant growth overshadowing of the existing frog ponds
- more extensive mowing of grassed areas on the Kogarah Golf Course increasing the risk of predation to frogs foraging on the golf course.

The Roads and Maritime M5 East asset team has undertaken works within the frog ponds over summer 2015/16 which has removed the excessive plant growth in the existing frog ponds. Maintenance is undertaken generally on a six monthly basis following inspections of the ponds by Dr Arthur White with the most recent maintenance undertaken in September 2017.

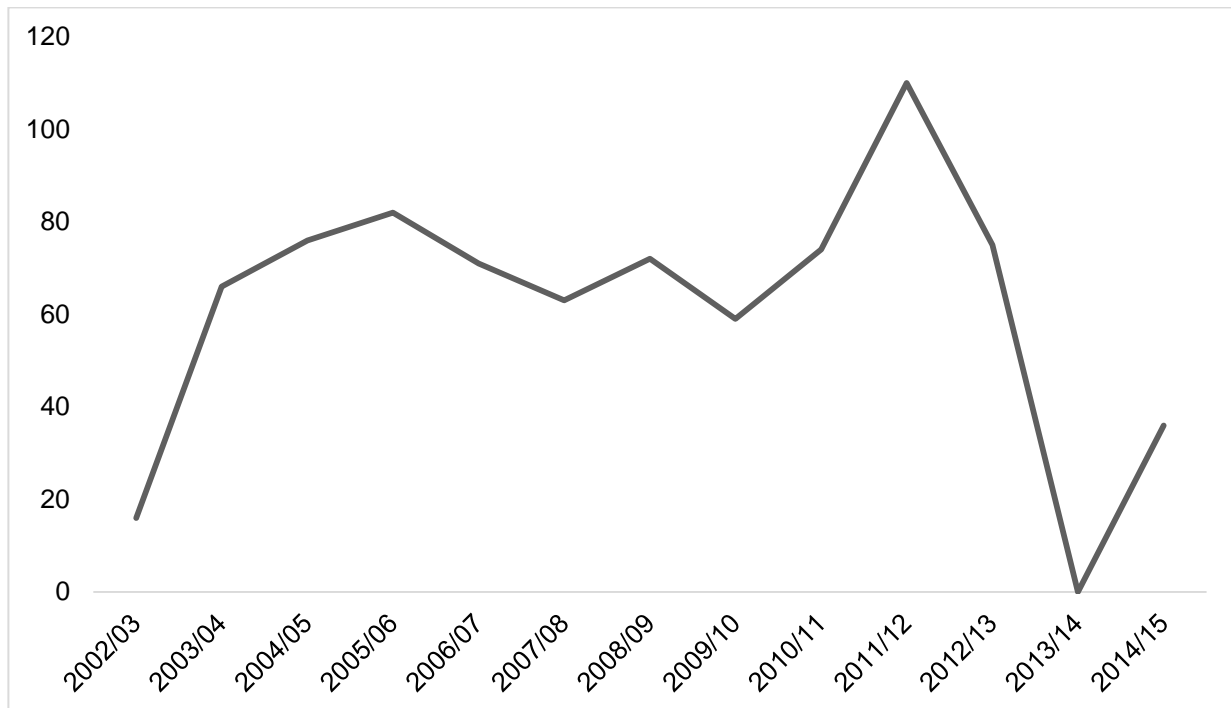


Figure 2: Maximum known number of adults between 2002/03 and 2014/15 at the RTA ponds (White unpubl. data)

The surveys have estimated the maximum known number of adults based on the Petersen-Lincoln index. Note that this estimate for 2013/14 could not be made due to the low numbers of frogs captured on the two successive nights surveyed in February 2014. The 'zero' does not mean there were no frogs present; it was that the estimate could not be reliably performed. No errors or confidence limits were calculated for any of these data.

Sex ratios are important to understand in populations of Green and Golden Bell Frog. This is because this species relies on a fast growth rates and rapid maturation to maintain the population (Pickett et al. 2014). These lifecycle attributes increase the importance of breeding events to enable replacement of adults in subsequent generations (Bower et al. 2014). To enable successful breeding and to improve genetic diversity, there would need to be enough males and females to breed. The table below describes the proportion of females and males tagged per survey season for the area that includes the RTA ponds, Kogarah Golf Course and the Marsh Street wetlands (**Table 1**).

Population age structures were not provided in any of the RTA pond monitoring reports from Dr Arthur White (White 2003 – 2015). Age structure is important to understand if there are enough adults of suitable breeding age to sustain the population. The monitoring report structure has been updated to include estimates of age structure.

Table 1: Proportion of male and female Green and Golden Bell Frogs from 2002/03 to 2014/15 (White unpubl. data)

Survey season	Female	Male	Unknown*
2002/03	0.3	0.7	-
2003/04	0.25	0.5	0.25
2004/05	0.4	0.6	-
2005/06	0.3	0.7	-
2006/07	0.35	0.65	-
2007/08	0.4	0.6	-
2008/09	0.2	0.8	-
2009/10	0.25	0.75	-
2010/11	0.3	0.7	-
2011/12	0.35	0.65	-
2012/13	0.45	0.55	-
2013/14	0	1	-
2014/15	0.25	0.75	-

* denotes that the individual captured would have been too young to determine sex. Proportions have been rounded to the nearest whole number.

3.4 Key threatening processes

A number of factors associated with direct and indirect consequences of human activity have contributed to the decline of Green and Golden Bell Frogs, including (extracted from DEC 2005):

- *Habitat loss, modification and disturbance.* The removal of and disturbances to habitat has occurred across large areas as a result of development, and is considered the most significance key threatening process. This includes the reduction of wetlands and poorly drained coastal flood plain land that formerly constituted prime habitat, which has been drained, in-filled or developed.
- *Habitat fragmentation.* This has historically occurred over wide areas as a result of developments or through construction of significant barriers to natural movement (e.g. major roads). In some cases, this has prevented connections within a population, effectively limiting gene flow and dispersal.
- *Predation by introduced fish.* Predation occurs on the eggs and tadpoles of frogs by the introduced Plague Minnow (*Gambusia holbrooki*). Other introduced fish are likely to be the European Carp (*Cyprinus carpio*) and Gold Fish (*Carassius auratus*).
- *Disease – Chytrid fungus.* The Chytrid fungus (*Batrachochytrium dendrobatidis*) has been implicated in the decline of frogs across the world, and is thought to be a significant contributor to the decline of frogs in Australia.

- *Water quality and pollutant issues.* Developments and other activities occurring within a catchment have consequences for downstream areas and may include altered flow regimes, increased nutrient loads, weed infestation, other contaminants and rubbish. Deteriorating run-off water quality and increased soil erosion and sedimentation reduces the area's suitability for frogs.
- *Other threats.* Other possible threats indicated by anecdotal evidence includes predation by the foxes, cats, dogs and rats, road mortality, mowing near breeding and foraging habitat, predator/prey interactions with Cane Toads, artificial and natural opening of coastal lagoon estuaries, changes to flow regimes of streams and associated wetlands and excessive grazing and trampling of habitat.

4 Impacts, mitigation and management measures

4.1 Description of impacts

Construction activities of the project are likely to result in direct and indirect impacts to Green and Golden Bell Frog habitat. The activities of the project include the establishment of permanent facilities on land adjacent to the existing RTA ponds. A construction area and temporary facilities have been constructed around 32 metres away from the RTA ponds, and extends onto land owned by Rockdale City Council (Figure 1). This construction area is known as the Arncliffe surface works area.

Unless mitigated, the proposed temporary and permanent activities are likely to impact on Green and Golden Bell Frogs within the site area, shown on Figure 1, resulting in:

Potential direct impacts:

- Removal of around 7.82 hectares of foraging, sheltering and dispersal habitat
- Potential mortality of frogs from heavy machinery movements within the construction zone
- Removal of one ephemeral pond that has previously been recorded as containing a breeding event.

Potential indirect impacts:

- To the RTA ponds (leading to reduction in the capacity of the ponds to function as habitat) by:
 - Increase in shading from the permanent facilities (e.g. ventilation stacks) during winter
 - Increase in dust from heavy vehicle movements
 - Increase in noise by heavy vehicle movements and tunnel boring
 - Increase in light from 24 hour construction operation
 - Increase in vibration from heavy vehicle movements, tunnel boring and stockpiling
 - Accidental introduction of predatory fish
 - Introduction of frog pathogen by construction personnel and construction equipment and machinery.
- Reduction of water quality in other habitat areas on Kogarah Golf Course through sediment-laden flow and/or contaminants originating from the construction zone
- A reduction of habitat connectivity to other areas within the golf course
- Limiting foraging habitat
- Reduction in breeding success
- Potential mortality of individuals as a result of habitat modification.

Temporary impacts for up to four years represent the bulk of the impacts to Green and Golden Bell Frog habitat at the Arncliffe surface works area. Frog habitat areas affected by the temporary construction areas on the Kogarah Golf Course will be reinstated to a condition that is the same as the pre-construction condition following the completion of construction works. Rehabilitation of construction compound on Kogarah Golf Course will be managed in accordance with the requirements of the Ancillary Facility Management Plan for the Arncliffe Compound.

4.2 Current management of existing habitat areas

Management and maintenance of the RTA ponds is managed by the Roads and Maritime M5 East asset team in accordance with the *Management Plan for the Green and Golden Bell Frogs (Litoria aurea) at Arncliffe* (White, 1998) and in consultation with a nominated herpetologist. Current

management includes regular manipulation of water levels and drainage of breeding ponds. This creates habitat preferred for breeding by the frog and enables the flushing of salt water and periods of dryness for the management of:

- Predators, including Plague Minnow (*Gambusia holbrooki*)
- Chytrid fungus, a disease that affects all frog species, including the Green and Golden Bell Frog, which is present within this population, although it has not been tested since 2007.

Additional ponds on the Kogarah Golf Course are also artificial, but are not purpose built for frog habitat and water levels are not manipulated to manage threats to the frogs or to provide suitable habitat. These ponds are managed by Kogarah Golf Course and not Roads and Maritime. Many of the golf course ponds contain fringing vegetation such as *Typha* spp. (Cumbungi) and *Juncus* spp., suitable for a diversity of frog species, including the Green and Golden Bell Frog.

Water quality in many of the golf course ponds is low as a result of nutrient run-off from management activities on the golf course along with saline influences. The predatory Plague Minnow *Gambusia holbrooki* is present in high densities in the majority of the remaining golf course ponds. In addition, adjacent vegetation exists as exotic grasses that are regularly mown for the purposes of golf course maintenance and use as fairways.

Habitat types within the golf course are described as follows (extracted from Management Plan Green and Golden Bell Frogs Lower Cooks River Key Populations, DECC 2008a):

- *Breeding habitat*: primarily consists of the purpose built artificial ponds (RTA ponds). These ponds were built as a requirement of a previous development approval. Other breeding habitat (ephemeral) also exists and includes golf course water hazards, although breeding in these ponds is occasional.
- *Foraging habitat*: Includes grassed areas (native or exotic), tussock vegetation and emergent sedges and reeds bordering water features and ponds. The drainage channel and reed beds that border the southern extremity of the golf course may also provide foraging and dispersal habitat.
- *Sheltering habitat*: includes similar vegetation to that used as foraging areas that contain rock piles, fallen timber, tussock grasses and other artificial sheltering sites. Sheltering habitat is present around the RTA ponds.
- *Dispersal habitat*: typically includes wet areas such as creek lines, drains, stormwater canals, connecting vegetation, and other easements and depressions. However, in the golf course, fairways currently provide movement habitat between the RTA ponds and foraging habitat. An artificial frog passage was built underneath the M5 to facilitate movement between the golf course and habitat to the west and south (Marsh Street Wetlands and Old Spring Creek Wetland site). However, this passage is not used because of the relatively hostile environment across which frogs would need to travel (White A., pers. comm. 2015). The underpass consisted of a circular culvert 60 centimetres in diameter that ran the entire length of the passage. The total length of the culvert was 38 metres. Near the mid-way point, the culvert sloped upwards and an open skylight was installed in the space in the median strip in the motorway. Travelling southwards from the centre section, the culvert dipped quickly downwards so that it could pass under the southern section of the M5 East and emerged at the edge of the stormwater basin that had formed the Marsh Street wetland. The centre skylight was the only light point in the culvert. The northern entrance to the culvert was only accessible by maintaining a cleared vegetation area on the southern side of the SWSOOS. The frog use of the underpass was monitored for the first two years only. It became clear that the frogs were not using the underpass. Either the underpass was too narrow, too dark or too long for the frogs to use. This did not mean that frogs did not move between the northern and southern areas either

side of the M5 East. Occasionally Bell frogs were captured beneath the M5 near the cycleway underpass. This area is 300 meters to the east of the frog culvert and much more exposed. Few frogs were found making the passage beneath the M5. The impoverished condition of the Marsh Street wetland after the installation of the M5 resulted in few Bell frogs remaining in this area (and hence few frogs moving beneath the M5). Frog monitoring since 2000 failed to detect any Bell Frogs in the Marsh Street wetland after 2006.

- *Over-wintering habitat.* Boulder piles were constructed surrounding the RTA ponds to provide over-wintering habitat. However it is unclear whether the frogs actually use the boulders as over-wintering habitat.

4.3 Proposed management

Roads and Maritime is seeking to manage impacts to Green and Golden Bell Frog habitat associated with the project. The actions include the implementation of mitigation and management measures detailed in this plan, enhancement of the existing habitat on the Kogarah Golf Course (i.e. construction of six stepping stones ponds) and implementation of the Habitat Creation and Captive Breeding Plan (required by the approval). The actions are to be implemented by the Construction Contractor, M5 Asset Trustee and Roads and Maritime.

The mitigation and management measures outlined in Section 4.4 of this Plan of Management must be implemented to minimise potential impacts to Green and Golden Bell Frog individuals and known habitat. These measures have been incorporated where relevant into the Construction Environmental Management Plan (CEMP) prepared for the project.

4.4 Project specific mitigation measures

All relevant construction mitigation measures are to be incorporated in the project CEMP. They are to follow an adaptive approach that seeks the continued improvement of this plan and its mitigation measures. The actions and measures are outlined in the tables below:

- Construction related activities within the construction zone (Section 4.4.1)
- Habitat enhancement and management within adjacent habitat (Section 4.4.2)
- Habitat creation at Marsh Street and captive breeding (Section 4.4.3).

4.4.1 Construction mitigation measures

Management measures relating to construction activities within the construction zone are outlined in Table 2. These measures should be considered as a minimum requirement and implementation is the responsibility of the Construction Contractor. More specific construction measures to address impacts on frogs are contained within the CEMP, including induction.

Table 2: Construction mitigation and management measures within the construction zone

Mitigation measure	Description	Responsibility	Role	Timing
Define the construction clearing areas	<p>Clear delineation of the construction boundary. Areas to be cleared should be marked and checked with surveyor's pegs and equipment to ensure that the minimum area of take is adopted.</p> <p>Clearing should only occur within these areas. Once areas are cleared, the area of take should be calculated to ensure that no additional areas have been cleared.</p> <p>The distance between the RTA ponds and the edge of the clearing required for the construction zone is expected to be at least 32 metres.</p>	CDSJV	Project ecologist	Pre-construction
Establish a Frog exclusion zone	<p>Establishment of a physical barrier, using frog exclusion fencing between all construction works, existing RTA Ponds and remainder of the golf course.</p> <p>This frog fencing should be designed in consultation with a person who has had at least five years' experience in the management of Green and Golden Bell Frogs.</p> <p>Frog-exclusion fences have been used routinely on construction sites and other hazardous areas where threatened frog species occur. Frog exclusion fences generally consist of a continuous curtain of impervious material (usually shade cloth fabric) strung between support posts. The fence is at least 1 metre high and has an overhanging lip. The current fence design has a 25 cm horizontal lip and then another 30 hanging vertical lip at the top of the fence. The overhanging lip is designed to prevent frogs climbing over the fence (see indicative fence design Figure 3). The final design is to be approved by the Project Herpetologist.</p> <p>The base of the fence is buried (to stop frogs from digging under the fence. If there are gates in the fence, the base section of the gate can still maintain a seal with the ground by being weighed down with length of flexible chain.</p> <p>There should be a section of fence adjacent to the RTA ponds (marked in Figure 1 as noise wall fence and yellow dashes) which will:</p> <ul style="list-style-type: none"> • Reduce sound and dust • Not exclude daylight • Exclude frogs • Exclude construction activities to clearly separate frog habitat to be retained from construction zone. 	CDSJV	Project Herpetologist	Pre-construction

Mitigation measure	Description	Responsibility	Role	Timing
	<p>This section of fence is to be inspected daily. Any breaches of the fence are to be raised with the Contractor for remediation.</p> <p>The remainder of the construction zone should be fenced to clearly separate frog habitat from the construction zone (marked in Figure 1 as frog exclusion fence and black dots). The frog noise wall will be constructed between the RTA pond site and the adjoining works compound. The wall is intended to reduce the amount of noise and dust that might otherwise reach the RTA ponds. To be effective the wall needs to be at least 4 metres high and 28 metres long. Because the wall is so high and is located on the NW side of the RTA ponds, it risks overshadowing the ponds. To alleviate this, the top 2 metres (as a minimum) of the wall will be constructed of transparent plastic. The noise wall will be continuous with perimeter frog fences and will form part of the barrier between the RTA ponds and the frog habitat in the Frog Enhancement Area and the works site.</p> <p>This fence should:</p> <ul style="list-style-type: none"> • Exclude humans from entering the construction zone • Exclude frogs from the construction zone. <p>The remaining section of fence is to be inspected weekly. Any breaches of the fence are to be raised with the Contractor for remediation.</p>			
<p>Undertake pre-clearance survey and salvage activities</p>	<p>Conduct a pre-clearance survey within the construction zone immediately prior to constructions works being undertaken.</p> <p>The survey should include two diurnal and two nocturnal surveys, with the last nocturnal survey conducted the night prior to works being undertaken.</p> <p>Winter to spring frog encounters:</p> <p>If Green and Golden Bell Frogs are encountered sheltering underneath rock, rubble or wood they need to be assessed for an over wintering position or torpor. Then the frogs are to be collected in accordance with the following protocol:</p> <ul style="list-style-type: none"> • Placed in a clean, plastic holding container with a small amount of purified water • Frogs should be micro-chipped if not already tagged • Adult frogs should be sexed, snout-vent length measured, weight recorded, condition of the 	<p>CDSJV</p>	<p>Project Ecologist</p>	<p>Pre-construction and construction</p>

Mitigation measure	Description	Responsibility	Role	Timing
	<p>frog, date and location of collection</p> <ul style="list-style-type: none"> If frogs are injured, they are to be taken to a vet or suitably experienced frog keeper and euthanased. If frogs are not in torpor, the procedure for spring to autumn encounters applies. <p>Spring to autumn frog encounters:</p> <p>If active frogs are encountered during the pre-clearance surveys or daily checks, then they are to be collected in accordance with the following protocol:</p> <ul style="list-style-type: none"> Placed in a clean, plastic holding container with a small amount of purified water Frogs should be microchipped if not already tagged Adult frogs should be sexed, snout-vent length measured, weight recorded, condition of the frog, date and location of collection. <p>Prior to works commencing, a number of water bodies within the construction zone will need to be decommissioned. Dam decommissioning needs to be done in the presence of a suitably qualified and experienced ecologist. Any frogs encountered will need to be collected as per above. Pre-clearance surveys should include searching for tadpoles. Tadpoles should be netted and then identified using Anstis (2013). Green and Golden Bell Frog tadpoles should be collected and handled as above, apart from tagging.</p>			
Transportation of frogs and tadpoles off construction site	<p>Any frogs encountered in the construction area are to be:</p> <ul style="list-style-type: none"> Transported to a suitable over-winter location in consultation with the project herpetologist and independent experts Relocated to the RTA ponds or the new Marsh Street habitat area based on the advice of the project ecologist. Frogs may be relocated to the Symbio Zoo where there is agreement with RMS and the project herpetologist to include them with captive breeding program. Otherwise any frogs or tadpoles encountered within construction areas are to be relocated to adjacent habitat areas. <p>Tadpoles encountered on the project site between autumn and spring should not be released, but should be kept in a suitable over-wintering facility, in consultation with the project herpetologist.</p>	CDSJV	Project Herpetologist	Pre-construction and construction

Mitigation measure	Description	Responsibility	Role	Timing
	<p>Tadpoles encountered from spring to autumn should be released into the RTA Ponds, artificial habitat at Marsh Street based on the advice of the project herpetologist. If tadpoles are not Green and Golden Bell Frogs, these should be released into ponds other than the RTA Ponds on the golf course.</p> <p>It is noted that due to the installation of the frog fence around the Arncliffe construction compound, it is unlikely that any tadpoles will be encountered within the construction zone as there is no access for frogs.</p>			
Site inductions	<p>Site inductions should contain a relevant section on the Green and Golden Bell Frog. The induction should incorporate:</p> <ul style="list-style-type: none"> • What to do in the event of unexpected finds of frogs within the construction zone. • Hygiene protocols • Highlighting the enhanced frog habitat area and why this is a 'no-go' zone. 	CDSJV	Project Manager	Construction
Stop work procedure	<p>Implement a stop work or unanticipated find procedure for when Green and Golden Bell Frogs are observed within the construction zone (Appendix A). The procedure will include a process to notify the construction environmental manager and suitably qualified ecologist, a relocation procedure and when it is okay to re-commence works.</p>	CDSJV	Project Manager	Construction
Sediment and erosion control	<p>Establish appropriate sediment and erosion control to prevent silt, sediments, spills and other contaminants from impacting water quality in frog habitat at Kogarah Golf Course. These controls should be regularly inspected by CDSJV, particularly after heavy rain events.</p> <p>It is noted that the construction area surface levels are below the RTA ponds and as such are not likely to generate discharge to the ponds, however other habitat areas on Kogarah Golf Course may be susceptible to discharge from the construction area.</p>	CDSJV	Project Manager	Pre-construction and Construction
Light spill management	<p>Directional lighting should be used in the vicinity of the transparent frog exclusion fence. Directional lighting should aim to reduce night time light spill onto the RTA ponds.</p>	CDSJV	Project Ecologist	Construction
Dust suppression	<p>Dust from heavy vehicle haulage, dumping and storing of spoil and general vehicle movements will need to be minimised. Dust may reduce water quality in the RTA ponds.</p> <p>Bulk water carriers and sprayers should apply rainwater and/or tunnel water / potable water to reduce dust. Slurry run-off should be managed in accordance with the sediment and erosion control measures.</p>	CDSJV	Project Manager	Construction

Mitigation measure	Description	Responsibility	Role	Timing
Contaminated lands management	Develop appropriate procedures to manage contaminated fill that may occur in surrounding soils during the construction works and any habitat enhancement, if applicable.	CDSJV	Project Manager	Construction
Acid sulphate soils management	Develop appropriate procedures to manage acid sulphate soils during construction and operation, if applicable. Management of acid sulphate soils should be carried out in accordance with the Roads and Maritime guideline or approved procedure. Relevant documents include: <ul style="list-style-type: none"> RTA Guidelines for the Management of Acid Sulphate Materials, April 2005 NSW Acid Sulphate Soils Manual (Stone et al 1998) NSW EPA publication “Assessing and Managing Acid Sulphate Soils”. 	CDSJV	Project Manager	Construction
Use of herbicides and other chemicals	During construction, herbicides and pesticides should not be used by the construction contractor near the RTA ponds or within the enhanced frog habitat area. If herbicides/pesticides are to be used within the construction zone, spray drift must not be able to reach aquatic habitat. This applies to herbicides/pesticides in solution in surface water run-off.	CDSJV	Project Manager	Construction
Habitat re-instatement	Re-instate all habitats that were temporarily impacted from the construction activities within the Arncliffe surface works area. Habitat reinstatement should be conducted in accordance with relevant guidelines and policies and be conducted in consultation with the Kogarah Golf Course and Bayside Council.	CDSJV	Project Manager	Post construction

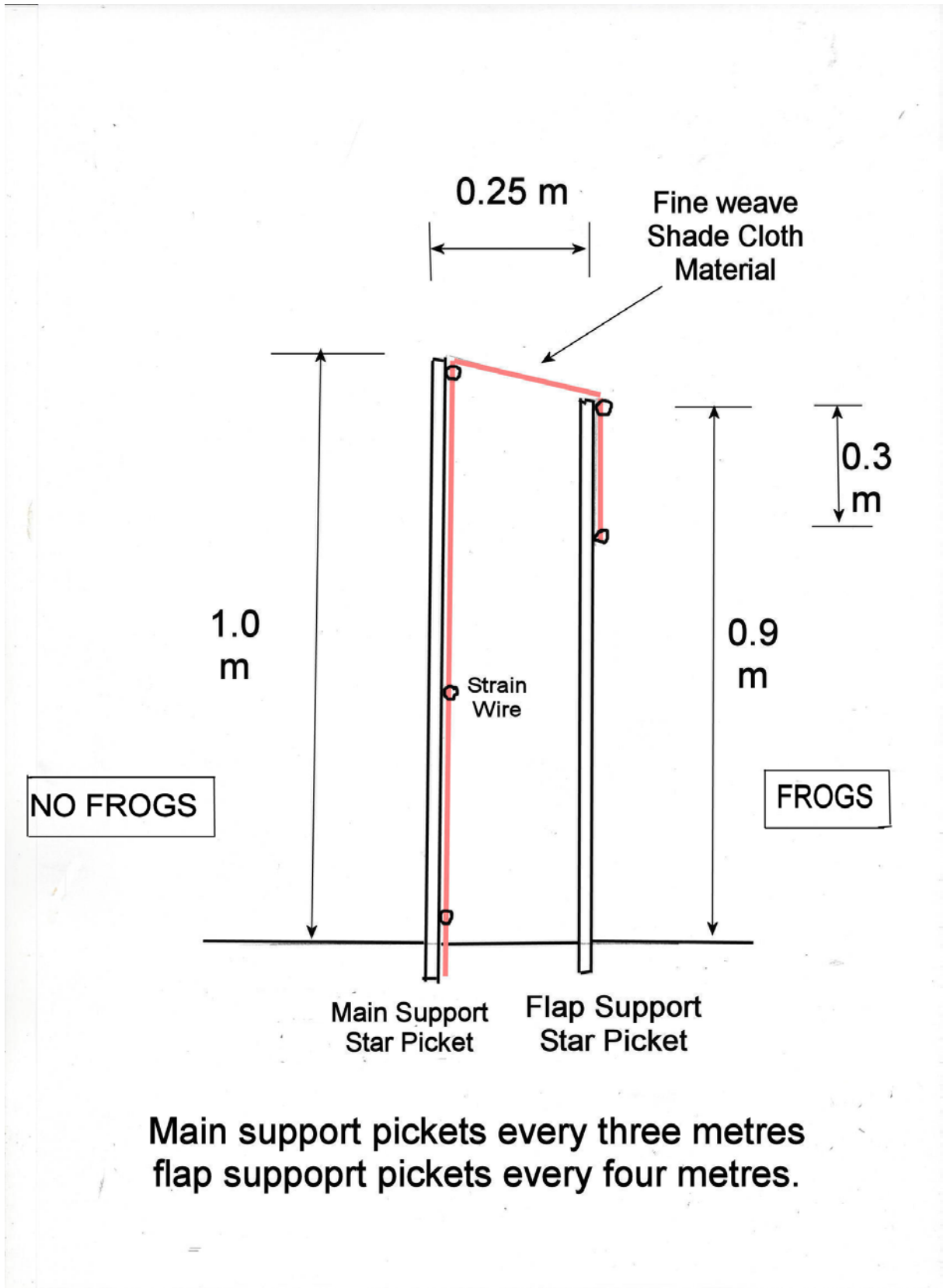


Figure 3: Frog exclusion fence design (indicative only)

4.4.2 Habitat enhancement and management within adjacent habitat including the RTA ponds

To compensate for loss of foraging habitat and to encourage frog movement to other habitat areas, habitat adjacent to the RTA ponds and between the existing M5 East Motorway and the construction zone will be enhanced. These measures are shown in Table 3.

Table 3: Habitat enhancement measures

Mitigation measure	Description	Where	Responsibility	Role	Timing
Enhance habitat adjacent to RTA frog ponds	<p>Enhanced frog habitat will consist of the following:</p> <ul style="list-style-type: none"> Improved areas of foraging habitat consisting of tussocky grasslands and swales Areas of vegetation and other structures, such as logs, suitable for sheltering Installation of six wet areas that will act as stepping stones to encourage frogs to move between the RTA ponds and the remainder of the golf course. <p>Establishment and enhancement of frog habitat is to be conducted in accordance with:</p> <ul style="list-style-type: none"> Best Practice Green and Golden Bell Frog Habitat Guide (DECC 2008b). Protecting and restoring Green and Golden Bell Frog habitat (DECC 2008c). To be designed by person with at least five years' experience in the design of frog habitat or by a frog expert. 	Kogarah Golf Course	CDSJV	Project Ecologist	Construction
Hygiene protocol	<p>Develop a hygiene protocol for the Project. This is to reduce the risk of the introduction and spread of Chytrid Fungus. The hygiene protocol is to be developed in accordance with the following:</p> <ul style="list-style-type: none"> Hygiene protocol for the control of disease in frogs (DECC 2008d). Environmental Impact Assessment 	Adjacent habitat (Kogarah Golf Course / RTA	CDSJV	Project Ecologist	Pre-construction and Construction

Mitigation measure	Description	Where	Responsibility	Role	Timing
	<p>Guidelines: Green and Golden Bell Frog (NPWS 2003).</p> <ul style="list-style-type: none"> RTA Biodiversity Guidelines – protecting and managing biodiversity on RTA projects (NSW Roads and Traffic Authority 2011). <p>The hygiene protocol should follow Murray et al (2011), which is appended to this plan.</p>	ponds)			
Maintain the existing RTA ponds	The RTA Ponds will continue to be managed separately to the New M5 project by Roads and Maritime in accordance with the existing <i>Management Plan for the Green and Golden Bell Frogs (Litoria aurea) at Arncliffe</i> (White, 1998)	RTA ponds	Roads and Maritime	M5 East Asset Manager	Construction Operation
Maintain adjacent habitat area	<p>Access, maintenance and water use arrangements for the habitat areas constructed within the Kogarah Golf Course by the New M5 project are to be managed by CDSJV during construction and by the M5 Asset Trustee (or their delegate) during operation.</p> <p>External parties (Kogarah Golf Course, Bayside Council and Roads and Maritime) are to be consulted prior to implementing management actions, in particular application of herbicides or pesticides on the golf course or habitat enhancement areas.</p>	N/A	CDSJV M5 Asset Trustee	Project Manager M5AT Operational Contractor	Construction Operation
Reinstate golf course	At the completion of construction, reinstate habitat areas used for temporary construction areas on Kogarah Golf Course in consultation with Kogarah Golf Course. Disturbed areas are to be reinstated to a condition consistent to that prior to construction.	Kogarah Golf Course	CDSJV	Project Manager	Post-construction
Control threats to additional habitat areas	<p>Develop measures to reduce threats of Chytrid, Plague Minnow, noxious weeds and predation by feral cats and foxes.</p> <p>Additional habitat areas (ponds) constructed by the project will be drained or flooded as required. Ponds would be periodically drained and flooded as part of the management of these ponds in response to observations of Plague Minnow. Presence of</p>	Adjacent habitat area (Kogarah Golf Course)	CDSJV M5 Asset Trustee	Project Ecologist M5AT Operational Contractor	Construction Operation

Mitigation measure	Description	Where	Responsibility	Role	Timing
	<p>predatory fish should be monitored and if present, the ponds should be drained to kill these fish.</p> <p>Kogarah Golf Course is to be consulted with prior to CDSJV commencing any maintenance works on golf lands and are subject to agreement with the golf course.</p>				
Control threats in the RTA ponds	Implement the existing <i>Management Plan for the Green and Golden Bell Frogs (Litoria aurea) at Arncliffe</i> (White, 1998) measures to reduce threats of Chytrid, Plague Minnow, noxious weeds and predation by feral cats and foxes.	RTA ponds	Roads and Maritime	M5 East Asset Manager	Construction Operation
Frog under pass near cycleway (pending results of population monitoring)	<p>In the event that Green and Golden Bell Frogs are identified on the existing Eve Street cycleway during population monitoring, the Department of Planning and Environment (DP&E) requested a review of the feasibility and consideration of the installation of a frog underpass within the footprint of the cycleway.</p> <p>The project will review population monitoring results with regard to Green and Golden Bell Frog movement/mortality on the cycleway and will meet with DP&E, OEH and relevant specialists to discuss options and requirements for installing an underpass to improve connectivity.</p>	Eve St cycleway	Roads and Maritime	Project Herpetologist RMS New M5 Environment Manager	Construction Operation

Note: RMS' internal herpetologist will be engaged as required during the construction and operation of the project.

4.4.3 Habitat creation at Marsh St and the establishment of a captive breeding population

A new Green and Golden Bell Frog habitat comprising three new ponds will be created and managed for the species on Roads and Maritime land at Marsh Street, south of the M5 East Motorway (see Figure 4).

A Habitat Creation and Captive Breeding Plan (HCCBP) has been prepared in accordance with Condition B15 which:

- Details the results of further population surveys undertaken from October 2015 to February 2016 (refer to Section 3.3 of the HCCBP). The purpose of this survey was to improve the understanding of the population structure in the RTA ponds and adjacent habitat including the number, age, breeding status and sex ratio of the population.
- Details how a captive population would be established including the objectives of the program, details of the suitable conservation facility to host the animals, husbandry techniques, welfare protocols, hygiene protocols, collection and transportation protocols, duration of the program and final release proposals (refer to Section 3.8 of the HCCBP).
- Details how the new habitat will be prepared, populated and managed at Marsh Street. This includes arrangements to secure a suitable water supply to the facility, fencing and site security protocols, weed removal and site remediation. New breeding habitat would involve the construction of three ponds capable of being managed as frog habitat over the long term (refer to Section 2 of the HCCBP).
- Details the long-term management framework and monitoring protocols to apply to the ponds (refer to Section 2.6 and 4.1 of the HCCBP).

The breeding program adopts a leading practice approach to captive husbandry, disease control and maintenance of the genetic diversity of the population. The objective of the captive breeding program is to provide a level of security, especially for such a small population. For example, outcrossing with other populations would be considered if this would improve genetic and survival for the frogs.

The habitat creation and captive breeding plan was reviewed by two independent frog experts and their advice was considered in the finalisation of the plan.

The long term management of the captive breeding population and the associated habitat area at Marsh Street is governed through the implementation of the Habitat Creation and Captive Breeding Plan required by Condition B15 and this Plan of Management. Roads and Maritime will explore the option of a biobanking agreement (or similar) for the land in which the habitat area has been constructed as a mechanism for securing the future of the land in which the habitat area has been constructed.

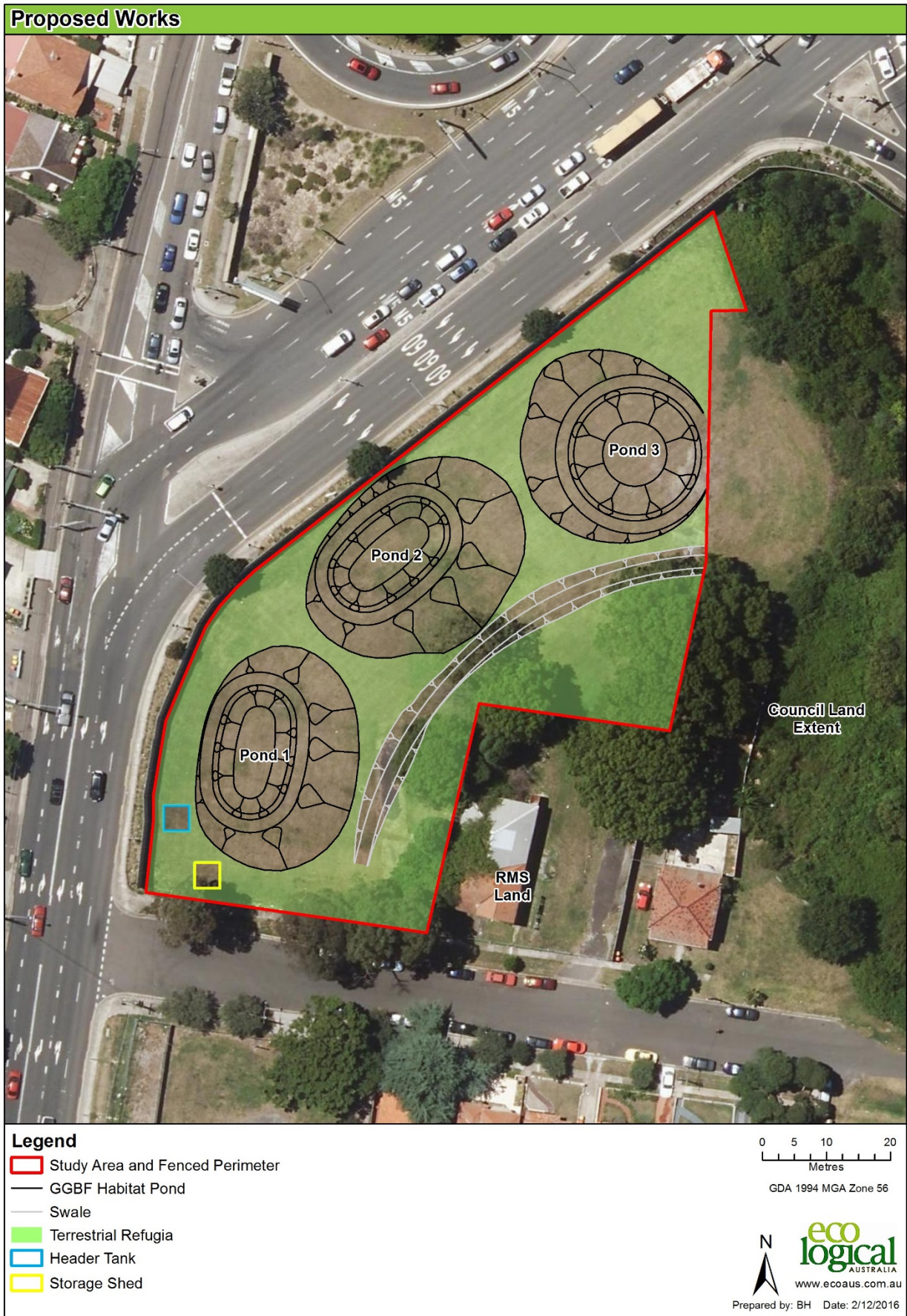


Figure 4: Area proposed for habitat at Marsh Street

5 Monitoring and Reporting

5.1 Monitoring implementation of mitigation strategies

A report detailing the implementation of the actions set out in Table 2 and Table 3 of this plan will be prepared by the contractor on a quarterly basis during construction. This report must be provided to OEH and DP&E.

The following is an outline of the adaptive monitoring program that will be undertaken to assess the effectiveness of the construction and operational mitigation measures for the Arncliffe population of the Green and Golden Bell Frog.

5.1.1 Monitoring effectiveness of management and mitigation measures during construction

A number of mitigation measures would be implemented during construction to minimise impacts to the Green and Golden Bell Frog Population at Arncliffe. These measures will be monitored to determine their effectiveness in managing these impacts. Table 4 outlines the monitoring program to assess the effectiveness of the mitigation measures during the construction period.

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Table 4: Monitoring requirements to assess effectiveness of mitigation measures during construction

Mitigation measure to be assessed	Element monitored	Where monitored	Frequency of monitoring	Who monitors	Threshold trigger	Action response
Frog exclusion fence	Fence integrity	Entire extent of frog exclusion zone construction zone, Arncliffe	Weekly	CDSJV	Damage to fence Fence breach	Fix fence within 24 hours of detection of damage Remedial action to be carried out by CDSJV
Control non-aquatic predator threat	Presence of vertebrate predators	Relevant areas in consultation with Project Herpetologist	Monthly	Project Herpetologist	Detect predators	Fix holes and / or damage to fence during construction Remove predators via appropriate method that limits harm to bell frogs If predators other than fox and cats are detected, other control measures would need to be considered. This must be done in consultation with OEH. Note: Bayside Council is responsible for managing pest control (i.e. foxes) on Kogarah Golf Course.
Maintenance of RTA ponds	Maintenance of RTA ponds	Within RTA ponds	In accordance with 1998 PoM	Roads and Maritime appointed herpetologist	Refer to 1998 PoM	RMS will act, monitor and report on actions within the RTA ponds in accordance with the requirements of the 1998 PoM.
Sediment and erosion control	Sediment and erosion fencing integrity	Construction zone and wherever control fences are located at the Arncliffe works	Weekly and following heavy rain events (i.e. over 20 mm)	Project Manager	Fence or control measures breached by runoff	Fix sediment and erosion controls within 24 hours of detection of breach.

Mitigation measure to be assessed	Element monitored	Where monitored	Frequency of monitoring	Who monitors	Threshold trigger	Action response
		area	within 24 hour period)			Remedial action to be carried out by CDSJV
Light spill control onto RTA ponds	Light reaching RTA ponds at night from construction zone sources	RTA Ponds	At first lighting and then during population monitoring (i.e. September to March)	Project Herpetologist	Light reaching pond from the construction zone	Project Herpetologist to advise on lighting effects at night

5.1.2 GGBF Population monitoring construction and operation

GGBF Population monitoring will be put in place to monitor any impacts of the project on frogs within the RTA and new Marsh Street habitat area and within adjacent habitats during the construction and operation of the project. The monitoring aims to assess the ongoing survival of the Arncliffe population at the Kogarah Golf Course and within the RTA ponds.

Table 5 outlines a number of areas to be monitored during construction and operation. Access to some of these areas must be agreed to by the landowners. The Project Herpetologist must seek letters of consent from all of the landowners. The letters must be passed to Roads and Maritime for consolidation and submission to M5 Asset Trustee and CDSJV.

The GGBF population monitoring methodology has been revised based on advice provided by Dr Arthur White and endorsed by Prof. Michael Mahony. The monitoring methodology is consistent to that detailed in Section 4.1 of the Habitat Creation and Captive Breeding Program. This helps ensure consistency in approach for the monitoring for the new Marsh Street habitat area and the wider habitat area, particularly during operation of the habitat area.

RMS' internal herpetologist will provide input and review of monitoring results during construction and operation.

Construction

The population monitoring must occur at the RTA ponds and the areas outside of the construction area during the construction of the Project.

Monitoring of the GGBF population within the RTA ponds and suitable areas outside the construction area would be undertaken during construction by a suitably qualified Project Herpetologist engaged by Roads and Maritime. A minimum of four surveys would be undertaken per month between September and May each year during the construction period. These surveys are to be opportunistic and undertaken during favourable climatic conditions. In accordance with the *Survey Guidelines for Australia's Threatened Frogs* (DEWHA 2010), small wetlands (<50 metres at greatest length) would be covered in a period of about one hour. Banks and emergent vegetation will also be searched.

The initial areas outside the construction area that would be monitored include the Kogarah Golf Course, the Kogarah Golf Course habitat enhancement areas, the new Marsh Street habitat area and nearby suitable areas within an approximate radius of 2 kilometres. This will give a more useful indication of GGBF distribution and habitat use within the locality. In early 2017, this initial area was extended to include wetlands at the northern end of Barton Park (North Barton Park, Spring Creek wetland and the Landing Lights wetland).

The GGBF surveys will still be mark/recapture based so that a population estimate is still possible using the Peterson/Lincoln Index, and to track the movement of marked individuals.

Tadpole surveys would be undertaken each month between September and May at sites where GGBFs have been detected and sufficient water is present for breeding to occur. Long-handled sampling nets and/or tadpole traps would be used to detect tadpoles. Any tadpoles captured will be measured, staged (using standard staging in Gosner (1960)), identified (using Anstis 2013) and released.

All frog surveys would be carried out in accordance with the Hygiene protocol for the control of disease in frogs (DECC 2008b) to minimise the spread of Chytrid disease.

All captured Green and Golden Bell Frogs would be measured, weighed, sexed and inspected for reproductive condition and signs of illness or injury. Frogs larger than 40 millimetres snout-vent length would be micro-chipped. This will be undertaken by an appropriately licenced herpetologist with ethics approval to undertake the above procedures. The frogs would then be released at point of capture.

Table 5 provides further details about monitoring procedures.

Monitoring can commence at the new Marsh Street habitat area once it has been created and tadpoles or metamorphs are introduced to this habitat area. Monitoring will be consistent with the RTA ponds and if higher densities of GGBFs are found, the Pollock’s robust design could be implemented. Monitoring of other suitable frog habitat in the vicinity of the Marsh Street frog habitat area will be considered and discussed with the Herpetologist following the completion of construction.

Operation

The population monitoring must occur at the Marsh Street habitat area (and at the RTA ponds if captive bred frogs are released) in accordance with Section 4.1 of the HCCBP and until such time as the use and effectiveness of the proposed mitigation measures can be demonstrated to have been achieved over a minimum of three generations of frogs (as required by Condition B14(a)(ii)).

Monitoring of the population within the RTA ponds would be undertaken by a Herpetologist engaged by Roads and Maritime and managed separate to the project. Monitoring of the population within the Marsh Street habitat area and outside of the construction area would be undertaken by a Project Herpetologist engaged by either Roads and Maritime or the M5 Asset Trustee (the same herpetologist may be engaged by both parties).

The population monitoring methodology would follow that described during construction.

All captured Green and Golden Bell Frogs would be measured, weighed, sexed and inspected for reproductive condition and signs of illness or injury. Frogs larger than 40 millimetres snout-vent length would be micro-chipped. The frogs would then be released at point of capture, or unless otherwise advised by the Herpetologist.

Table 5: Population monitoring and corrective actions for Green and Golden Bell Frog at Arncliffe during construction and operation

What monitored	How monitored	Where	Who monitors	Trigger threshold	Remedial action
Green and Golden Bell Frog population	Mark and recapture, use Peterson/Lincoln index, collect physical data. See section 5.1.2 for details	<p>RTA Ponds</p> <p>New Frog Habitat at Marsh Street (once established)</p> <p>Habitat enhancement area on Kogarah Golf Course</p> <p>Kogarah Golf Course</p> <p>North Barton Park wetlands including Spring Creek wetland and Landing Lights wetlands</p> <p>Other suitable frog habitat areas as discussed with Project Herpetologist</p>	Project Herpetologist	If in the opinion of the Project Herpetologist the situation is declining significantly as population estimate is already low	<p>Assess whether food supply is sufficient at Marsh Street habitat area; if not, introduce or increase food supply via compost bins as per HCCBP.</p> <p>Assess whether predation by <i>Gambusia</i> or other vertebrate pests is occurring; remediate as per Table 4.</p> <p>Assess whether decline is due to chytrid via standard chytrid assessment methods; remediate as per Table 4.</p> <p>Consider further habitat enhancement measures.</p> <p>Remediation of habitat enhancement areas.</p> <p>Introduce stock from captive breeding program to Marsh or RTA ponds (following advice from Project Herpetologist).</p> <p>Initiate translocation of tadpoles to Marsh Street habitat area.</p>
Tadpole presence to indicate successful breeding (Note: other factors such as calling males	The Marsh habitat area would be sampled each month between September and May in	<p>Marsh Street habitat area</p> <p>RTA ponds</p> <p>Other habitat areas where evidence of breeding is</p>	Project Herpetologist	No tadpoles present	<p>Assess whether predation by <i>Gambusia</i> is occurring; remediate as per Table 4.</p> <p>Release tadpoles with hind limb buds from the captive colony into</p>

What monitored	How monitored	Where	Who monitors	Trigger threshold	Remedial action
and gravid females may indicate successful breeding)	accordance with section 5.1.2. The RTA ponds will be sampled in accordance with the M5 East 1998 POM.	noted.			Marsh St habitat area or RTA ponds where determined appropriate. Release tadpoles only on advice from Project Herpetologist Test water quality, assess presence of other predators/competition by conspecifics (eg Striped Marsh Frogs)
Green and Golden Bell Frog use of Eve Street cycleway	Visual inspection during population monitoring	Eve Street cycleway	Project Herpetologist	Presence of Green and Golden Bell frogs on cycleway	Review requirements for frog underpass in consultation with DP&E, OEH and frog specialists. Installation (where required) of frog underpass within Eve Street cycleway

5.1.3 Population performance criteria during construction and operation

Table 5 outlines the performance criteria against which the ongoing survival of the Arncliffe population at the Kogarah Golf Course would be measured, details of contingency measures and corrective actions that would be implemented in the event of reductions in population numbers.

The performance criteria for the population at Arncliffe consist of two foci:

- That the population size estimate does not decline significantly (in the opinion of the project herpetologist) beyond the current population size
- That there is successful annual breeding at the existing habitat (including RTA ponds) during spring-summer for each year the works are in place.

5.1.4 Goals and performance indicators for mitigation measures

Table 4 outlines the performance indicators for the mitigation measures. For each measure, the method of monitoring, the timing or frequency, the responsibility has also been presented. The table includes remedial actions and the trigger thresholds for each measure.

The goals for the mitigation measures for the Marsh Street habitat area are detailed below. Goals for the RTA ponds are detailed in the M5 East Plan of Management.

- The frog exclusion fence is to be intact during the entire period of construction works
- Non-aquatic predators are not present in the Marsh Street habitat area or new frog habitat areas. Note predator management within the RTA ponds is managed separately to the project by the M5 East Asset Manager and/or Bayside Council.
- Sediment and erosion has been controlled so that it does not impact on the Marsh Street habitat area, the enhanced habitat area or any frog habitat area outside the construction zone
- Light spill onto frog habitat areas (including the RTA ponds) from the construction zone is controlled so that the known habitat areas are not impacted by construction zone light during the night
- The new Marsh Street habitat area is maintained to manage the presence of *Gambusia holbrooki* to the extent they are not present
- The new Marsh Street habitat area is maintained to manage the presence of chytrid in the Green and Golden Bell Frog population
- That dust from the construction zone does not impact known frog habitat areas.

5.1.5 Contingency measures and corrective actions for declines in the frog population

Table 5 outlines the corrective actions to be taken in the event that the population declines beyond the current size estimate. An insurance population has been established as a captive colony as outlined in the Habitat Creation and Captive Breeding Plan. The release of progeny from the captive population would be predicated on an assessment of the capacity of the Marsh Street habitat area (and where deemed appropriate, the RTA ponds) to accommodate these tadpoles.

Release of tadpoles from the captive colony is to be managed in accordance with the Habitat Creation and Captive Breeding Plan (refer to Section 3.8.6). Relevant factors including abundance of food, water quality, presence of non-aquatic vertebrate and aquatic predators and evidence of Chytrid will be taken into account prior to release.

5.2 Evidence of consultation with OEH

This plan of management has been reviewed by OEH. Ongoing discussions with OEH will be required throughout the project. Evidence can be found at Appendix B.

5.3 Review of Plan of Management

This plan of management must be reviewed annually. The review must be conducted after the population monitoring has been completed and after population size at the RTA ponds and Kogarah Golf Course has been estimated. The annual review must be carried out in consultation with relevant agencies (OEH, DP&E and Roads and Maritime) with input from independent frog expert(s) where required.

Information included in the review will include monitoring results, details of any corrective actions and details of any action or activity carried out to increase the security of the population at Arncliffe.

The plan must be amended if the review indicates that elements of the plan require updating. These should reflect the effectiveness of mitigation and the ongoing survival of the population at Arncliffe.

5.4 Annual reporting of monitoring

Results of the monitoring, review and any amendments must be reported annually to the Secretary of the Department of Planning and Environment and provided to OEH. This should be done after the monitoring results have informed the next iteration of the plan; the plan has been reviewed and amended. The monitoring results should be published on the project website.

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Appendix A Unanticipated find procedure

- Step One: Frogs observed during course of construction
- Step Two: STOP WORK IMMEDIATELY in the vicinity of the sighting and notify your supervisor. Try to photograph the frog to assist in confirmation of species. DO NOT recommence work until directed by the approved Environmental Representative.
- Step Three: Supervisor to immediately notify the Environmental Manager
- Step Four: Environmental Manager to inform:
 - Project Director
 - Construction Manager
 - Environmental Representative (ER)(engaged CDS)
 - Roads and Maritime Environment Manager
 - Project Herpetologist (PH)(engaged by CDS, with direct experience in Green and Golden Bell Frog)
- Step Five: CDS Project Ecologist or CDS Environmental Representative place frog in re-sealable plastic bag or clean holding container. Pour approximately 5 – 10 mm bottled spring water into bag or container. PH to transport container / bag to site office and commence assessing the health of the frog. Details to be taken (e.g. lifecycle stage, sex, location and date where found, tag number, weight, snout-vent-length). Frogs larger than 40 millimetres snout-vent length to be micro-chipped by PH if not already tagged.
- Step Six: If frogs are detected between winter and spring, they should be checked for over-winter activity. If frogs are in torpor, they must not be released. Over-wintering frogs should be retained in an approved over-winter facility or be included in the captive breeding colony (Symbio Zoo). If frogs are detected between spring and autumn, they should be released by the PH in the Marsh Street habitat area (if this area is available and suitable) or RTA ponds (where deemed appropriate).
- Step Seven: PH and ER declare works 'okay' to re-commence.

Appendix B Consultation with OEH

The following is a tabulated account of consultation with OEH during the process of updating the Plan of Management.

Consultation details	Date and time
Initial phone call with [REDACTED] from OEH to explain process and timeframes	19/4/16 1.01pm
Email received from Ray Giddins outlining initial points for consideration at meeting planned for 20/4/16	19/4/16 4.12pm
Meeting held with [REDACTED] (OEH) and [REDACTED] (ELA) to discuss updates to GGBF plan and expectations regarding amendments	20/4/16 8.30am
[REDACTED] provided first draft of updated Plan of Management to SMC and [REDACTED] for comment	20/4/16 3.44pm
[REDACTED] provided comment on updated Plan of Management (see note below)	20/4/16 4.39pm
[REDACTED] issued final Plan of Management with OEH and SMC comments incorporated	22/4/16

[REDACTED] provided the following feedback on the updated Plan of Management in the form of an email on 20/4/16 4.39pm:

1. Added a row to Table 3.

Maintain RTA ponds	Noticeable presence or increase in dust	RTA ponds and exclusion zone	Weekly	Project ecologist	The opinion of the project ecologist is that the level of dust may be affecting GGBF	Review dust suppression measures with....
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2. Corrected typographical errors in sections 5.1 and 5.2.

RMS accepted all of the changes made by [REDACTED].

Upon reviewing his changes on the following draft, [REDACTED] stated in an email on 22/4/16 at 11.38am that 'All of the additions we've discussed this week are in the document to my satisfaction.'

Appendix C Hygiene protocol – Murray et al 2011

Appendix D Consultation with DP&E

Report name	Ecological Australia Green and Golden Bell Frog Plan of Management Arncliffe (GGBFPOM) April 2016		
Agency	Department of Planning and Environment		
Date	29/04/2016		
Comment number	Document section/Ref CoA	DP&E Comment	Reference in PoM
1.	Section 2.1	This section states that under the TSC Act, public authorities must not make decisions that are inconsistent with the provisions of the draft species Recovery Plan. The GGBFPOM must provide details of how the POM addresses the provisions of the GGBF Recovery Plan.	Section 2.1
2.	Section 3	This section must provide details of the Arncliffe GGBF population (RTA ponds) and its environment, to follow section 3.3.1.	New section 3.3.2
3.	Section 4.1	Add the following potential indirect impact to the RTA ponds – introduction of frog pathogen by construction personnel and construction equipment and machinery.	Section 4.1
4.	Section 4.2	The discussion of GGBF habitat includes dispersal habitat. A frog passage was provided beneath the M5 East Motorway to facilitate movement between the golf course and habitat to the west and south (Eve and Marsh Street wetlands). Details of the frog passage (size, length, etc) should be provided and the location of the passage shown in Figure 1.	Section 4.2; figure 1
5.	Table 1	The proposed mitigation measures include the provision of fencing to exclude frogs from construction areas, noise wall fence adjacent to the RTA ponds and frog exclusion fencing around the construction zone. The POM must provide details of the fencing and how it would be installed.	New Table 2 and Figure 3
6.	Table 1	The mitigation measures include pre-clearance survey and salvage. Details are provided of measures to handle frogs should they be encountered. The POM states that water bodies will need to be decommissioned prior to work commencing. Frogs encountered during decommissioning would be collected in accordance with the process described in Table 1. However, no details are provided on how tadpoles encountered would be handled. Details of the handling of tadpoles encountered during water body decommissioning must be provided.	New Table 2

Report name	Ecological Australia Green and Golden Bell Frog Plan of Management Arncliffe (GGBFPOM) April 2016		
Agency	Department of Planning and Environment		
Date	29/04//2016		
Comment number	Document section/Ref CoA	DP&E Comment	Reference in PoM
7.	Table 2	The Hygiene Protocol must be included in the POM. The introduction of frog pathogens, in particular Chytrid fungus is identified as a key threatening process leading to the decline of the GGBF. The measures to prevent/address the introduction of the pathogen to the GGBF must be included in the POM and not developed separate to and outside the POM.	Table 3 and Appendix C
8.	Table 2	Details of the management measures to maintain the RTA ponds must be provided in the POM. This includes details of the water supply, water level management and salt water supply.	Table 3
9.	Table 2	Details of measures to reduce predatory fish, noxious weeds and predation by cats, rats and foxes must be provided in the POM.	Table 3
10.	Section 5.1	The quarterly report on the implementation of the actions in Table 1 and 2, during construction, must be provided to DPE and OEH.	Section 5.1
11.	Table 3	The monitoring requirements do not include monitoring of the water quality of the existing RTA ponds. The POM must provide details of water quality monitoring.	Table 3
12.	Section 5.1.2	Population monitoring must be undertaken at the new habitat at Marsh Street following its occupation by frogs.	Table 4
13.	Table 4	Monitoring would be established in accordance with Pollocks Robust Design and monitoring data analysed using MARK. The POM must provide details of this methodology and the suitability of these for determining the population status of the GGBF. Population monitoring must include the existing Marsh Street and Eve Street wetlands.	Section 5.1.2
14.	Table 4	The Department considers that monitoring of the frog passageway beneath the M5 East Motorway must be included in population monitoring. This would inform the current usage of the underpass (it is understood the passage was last monitored in 2007). Once the new habitat was created at Marsh	Section 5.1.2

Report name	Ecological Australia Green and Golden Bell Frog Plan of Management Arncliffe (GGBFPOM)		
Agency	Department of Planning and Environment		
Date	29/04//2016		
Comment number	Document section/Ref CoA	DP&E Comment	Reference in PoM
		Street and the ponds populated by frogs, the passage would become more important in east west movements between the new habitat and the Kogarah Golf Course. Should monitoring show the passage is not being used, then actions to improve accessibility to the underpass would need to be considered, including the provision of new connectivity. The monitoring must include the Eve Street cycleway.	
15.	Section 5.1.4	Include the following as a goal for mitigation – no frog mortality on the Eve Street cycleway underpass of the M5 East Motorway. Once the new March Street habitat is created and occupied, movement between the new ponds and the Kogarah Golf Course would be expected to occur, given there is very limited foraging habitat on the western side of the M5 East Motorway. Anecdotal evidence has been cited that frogs use the cycleway. Given that the cycleway is a hostile environment for frogs, measures to provide suitable frog movement must be considered in the event of frog on the cycleway.	New Table 3 Section 5.1.4
16.	Section 5.4	The annual monitoring reports must be provided to OEH.	Section 5.4
17.	Appendix A	Unanticipated finds procedure – the procedure makes a number of references to the approved Environmental Representative (ER), the Roads and Maritime Environmental Representative and the Environmental Representative. Is the RMS ER and the approved ER separate positions? Is the approved ER and the ER the ER under condition D1 of the approval?	Appendix A
18.	Appendix A	Step six states frogs detected should be released by the Project Ecologist the Taronga Zoo – this position should be clarified. Is the project ecologist an employee of the Taronga Zoo. Is the project ecologist the position created by the Contractor or a RMS ecologist? Does the project ecologist have expertise in the handling of the GGBF?	Appendix A
19.	Appendix B	The consultation with OEH must include comments made by OEH on the POM and how RMS has responded to the issues raised.	Appendix B

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