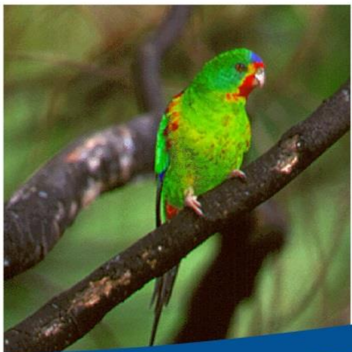
Green and Golden Frog (*Litoria raniformis*)

Management Guideline



Department of State Growth

Tasmanian Government

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Purpose of Document

***"State Roads will acknowledge and proactively limit disturbance of natural and cultural heritage values"*: State Roads Policy Statement.**

The aim of this document is to provide guidance on the management of impacts on the green and golden frog (*Litoria raniformis*), listed under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) and *Tasmanian Threatened Species Protection Act 1995* (TSPA), throughout the lifecycle of road infrastructure projects in Tasmania to ensure impacts on green and golden frogs and their habitat are minimised.

Road infrastructure projects can be large developments which have the potential to impact on the natural environment, including aquatic and terrestrial habitats, and their associated flora and fauna. Concomitant with the requirement for new and safer roads, there has been a growing awareness of the need to incorporate specific design and management measures into infrastructure developments to conserve and protect Tasmanian natural heritage and biodiversity.

The objective is to avoid impacts where possible, however when impacts on species specific habitat are unavoidable, a variety of measures can be introduced to reduce and remedy these impacts. Principles and general guidance with regard to the consideration, management and enhancement measures are presented in this document. The Department of State Growth are committed to providing 'best environmental practice' for any activities that have a potential to impact on biodiversity conservation. The development of these guidelines forms part of this commitment.

This guideline is designed to provide general information as well as management information for the green and golden frog; it has been aimed specifically at State Growth employees, but may also be used for information by a wider audience (local government, forest industry, mining and quarrying sector, agricultural sector, forestry sector and environmental consultants). It is intended that those who use this guideline document also receive training for green and golden frog management.

The guideline has been designed to provide management and decision making tools for each of the key phases of the road design and construction process (Figure 1).

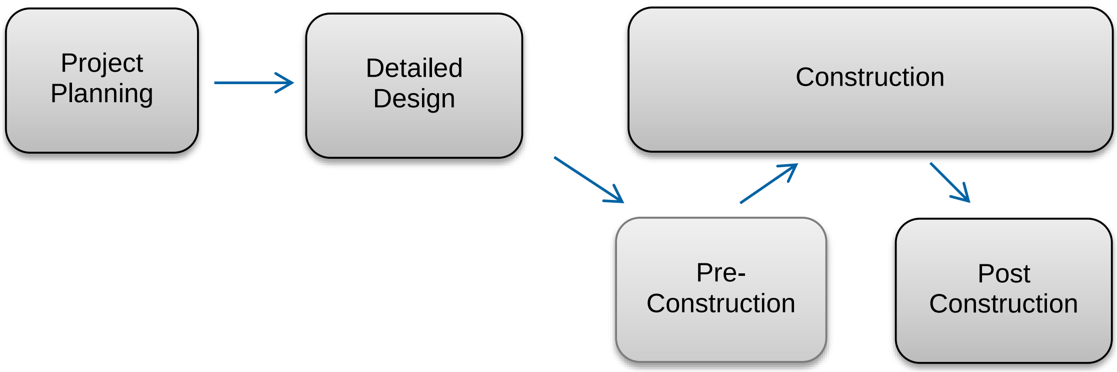


Figure 1 Key phases of the road design and construction process

1.1 How to use this guideline document

Section 2 provides an overview of the range boundaries and habitat requirements for the species, including a definition of potential habitat.

Section 3 of this document outlines the Commonwealth and State legislative requirements to manage the species.

Section 4 provides guidance on how to manage the species during the planning phase of road infrastructure projects.

Section 5 provides guidance on how to manage the species during the detailed design phase of road infrastructure projects.

Section 6 provides guidance on how to manage the species during the pre-construction phase of road infrastructure projects.

Section 7 provides guidance on how to manage the species during the construction phase of road infrastructure projects.

Section 8 provides guidance on how to manage the species during the post construction phase of road infrastructure projects.

Section 9 provides a list of references used in this document, and a reference list for further reading.

Table of contents

Table index

Figure index

2. Introduction

2.1 Description of species

Litoria raniformis is a large aquatic frog found across the southeastern Australian mainland and Tasmania. This species' common names vary between states; the name 'southern bell frog' applies to New South Wales, 'growling grass frog' in Victoria and South Australia, and 'green and golden frog' in Tasmania. For the purpose of this report, *Litoria raniformis* is referred to as the 'green and golden frog' herein.

Commonly reaching a length of up to 80 mm and weighing up to 40 g, its colouration can vary considerably from almost totally green, through green and golden mottling, to very dark brown and black patterning. However despite this, all colour types have a pale green stripe down the middle of the back and turquoise thigh colouration in adults (Plate 1).

Plate 1 Example of green and golden frog colour variation

Green and golden frogs are active during both day and night throughout the warmer months and can sometimes be seen ‘basking’ out of water; it is the only Tasmanian frog to exhibit this behaviour.

The breeding season in Tasmania spans November to March when males can be heard calling. Calling activity can be erratic, often being restricted to warm calm days and evenings. Choruses (many males calling) often reach peaks during mid-morning and early evening. In breeding condition, the male frog exhibits a mottled black throat and develops black nuptial pads (hard calluses) on the back of each thumb with which he grasps the female when mating.

Green and golden frogs hunt and take refuge in dense patches of vegetation, rarely venturing into open water. They have a varied diet, which includes insects, lizards, and other frogs.

2.2 Distribution

The green and golden frog is dependent upon permanent freshwater lagoons for breeding. Ideal breeding habitat is the shallow part of lagoons (to approximately 1.5 m) where there is generally a complex vegetation structure.

The green and golden frog is a highly mobile species, capable of moving up to one kilometre in 24 hours (NSW DEC, 2005). Research suggests that in areas other than the semi-arid/riverine part of the species' range, there are interactions between neighbouring populations (Clemann and Gillespie, 2004).

When the green and golden frog is restricted to small, permanent waterbodies, dispersal is low indicating high levels of site fidelity with individuals tending to move shorter distances.

When occupying ephemeral waterbodies, the green and golden frog has significantly higher levels of dispersal, indicating lower site fidelity, with individuals moving large distances (Wassens, 2005).

The range of the green and golden frog in Tasmania is restricted to lowland areas, mainly in coastal zones with the exception of the Deloraine – Longford – Launceston region, and historically it was common in the Midlands region (Figure 2) (Threatened Species Section, 2015).

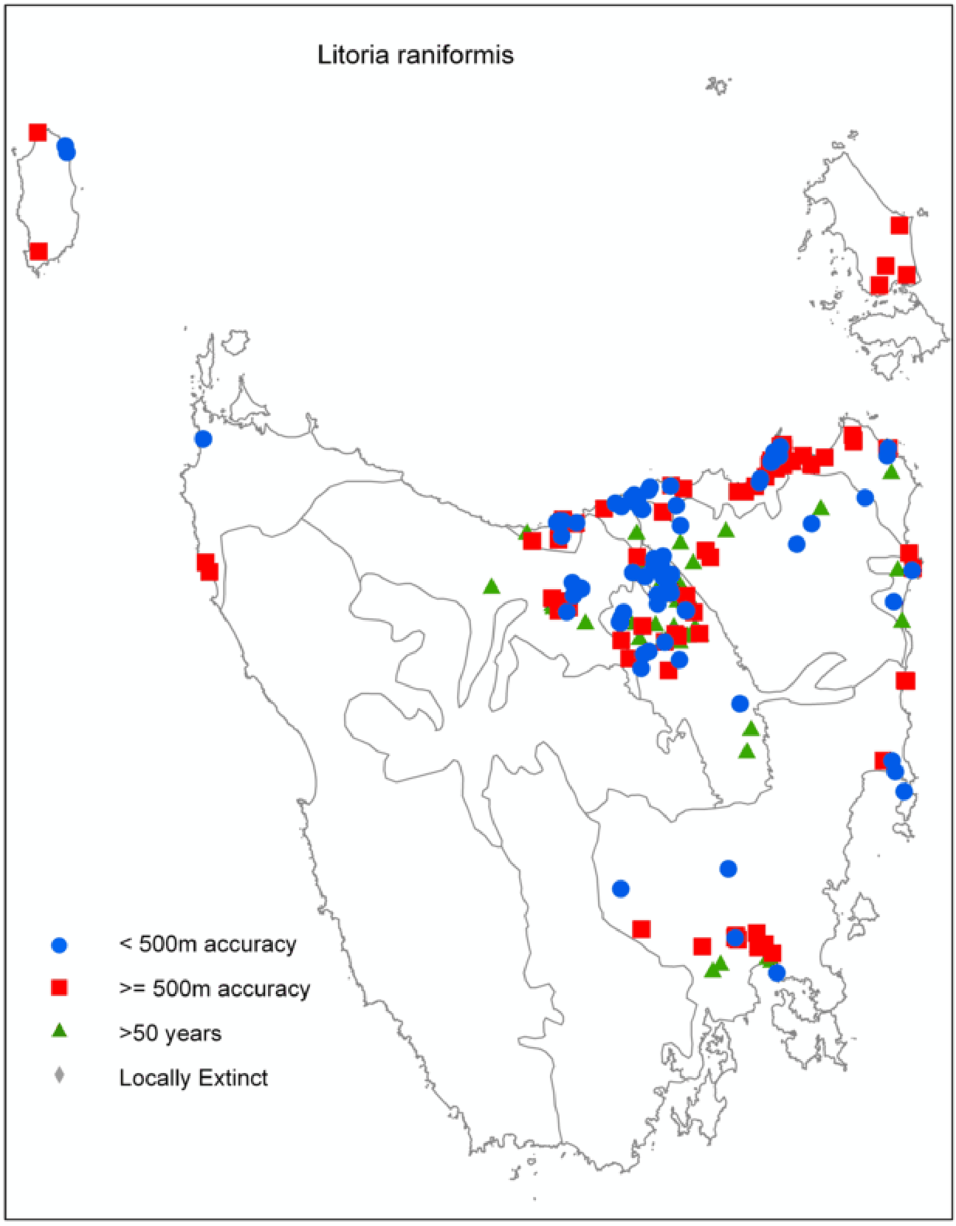


Figure 2 Distribution of green and golden frog in Tasmania (Threatened Species Link)

2.3 Habitat

The green and golden frog can colonise, use and survive in a wide range of habitats, including highly modified sites such as disused industrial areas. The frog requires different habitat during different parts of its life cycle, including habitat for:

- Breeding;
- Foraging;
- Refuge; and
- Movement.

2.3.1 Breeding habitat

The green and golden frog breeds in and around a wide variety of water bodies. These range in size from large freshwater and estuarine lakes to small temporary pools and depressions.

The species has been recorded in coastal swamps, marshes, dune swales, lagoons, lakes and other estuary wetlands as well as around riverine floodplain wetlands, billabongs and ponds in slow flowing or ephemeral streams.

Constructed water bodies such as stormwater retention basins, farm dams, areas bunded by earthworks and by road or rail structures, drains, ditches and other excavated areas that can capture water (including quarries and brick pits) have been used as breeding habitat. Smaller or less obvious structures have also been observed in use, such as water tanks, bunded safety areas surrounding industrial chemical storage areas, wells, irrigation pits, water troughs, laundry tubs and old bath tubs.

The ideal breeding habitat is the shallow part of lagoons (up to approximately 1.5 m deep) where there is generally a complex vegetation structure. Breeding sites in Tasmania often contain vegetation communities dominated by emergent plants such as waterribbon (*Cycnogeton, formerly Triglochin*) and spikesedge (*Eleocharis*) and submerged plants such as watermilfoil (*Myriophyllum*), running marshflower (O*rnduffia raniformis*), erect marshflower (*Liparopyllum exaltatum*) and pondweed (*Potamogeton*). However, other plant communities can form equally suitable habitat (Threatened Species Section 2015).

2.3.2 Foraging habitat

The preferred foraging habitat of the green and golden frog generally contains flowering plants, grasses and foliage. Plants that form tussocks provide foraging habitat and shelter. This vegetation may be near breeding habitat sites or some considerable distance away. Frogs can be found up to 500 m from the nearest waterbody.

2.3.3 Refuge habitat

Refuge habitat contains areas in which the frog can escape from dangers such as predation or fire, and can retreat to in order to avoid climatic extremes for short periods. Refuge habitat can also include sites where individuals might shelter over winter and spend extended periods during cooler months in an inactive state.

The frog may also be found at times amongst human refuse, including dumped building materials, which substitute for natural shelter. These can include piles of sheet iron, fibro, concrete and bricks. When unfavourable conditions occur in the natural environment, these shelter sites may be occupied by many green and golden frogs.

The green and golden frog is frequently found basking on grassy banks near water (Courtice & Grigg 1975). During winter it is through to hibernate in warm, moist areas such as the mud at the bottom of ponds, under logs, rocks and debris or beneath thick vegetation (Department of the Environment, 2015).

2.3.4 Connectivity habitat

Connectivity habitat enables frogs to move between areas of habitat at different times of the year. It also allows for interaction between frogs from different populations to allow genetic diversification. Connectivity habitat generally includes:

- Wet areas such as river banks or wetlands;
- Drainage lines;
- Stormwater culverts;
- Swales;
- Periodically damp areas;
- Connecting or partially connecting areas of vegetation the frog prefers;
- Easements;
- Laneways; or
- Grassy open areas.

2.4 Threats

There are a number of threats to the ongoing conservation of the green and golden frog. The key issues listed by the *Species Profile and Threats Database* (Department of the Environment, 2015) include:

- Habitat loss and fragmentation;
- Habitat degradation;
- Altered flooding regimes;
- Disease;
- Drought;
- Road kills; and
- Application of agricultural chemicals, including fertilisers.

2.4.1 Habitat loss and fragmentation

Habitat loss and fragmentation are considered to be the primary threat to green and golden frog populations. The draining and infilling or flooding of permanent and non-permanent wetlands plus their adjoining watercourses and vegetation removes critical connectivity corridors, refuge and breeding habitat and displaces the species from their natural habitat. Over-grazing by cattle has the capacity to reduce vegetation cover which may impact upon green and golden frog populations as the species preferentially occupies habitats with a high percentage of aquatic and fringing vegetation cover (Wassens, 2005).

2.4.2 Habitat degradation

Overgrazing by livestock around margins of wetlands disturbs essential habitat by destroying surrounding vegetation and affecting the quality of the water (Jansen & Healey 2003; Tyler 1993). The removal of aquatic vegetation destroys refuge habitat and shelter for tadpoles. Clearing of terrestrial vegetation, fallen logs and ground debris surrounding wetlands removes essential habitat (NSW DEC, 2005). Dredging to remove aquatic vegetation, spraying or burning vegetation along the edges of waterways is likely to be an important factor in limiting the distribution of the green and golden frog in an irrigated landscape (Wassens et al 2008).

2.4.3 Altered flooding regimes

The number of potential breeding sites for the green and golden frog along natural drainage systems has been reduced over time through local changes in land contours as a result of anthropogenic activities such as the drainage and infilling of wetlands, alteration of river flow and diversion of surface flow for residential and industrial developments. (NSW DEC, 2005). Local extinctions of populations have also occurred in wetland systems that have been converted to permanent water storages (Wassens 2005).

2.4.4 Disease

Chytrid fungus, a water-borne pathogen responsible for the Chytridiomycosis (an infectious disease which affects amphibians worldwide), is widespread in frog populations in eastern Australia and has been detected in some green and golden frog populations (Voyles et al., 2014). Chytridiomycosis disease is believed to be a significant cause of death in some frog species and is also found in a small proportion of apparently healthy frogs and tadpoles (Voyles et al., 2014).

Chytrid fungus was first diagnosed in Tasmania in a captive bred frog at the Animal Health Laboratories (AHL), Launceston in 1993 (AHL records) and in wild amphibian populations in 2004. Chytrid fungus has now spread across much of Tasmania, particularly to areas associated with human activities and habitation.

The construction of road infrastructure has the potential to introduce and/or spread chytrid fungus though the movement of water, mud and other moist substrates transported by machinery, equipment and clothing.

2.4.5 Drought

Long periods of drought may act in combination with other threats to cause declines in green and golden frog populations. In the Southern Tablelands of NSW, the decline of the species coincided with a series of severe droughts between 1978 and 1980 (Osborne et al., 1996). This is thought to be due to the fact that the species has a very narrow window of opportunity for breeding and any stochastic event (i.e. drought) that prevents animals from breeding for more than a year is likely to have profound detrimental effects on populations (Mann et al., 2010).

2.4.6 Road kills

Green and golden frogs frequently cross roads, particularly in areas where occupied habitats are located adjacent to roads and major highways, therefore road kills of this species may have a significant impact on green and golden frog populations (NSW DEC, 2005a).

Road impacts on Australian frogs are poorly documented, however a study completed by Goldingay and Taylor (2006) ear Lennox Head (NSW) found that over 13 survey mornings of known frog habitat, more than 1000 dead frogs were counted along two 100 m road sections. Extrapolated out, they estimated that in an average summer period, there would be over 40,000 frogs killed on the four km span of road through the surveyed habitat.

2.4.7 Application of agricultural chemicals, including fertilisers

Herbicides, insecticides or other such chemical substances that may be introduced inadvertently or intentionally into the species' habitat may be lethal to both adult frogs and tadpoles (Ehmann and White, 1997; Robertson et al., 1994). Because this species has a semi-aquatic lifestyle and semi-permeable epidermis that is used for gas exchange with the environment, it is particularly susceptible to toxins. Toxic compounds in various biocides have been demonstrated to cause death, morbidity and/or abnormalities in many frog species (Mann and Bidwell, 1999; Tyler, 1989).

3. Legislative Requirements

Outlined below are the legislation, processes and policies relating to green and golden frog management that are relevant to road maintenance, modification and construction.

3.1 Commonwealth

Under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* an action will require approval from the minister if the action has, will have, or is likely to have, a significant impact on a matter of national environmental significance.

Matters of national environmental significance considered under the EPBCA include:

- listed threatened species and communities
- listed migratory species;
- Ramsar wetlands of international importance;
- Commonwealth marine environment;
- world heritage properties;
- national heritage places;
- the Great Barrier Reef Marine Park;
- nuclear actions; and
- a water resource, in relation to coal seam gas development and large coal mining development.

The Commonwealth Department of the Environment provides a policy statement titled *Matters of National Environmental Significance: Significant Impact Guidelines 1.1* (Commonwealth of Australia (CofA) 2013, herein the *Guidelines*), which provides overarching guidance on determining whether an action is likely to have a significant impact on a matter protected under the EPBCA.

The *Guidelines* define a **significant impact** as:

"…an impact which is important, notable, or of consequence, having regard to its context or intensity. Whether or not an action is likely to have a significant impact depends upon the sensitivity, value, and quality of the environment which is impacted, and upon the intensity, duration, magnitude and geographic extent of the impacts"

and note that:

*"…all of these factors [need to be considered] when determining whether an action is **likely** to have a significant impact on matters of national environmental significance".*

The *Guidelines* provide advice on when a significant impact may be **likely**:

"To be 'likely', it is not necessary for a significant impact to have a greater than 50% chance of happening; it is sufficient if a significant impact on the environment is a real or not remote chance or possibility.

If there is scientific uncertainty about the impacts of your action and potential impacts are serious or irreversible, the precautionary principle is applicable. Accordingly, a lack of scientific certainty about the potential impacts of an action will not itself justify a decision that the action is not likely to have a significant impact on the environment".

The following steps and matters are recommended under the *Guidelines* to determine whether a referral under the EPBCA is required.

1. *Are there any matters of national environmental significance located in the area of the proposed action (noting that 'the area of the proposed action' is broader than the immediate location where the action is undertaken; consider also whether there are any matters of national environmental significance adjacent to or downstream from the immediate location that may potentially be impacted)?*
2. *Considering the proposed action at its broadest scope (that is, considering all stages and components of the action, and all related activities and infrastructure), is there potential for impacts, including indirect impacts, on matters of national environmental significance?*
3. *Are there any proposed measures to avoid or reduce impacts on matters of national environmental significance (and if so, is the effectiveness of these measures certain enough to reduce the level of impact below the 'significant impact' threshold)?*
   i) *The Guidelines also state:*
   ii) *However you should not conclude that a significant impact is not likely to occur because of management or mitigation measures unless the effectiveness of those measures is well-established (for example through demonstrated application, studies or surveys) and there is a high degree of certainty about the avoidance of impacts or the extent to which impacts will be reduced.*
4. *Are any impacts of the proposed action on matters of national environmental significance likely to be significant impacts (important, notable, or of consequence, having regard to their context or intensity)?*

The *Guidelines* provide a set of Significant Impact Criteria, which are *"intended to assist…in determining whether the impacts of [the] proposed action on any matter of national environmental significance are likely to be significant impacts".* It is noted that the criteria are *"intended to provide general guidance on the types of actions that will require approval and the types of actions that will not require approval [and]…not intended to be exhaustive or definitive"*.

In relation to species listed as Vulnerable, the definition of an **important** population is:

"An 'important population' is a population that is necessary for a species' long-term survival and recovery. This may include populations identified as such in recovery plans, and/or that are:

- *key source populations either for breeding or dispersal;*
- *populations that are necessary for maintaining genetic diversity; and/or*
- *populations that are near the limit of the species range".*

3.1.1 Green and Golden Frog Listing

The green and golden frog is listed as Vulnerable under the *Environment Protection and Biodiversity Conservation Act 1999* (the EPBC Act).

The Commonwealth EPBC Act provides protection to matters of national environmental significance, including threatened species. Under the EPBC Act a referral to the Department of the Environment is required if there is a likelihood of an action having a significant impact on a threatened species. Under the Significant Impact Guidelines (CofA, 2013), an action is likely to have a significant impact on a listed species if there is a real chance or possibility that it will:

- Lead to a long-term decrease in the size of a population;
- Reduce the area of occupancy of the species;
- Fragment an existing population into two or more populations;
- Disrupt the breeding cycle of a population;

- Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline;
- Result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat;
- Introduce disease that may cause the species to decline; or
- Interfere with the recovery of the species.

Significant impact judgements must be made on a case by case basis and with consideration for the context of the action. It is deemed that there is a real chance or possibility of a significant impact on the species if the action occurs in an area which supports an important population of the green and golden frog as shown in Table 1.

Habitat and/or populations may, and usually will, extend beyond the site boundaries; consideration must therefore also be given to the context of the site in the broader landscape.

Table 1 Significant impact thresholds for the species (Commonwealth of Australia 2009)

Ecological Element affected	Impact Threshold	Comment
Habitat degradation in an area supporting an important population	Permanent removal or degradation of terrestrial habitat (for example between ponds, drainage lines or other temporary/permanent habitat) within 200 metres of a water body in temperate regions, or 350 metres of a water body in semi-arid regions, that results in the loss of dispersal or overwintering opportunities for an important population.	Habitat is a connected area that supports one or more key ecological functions for this species. These functions may include, but are not limited to: foraging, breeding, dispersal, shelter.
	Alteration of aquatic vegetation diversity or structure that leads to a decrease in habitat quality.	Any action that results in the degradation of habitat such that the recruitment, survival or dispersal rates of an important population are lowered may have a significant impact on the species.
	Alteration to wetland hydrology, diversity and structure (for example any changes to timing, duration or frequency of flood events) that leads to a decrease in habitat quality.	Habitat quality increases with: • Increasing wetland area; • Water permanence; • Aquatic vegetation cover.
	Introduction of predatory fish and/or disease agents.	Habitat quality decreases with: • The degree of development in the terrestrial zone (that is, Roads,

Ecological Element affected	Impact Threshold	Comment
		buildings etc); and • The presence of predatory fish.
Isolation and fragmentation of Important populations	Net reduction in the number and/or diversity of water bodies available to an important population.	Habitat connectivity could be provided by a linear water body (e.g. a creekline) or by suitable terrestrial habitat between waterbodies. Individuals may use a range of terrestrial and aquatic habitats as movement corridors between water bodies, including floodways or grassy fields.
	Removal or alteration of available terrestrial or aquatic habitat corridors (including alteration of connectivity during flood events).	Any isolation of water bodies, through destruction of habitat, or creation of a barrier such that movement or migration between waterbodies is likely to have a significant impact on the species.
	Construction of physical barriers to movement between water bodies, such as roads or buildings.	

The elements and thresholds in the table above give guidance to the level of impact that may be significant for the species at a site. They are not intended to be exhaustive or prescriptive, but rather to highlight the need to maintain the ecological function of the habitat area.

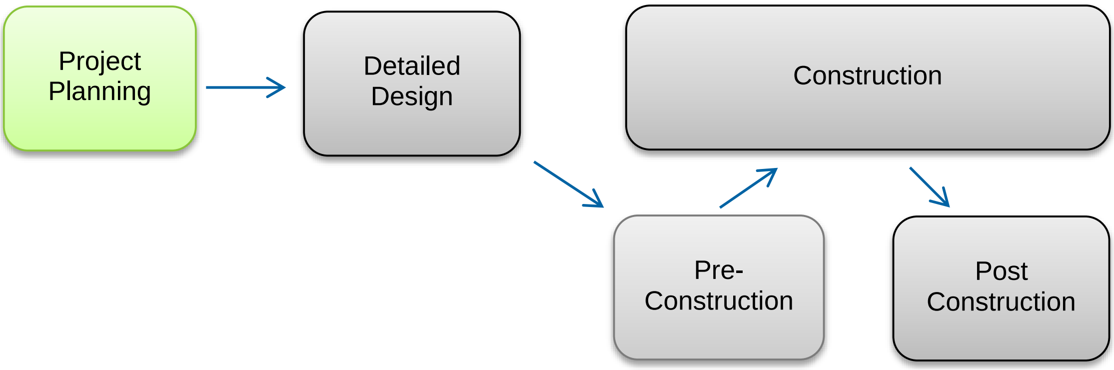
3.2 State

The green and golden frog is listed as 'Vulnerable' under the Tasmanian *Threatened Species Protection Act 1995* (TSPA).

The Act provides for the protection and management of threatened native flora and fauna in Tasmania, and enables and promotes the conservation of native flora and fauna. Under the TSPA (Section 51), "…a person must not knowingly, without a permit – (a) take, keep, trade in or process any specimen of a listed taxon of flora or fauna…". This legislation protects against direct impact upon listed fauna (eg direct physical impact to green and golden frog) but does not provide habitat scale protection. Green and golden frog is classed as "Specially Protected Wildlife" (Schedule 1).

The *Tasmanian Nature Conservation Act 2002* (NCA) makes provision with respect to the conservation and protection of the fauna, flora and geological diversity of the State, to provide for the declaration of national parks and other reserved land and for other related purposes. It states under Section 29, that the Secretary may grant a permit authorising, subject to compliance with any specified conditions and restrictions, the taking on specified lands of specified wildlife, or specified products of specified wildlife. Under the *Tasmanian Wildlife (General) Regulations 2010*, a permit is required from DPIPWE to "take" (which includes kill, injure, catch, damage, destroy and collect) both individuals of specially protected wildlife and "products" of such species, where "products" may include parts of animals or burrows.

4. Project Planning



The planning phase refers to the period prior to development occurring. The activities that occur during this phase include:

- Determination of study area (to capture context issues as well);
- Early assessment of values – DTA surveys; and
- Development of concept design so that consideration can be given to relevant habitat features such the ones outlined in this section.

For the green and golden frog, this stage of the development is essential for identifying important habitat, avoiding these habitats and /or creating additional or compensatory viable, secure and stable habitat for the species. This can be achieved through ecologically sensitive landscape design, including the maintenance of open space networks, to ensure that the project region remains a key area for the conservation of the species in the long term.

When planning a project it is important to ascertain initially whether or not the green and golden frog has the potential to occur within the planned works area.

The following characteristics can be indicators of whether a site supports habitat that is suitable for the green and golden frog. These should be investigated prior to, or in conjunction with, surveys for the species:

- Presence of water bodies, including slow flowing streams and rivers, or off-stream wetlands, which contain water at least periodically;
- Records of green and golden frogs in the local area/catchment; and
- Presence of other frog species.

This can be achieved through a combination of methods including desktop analysis and site surveys.

4.1 Preliminary Desktop Analysis

The preliminary desktop analysis involves interrogating State and Commonwealth databases to determine if the green and golden frog have historically been recorded/ or have the potential to occur within the project region. The key databases that should be analysed are:

- EPBC Act Protected Matters Search Tool (http://www.environment.gov.au/webgis-framework/apps/pmst/pmst.jsf);
- Natural Values Atlas (https://www.naturalvaluesatlas.tas.gov.au/);
- *The LIST* database (https://www.thelist.tas.gov.au/app/content/home); and
- Conservation of Freshwater Ecological Values (CFEV) Database (https://wrt.tas.gov.au/cfev/navigator).

If the preliminary desktop analysis indicates that green and golden frogs are or have the potential to be present within the proposed project area and suitable habitat exists, site specific surveys should be undertaken.

4.2 Survey

The EPBC Act policy statement 3.14; *Significant impact guidelines for the vulnerable green and golden frog (Litoria raniformis)* outlines the preferred survey techniques for detecting green and golden frogs.

Night time surveys are preferable to day time surveys, with ideal survey conditions including warm and windless nights throughout spring and summer months (Heard et al., 2006), specifically:

- Daytime air temperatures greater than 15ºC, with moderate to no wind; and
- Night time air temperatures greater than 12ºC, with moderate to no wind.

Call detection, call play back and visual encounter surveys are the recommended survey methods for detecting the green and golden frog.

DPIPWE *Draft Survey Guidelines for the vulnerable Green and Gold Frog (*Litoria raniformis*)* recommends that, as a minimum:

- Three repeated surveys are required when undertaking night time surveys; or
- Five repeated surveys are required when undertaking daytime surveys.

4.2.1 Call detection and call play back

Call detection and call play back involves listening for the distinctive call made by green and golden frogs. Male green and golden frogs generally call during the breeding season (November through March). If frogs aren't calling at a site during this period, it is possible to encourage calling by playing recordings (call play back).

This survey method is only useful during the breeding period, and only when conditions are conducive to calling.

It is important that the observer has learnt to identify the species-specific call, or has the facilities to record calls for subsequent analysis. Call play backs should be conducted every 100 m along the edge of a water body and care should be taken when utilising these techniques in areas of strong or fast running water, as calls can go unheard because of noise generated by fast flowing waterways.

Call detection and play back is not a reliable tool on its own and must be completed in conjunction with active visual encounter surveys (see below).

4.2.2 Visual encounter surveys

Visual encounter surveys involve actively searching for frogs within a designated area. These are best carried out between 20:30 and 03:00 hours. Sites should be systematically searched for frogs following general procedures outlined by Crump and Scott (1994), including using spotlights to scan all surfaces of the water body while traversing its length, focusing on inspection of aquatic vegetation (Heard et al. 2006).

Table 2 Survey guidelines for detecting the green and golden frog (Commonwealth of Australia, 2008)

Survey Objective	Comments
Aim	To maximise the chance of detecting the green and golden frog at the local site, and in the surrounding landscape.
Timing	At the time of peak activity for the species* • Temperate southern regions: Between November and March (calling takes place primarily between November and December however the frogs may still be active until March). • Semi-arid regions: within one month of flooding (generally October–February).
Effort and Methods	Over at least two nights, under suitable conditions: • Using a combination of call play back and night time visual encounter • Surveys (for example as per Heard et al. 2006) covering a range of stream structures, billabongs, farm ponds and dams, swamps and irrigation channels • Accompanied by habitat assessment, and • Undertaken by appropriately experienced personnel. *Important: Chytrid fungus is readily transported between sites (for example on boots) and suitable precautionary measures must be taken whilst surveying. Please see the threat abatement plan for chytrid fungus and/or refer to relevant state publications.*
Area to be covered 1) Study site	Small water bodies (<50 metres at greatest length) should be covered in a period of about one hour, including searches of banks and emergent vegetation. Larger water bodies (>50 metres) should be searched by sampling subsets of the whole waterbody in a systematic manner.
2) Local area	Local area studies should include waterbodies surrounding the survey area to place observations at target site in context.

4.2.3 Habitat Assessment

In addition to undertaking surveys for the green and golden frog, the following habitat characteristics should be assessed.

Surveys should endeavour to determine the potential connectivity of water bodies on site to neighbouring water bodies, even if green and golden frog individuals are not detected on site. This is because if the green and golden frog uses a series of water bodies, not all of which will be permanently occupied, the presence of the species in neighbouring water bodies provides an indicator of the likely use of associated water bodies.

The following questions should be asked to determine the context of the site and quality of habitat:

- How close is the nearest water body?
  - In temperate areas, individuals are unlikely to move further than one to two kilometres between water bodies.
- How many water bodies occur within ten kilometres?
- Is there habitat connectivity (terrestrial or aquatic) between waterbodies on site, and between water bodies on site and those on neighbouring sites?

Surveys for the green and golden frog should be accompanied by a detailed description of the habitat present on the site, its history of management, and the context of the site in the surrounding landscape. Where surveys cannot be conducted outside of the site, other aids such as aerial photographs, historical records and vegetation datasets can be useful in providing context to the site.

4.2.4 Absence of Survey

Where it is not possible to conduct surveys in the manner recommended, the precautionary principle should be used, that is, failure to detect the green and golden frog should not be considered indicative of its absence.

4.3 Conceptual Design

Prior to any construction in established green and golden frog habitat, it is important to determine the key characteristics of the population and habitat.

The following key factors should be considered:

- The presence of a population at the site or in adjacent areas;
- The presence of suitable habitat within and surrounding the site;
- Location of existing waterways, drainage lines, wetlands, vegetated swales, and open grassland for landscape habitat connectivity;
- Location of artificial barriers to connectivity, such as roads, railway lines, buildings, quarries, etc; and
- Whether habitat and connectivity routes can be maintained, or created, within at least one kilometre (preferably less than 500 m) of existing habitat to increase the chances of occupancy by green and golden frog (Heard, Scroggie & Clemann, 2010).

From this information it is possible to create a conceptual model of potential movement pathways for frogs within the landscape which can then be taken into account during project design (Figure 3).

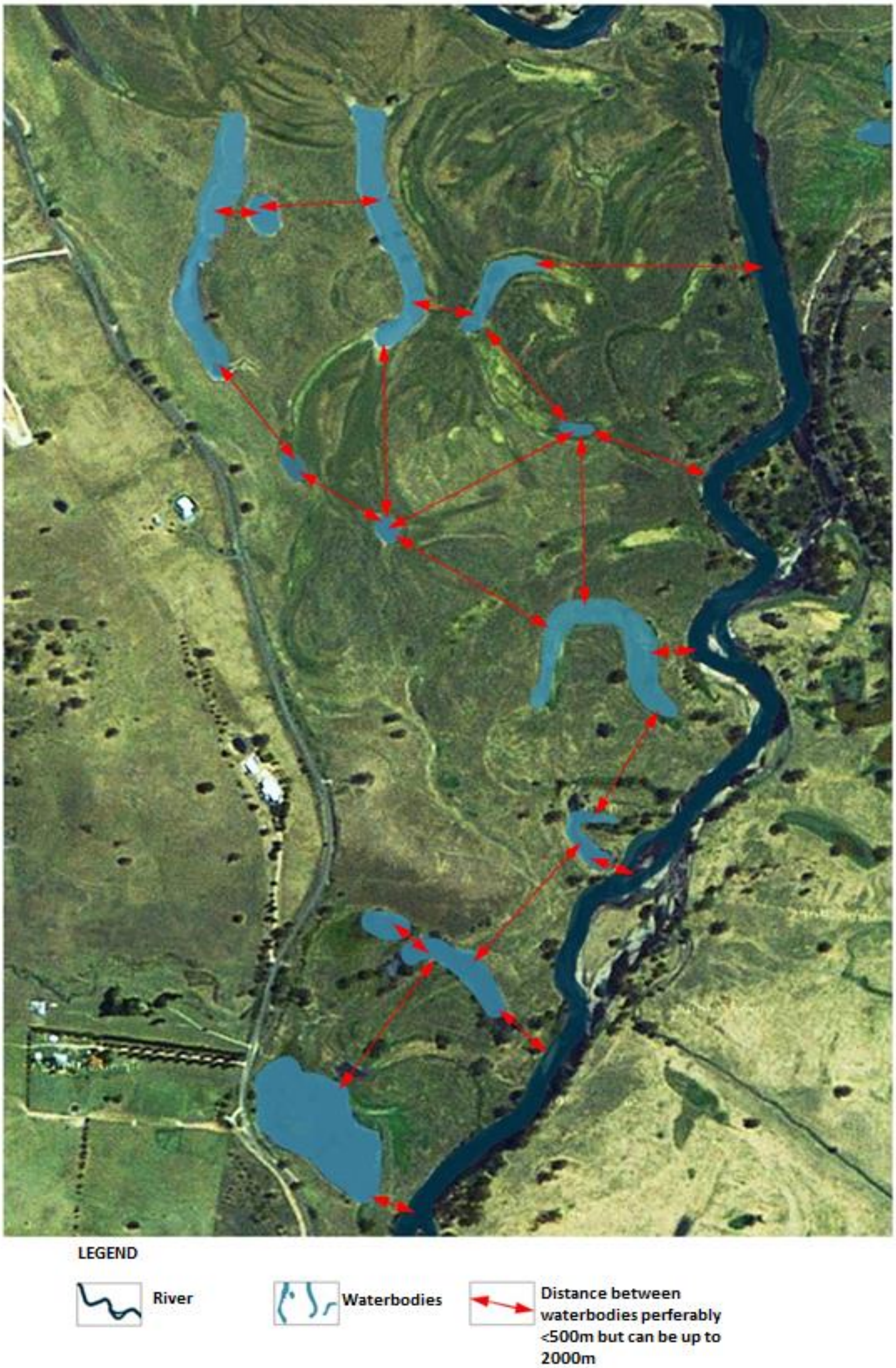


Figure 3 Example of conceptual model of frog movement (Source: Ecology Partners 2012)

4.3.1 Road placement/alignment in known frog habitat

The information obtained using the conceptual model (Section 4.3) can then be used to identify the most appropriate location for alignments and/or management structures to facilitate the safe passage of frogs across the landscape. Maintaining population connectivity in highly cleared landscapes is equally as important as maintaining connectivity across large areas of intact habitat.

When planning the alignment of new roads, designers should consider the wider landscape. Design goals should be set that consider known movement corridors (e.g. drainage lines, creek lines and strips of native vegetation See 2.3.4) that have the potential to be used by a number of species as part of a landscape scale perspective when making decisions about habitat connectivity measures.

Avoid High Quality Habitat Entirely

During the planning and design phase, efforts to avoid construction in areas of known and likely habitat should be the first priority. Construction in these areas may result in fragmentation of habitat.

Minimise Width of Construction Zone

In situations where avoidance is not an option, the project should continue to work towards achieving a proposed construction zone of minimal width in known and possible habitat areas. Lay down areas and the location of site facilities, haul roads and impacts of utility works also need to be included in this decision making process to ensure that ancillary infrastructure does not cause further impact.

Management

Management measures to facilitate movement must be considered where avoidance is not an option. These are discussed further in section 5 of this document.

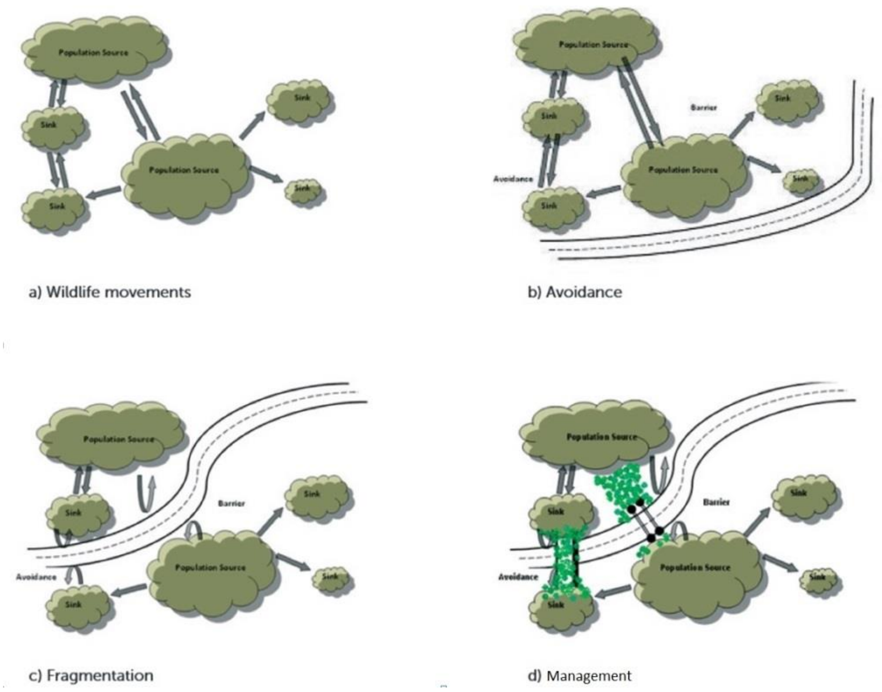
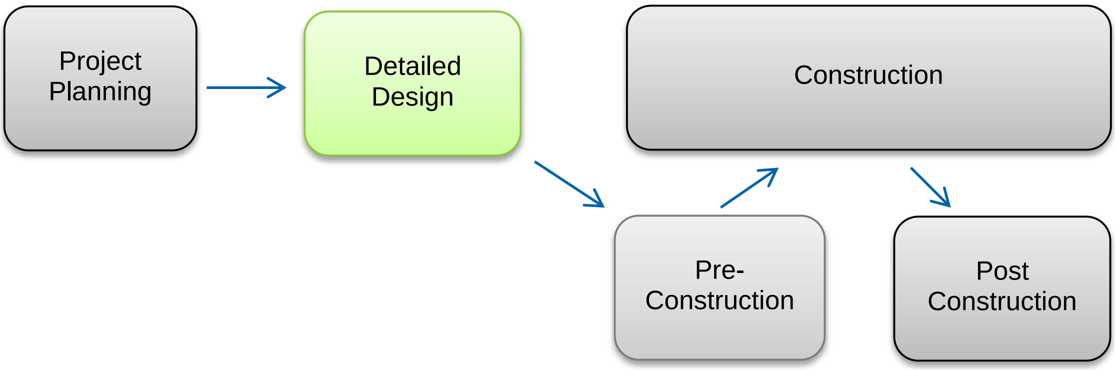


Figure 4 Representation of wildlife movements when considering road design on a) wildlife populations b) avoidance c) fragmentation and d) management (source VicRoads 2012)

5. Detailed Design



The detailed design phase builds on the already developed concept, aiming to further elaborate each aspect of the project through solid modelling, drawings as well as production of specifications.

In the event that avoidance measures cannot be achieved in all locations, there are a number of different management measures that can be employed to facilitate the movement of animals from one side of the road to the other including bridges, culverts, fencing, habitat enhancement and local fauna management.

5.1 Ranking waterways

The connectivity habitats (section 2.3.4) that green and golden frog utilises to move between breeding and refuge habitats generally follow the moist drainage lines throughout the catchment.

After identifying the potential movement pathways of green and golden frogs (section 4.3) the location of structures to facilitate movement need to be prioritised to achieve the maximum benefit.

Strahler stream ordering is an internationally recognised stream ordering classification for stream networks which rates each stream segment according to the orders of the incoming upstream segments (Figure 5).

The Strahler stream order (Strahler, 1957) can be derived from a waterways spatial data layer, where headwater reaches are assigned a stream order of 1 through to reaches entering estuaries, which could attain a maximum stream order of 9 (in Tasmania).

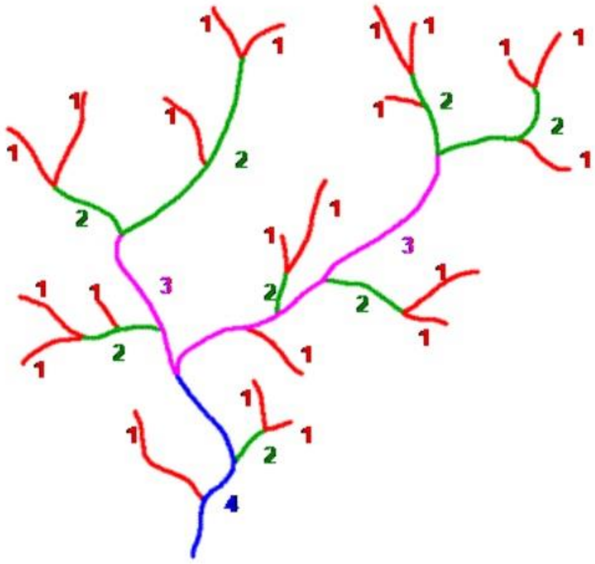


Figure 5 Schematics of Strahler stream order

Stream order should be used as a guide to determine the best method to facilitate movement (see Table 3). An “Order 3” waterway (or greater) is likely to require a more substantial structure such as a spanned bridge due to the hydraulics and morphology of the waterway. In these cases, the need to build a specific structure for frog movement would likely not be required as the default structure would not significantly impact on habitat linkage.

Frog specific culvert design should be seriously considered as a priority where Order 1 and Order 2 waterways occur within an area known to be populated by green and golden frogs, or where the road infrastructure bisects areas of known habitat.

Table 3 Description of waterway order

Classification	Characteristics of Waterway Type	Minimum Recommended Crossing Type
Order 4 and above	Major permanently or intermittently flowing waterway (e.g. river or major creek); habitat of a threatened fish species or ‘critical habitat’.	Bridge, arch structure or tunnel
Order 3	Named permanent or intermittent stream, creek or waterway with clearly defined bed and banks with semi-permanent to permanent waters in pools or in connected wetland areas. Marine or freshwater aquatic vegetation is present. Known fish habitat and/or fish observed inhabiting the area.	Bridge, arch structure culvert
Order 2	Named or unnamed waterway with intermittent flow and potential refuge, breeding or feeding areas for some aquatic fauna (e.g. fish, yabbies). Semi-permanent pools form within the waterway or adjacent wetlands after a rain event. Otherwise, any minor waterway that interconnects with wetlands or recognised aquatic habitats.	Culvert
Order 1	Named or unnamed waterway with intermittent flow following rain events only, little or no defined drainage channel, little or no flow or free standing water or pools after rain events (e.g. dry gullies or shallow floodplain depressions with no permanent aquatic flora present).	Culvert

5.2 Frog friendly underpass design

A "*Review of Mitigation Measures used to deal with the Issue of Habitat Fragmentation by Major Linear Infrastructure*" Report for Department of Environment, Water, Heritage and the Arts (DEWHA, 2008) found that there is sufficient evidence to demonstrate that many species of terrestrial vertebrates will use a range of crossing structures.

An underpass is a structure that allows wildlife to cross the road beneath the road surface. It can include culverts, tunnels, pipes, bridges and viaducts. The size or "openness" of the underpass appears to be the primary factor influencing crossing rates. Wherever possible, the height and width of underpasses should be maximised.

Of the various crossing types available, the bridge underpass is acknowledged as the most effective but also the most costly. The structure maintains the grade of the road or elevates the traffic above the surrounding land, allowing animals to pass under the road. Bridges typically traverse watercourses and can be the chosen preference when building a road through flood-prone areas.

If constructed and positioned appropriately, bridges or road culvert crossings should facilitate safe frog movement between both sides of the road and significantly reduce the likelihood of road kill deaths occurring. Maintaining habitat connectivity also allows for frog dispersal and increases the likelihood of long-term persistence (viability) of populations in the immediate area.

5.2.1 Design Criteria

Road underpass crossings should be designed and constructed in a way that maximises their potential to facilitate frog movement under roads. A review of underpass structures built to facilitate the movement *of Litoria raniformis* around Australia identified the following key design criteria.

- Strategic placement of crossings to ensure they link suitable habitat areas, and make underpass (under road crossings) as short as possible;
- Flaring at culvert entrance points should be adopted, and a smooth surface provided along the base of the underpass, with a flat bottom rather than curved;
- Culverts should be rectangular in cross section with 'minimum' dimensions of 0.9 m high x 1.5 m wide (i.e. standard size of a box culvert) at ground level and as straight as possible (no bends), running perpendicular to the road where possible;
- There must be visibility from one end of the underpass to the other;
- Where the underpass forms part of an ephemeral drainage line, entrances of the underpass should support areas of suitable wetland habitat, comprising a variety of indigenous aquatic and semi-aquatic vegetation, and extensive areas of rock;
- Constructed ponds and wetlands at underpass entrances should be 30 m x 10 m in diameter, up to 1.5 m in depth (if possible), and contain sufficient vegetation cover and refuge sites. No obstructions such as rocks or logs should be placed within the culvert;
- Artificial lighting at entrances is discouraged as this may reduce their effectiveness to facilitate frog movement;
- Relatively open areas should be provided leading to the entrances of each underpass. Clear access in and out of the underpass is required, while any openings along the culvert length should be such that they do not enable fauna to access the road surface;
- Incorporation of light or air slots in the top of the underpass should be installed to maintain aeration and temperature equilibrium;
- A suitably sized grated heavy duty pit lid opening in the light or air slots to be located in the central median of the road is recommended to allow light to enter the underpass. These grates should be a minimum of 50 mm x 50 mm in size. Grates must be protected from receiving direct runoff from roads, which could potentially contain harmful pollutants; and
- Culverts should not be permanently inundated and should be designed to receive water periodically.

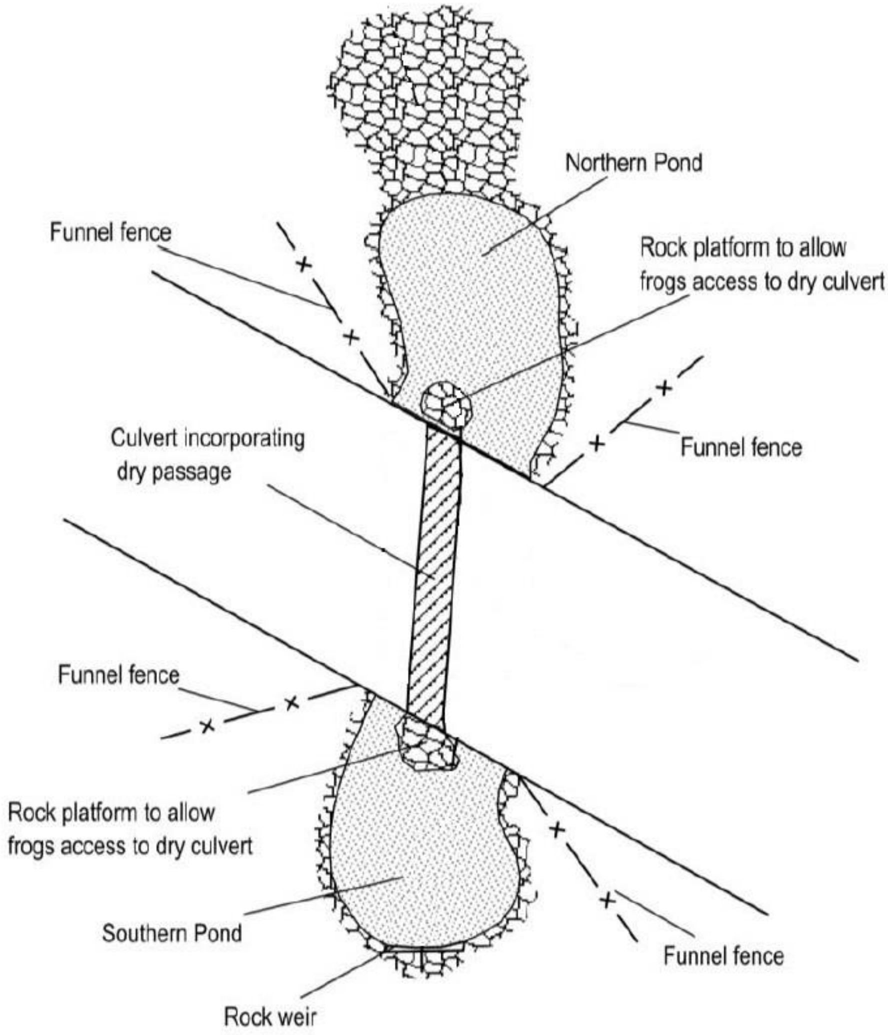


Figure 6 Frog underpass concept (plan view)

5.3 Frog exclusion barriers

Drift fencing should be used along both ends of all proposed underpasses and culverts, and along the edges of any wetlands and ponds which come in direct contact with roads within the development. They are designed to prevent frogs entering the road surface by guiding frogs towards underpasses (see Van Leeuwen, 1982).

Overseas studies investigating the effectiveness of underpasses or tunnels in providing habitat connectivity and offsetting the barrier effects of roads have shown that frogs have difficulty in finding these structures if drift fences are not installed (Brehm, 1989).

5.3.1 Design Criteria

The following are requirements for the design of frog drift fencing:

- Either a solid (preferred – concrete or UV resistant plastic) or a mesh structure could be used. A solid structure could be constructed with concrete or other material, however durable mesh is commercially available;
- Fencing must be installed both sides of roads that directly abut any of the ponds or wetlands within a project area. The length of this drift fencing will vary;
- Fencing must be 1 m high with an additional 0.2 m below ground and a 0.2 m section at the top angled outwards (away from the road) and downward from the horizontal;
- Fencing must be erected along the edge (10 m buffer from the edge of any waterbody) of ponds and wetlands either running parallel, or at a 45 degree angle to the road verge to prevent frogs entering the road pavement;
- Acoustic fencing may be used to act as a barrier to frog movement onto the road; however, it must not impede frog movement at entrances of underpasses or culverts;
- Rock, wood and logs may be placed at least one metre away from the fence, along likely dispersal routes, to provide temporary sites of refuge; and
- Vegetation within 0.5 m of the drift fencing should be less than 0.5 m high.

5.4 Constructed wetland habitat design criteria

Wetland ponds should be constructed at the entrance of the underpass culvert and should incorporate the following zones, as depicted in Figure 7:

- Littoral/ Ephemeral Wetland Zone with bare ground areas;
- Entry Zone;
- Embankment Zone; and
- Deep Water Zone.

5.4.1 Littoral/ Ephemeral Zone with bare ground areas

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 ground vegetation stands. Vegetation around the margins of the pond need to withstand extended dry periods, whilst the littoral/ephemeral zone is subject to periodic inundation, and therefore must support plants able to tolerate wet conditions.

The zone should be created to incorporate the following structural features based on known sites where the species occurs:

- Establish a moderate to high percentage cover of vegetation with bare ground areas, rocks and logs (Figure 7);
- A minimum width of 5 m of ephemeral wetland zone should be created;
- Plant species to reflect the local vegetation community and include, where appropriate, native vegetation including Common spikesedge *Eleocharis acuta* (in low densities to prevent spreading), tall spikesedge *Eleocharis sphacelata*, tall sedge *Carax appressa,* rushes (*Juncus* spp. and tussock grasses *Poa labillardierei.* Where possible local seed or propagules should be used;
- Selection and application of rock must be appropriate and complementary to local site condition;
- A selection of large concave (300 – 1500 mm in diameter) and small (3-5 boulders per square metre) rocks, extending at least 1 m into the entry zone (see Figure 7); and
- Large woody debris around the outer pond margins, and logs along the banks.

Exposed rocks retain more heat and are used by the species for thermoregulation, while woody debris provides additional refugia and attracts invertebrate prey.

5.4.2 Entry Zone

This zone refers to the edge of the pond where frogs can enter the water (Figure 7). The zone will be subject to frequent drying and will require plant species capable of tolerating fluctuating water levels. The zone should incorporate the following structural features:

- A profile length of at least 1 m;
- A shallow 1:8 grade slope containing a variety of rocks and logs from the bank, with rocks down to at least 1 m below freeboard water level; and
- Entry zone should extend from water's edge to 0.25 m below the water level. Terrestrial and aquatic species should be planted at a density of six plants per square metre.

5.4.3 Embankment

This zone should provide a variety of aquatic vegetation, i.e. emergent (low density), submergent and floating plants (higher densities), for frog courtship, egg-laying, metamorphling/ tadpole cover and territorial displays. Heard *et al* (2008) observed many green and golden frogs in or on mats of submergent and floating vegetation in post-breeding months. The study demonstrated that occupied microhabitats were characterised by a high cover of floating vegetation. The zone should be created to incorporate the following structural features:

- A profile length of at least 5 m;
- Variable grade with steepening in the final approach to the adjacent deep water zone;
- Embankment extending from 0.25 - 0.5 m below the water level; and
- Plantings at a nominal 6 individuals/m^2 for semi-aquatic plants (emergent species) and 3/m^2 for aquatic species to a depth of 0.5 m.

5.4.4 Deep Water Zone

This zone serves to act as a reservoir for open water during extended periods of drought/ dry weather conditions, and for larval development and successful recruitment. This zone should include the following structural features:

- A zone at least 5 m x 10 m in area, with a depth up to 1.5 m and a flat bottom; and
- The deep water zone should support at least 30% submerged vegetation within 1-3 years of completed construction, predominantly comprising of pondweed *Cycnogeton.* spp.

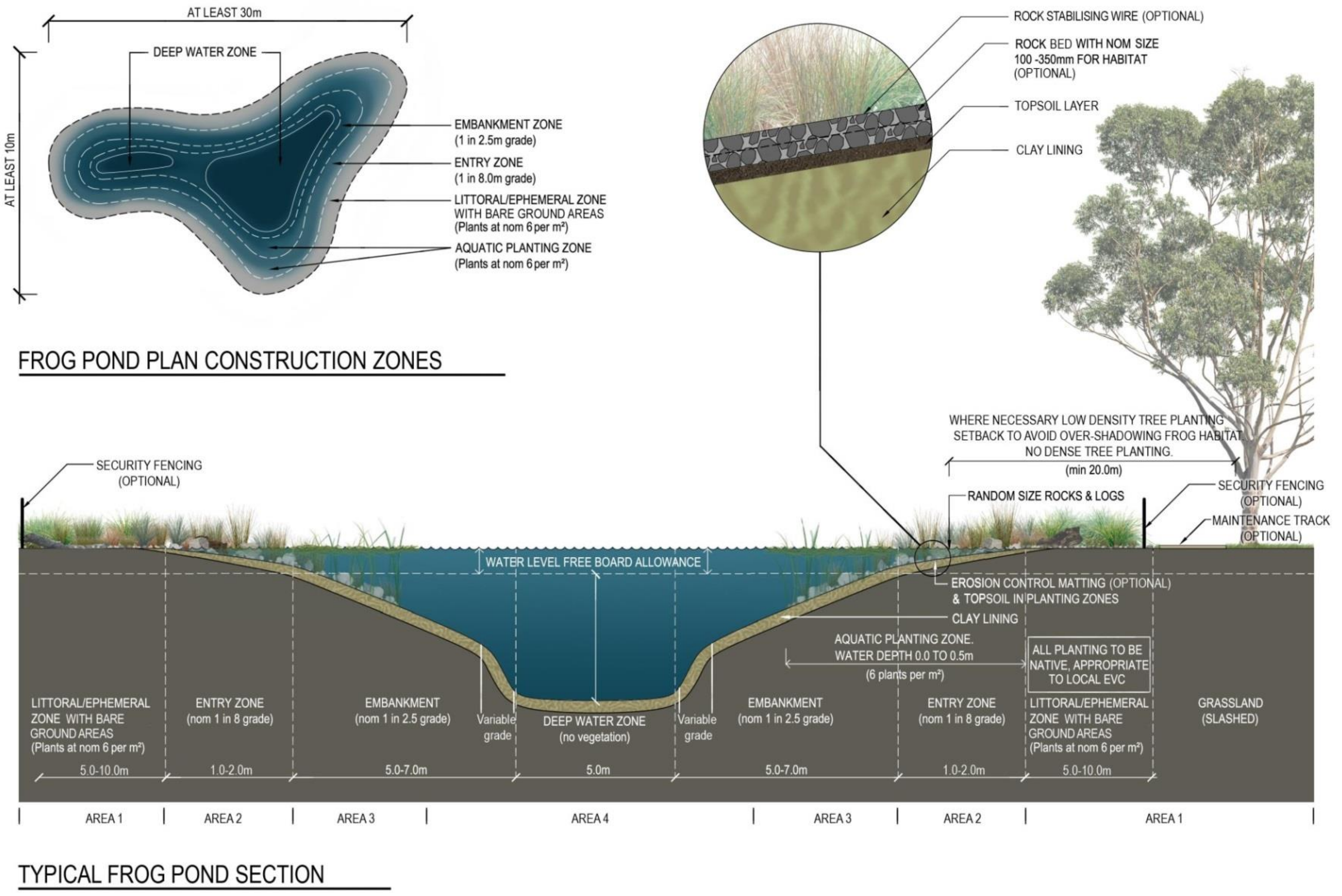


Figure 7 Constructed frog habitat lagoon concept (GHD 2011)

5.5 Identification of possible relocation sites

In the event that an identified habitat cannot be avoided, a clearance survey may be required to remove frogs from the construction corridor (See Section 7.1). Where this is the case a suitable relocation site may need to be identified during the design stage. Ideally relocation habitats will be within a 500 m radius of the impacted location. This this has two benefits:

- Firstly, if the population is close to the impacted habitat, there is a high likelihood that relocated individuals and resident frogs will be from the one gene pool.
- Secondly, the risk of transmitting Amphibian Chytrid Fungus (*Batrachochytrium dendrobatidis*) is reduced if there is an existing exchange of individuals (see Section 6.3) between habitat, or if they are hydrological linked.

Additional surveys may need to be completed if an initial survey was not completed, or failed to identify suitable habitat within the original study boundary (See Section 4.2).

Potential relocation habitats should be identified, mapped and included in the contractor's tender documentation (See Section 6).

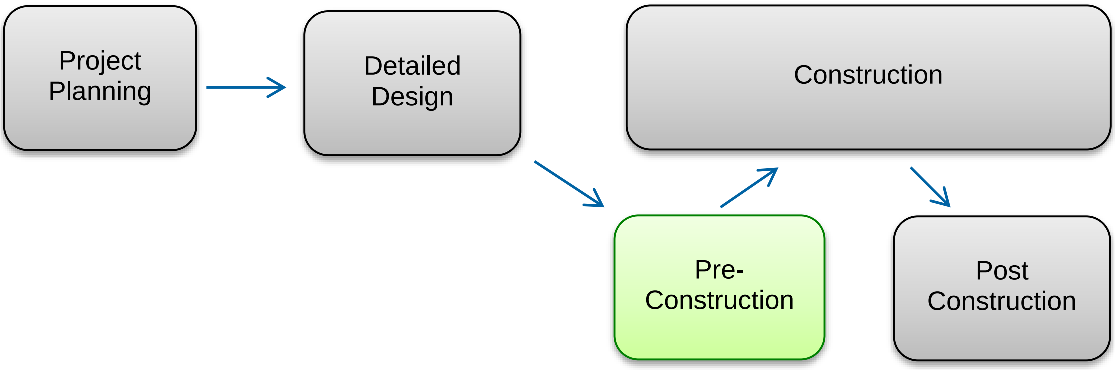
Chytrid fungus risks need to be managed as per section 7.1.4 of this document.

It is recommended that DPIPWE Threatened Species Section be consulted prior to the relocation of frogs as a threatened species collection permit is likely to be required.

The contact details for Threatened Species Section are:

GPO Box 44
HOBART TAS 7000
Phone: 03 6165 4340
Fax: 03 6223 8603
Email: ThreatenedSpecies.Enquiries@dpipwe.tas.gov.au

6. Pre -construction



The pre-construction phase is considered to be part of construction project management, which is the overall planning, coordination, and control of a project from inception to completion. This process includes:

- Installation of site offices;
- Clearing and grubbing;
- Relocation of services;
- Establishment of site controls; and
- Designation of Exclusion zones – 'No Go Areas'.

During the pre-construction phase, it is important to ensure that the contractor has incorporated all biodiversity objectives, including any fauna sensitive road design requirements, into their Construction Environmental Management Plan (CEMP). During this process a Department of State Growth officer will have to sign off this aspect of the design drawings and tender documents.

6.1 Designation of 'no-go' areas

Using the information obtained during the planning and design phase, identified areas of habitat within the works corridor need to be designated as exclusion zones for the construction phase. These exclusion zones need to be specified within contractor tender documents and clearly marked on Final Detailed Design Drawings.

6.2 Contractor induction and training

For sites where green and golden frogs have been identified as present, or where actions have been identified as required to manage habitat or sites, all employees and contractors should undergo green and golden frog awareness training as part of the broader environmental awareness training for the site.

The training should inform site personnel about their responsibilities under the TSPA and the EPBC Act. The training should ensure that all employees understand their obligation to exercise due diligence towards the protection of the species and the site specific restrictions i.e. what and where certain activities can and cannot occur.

The site specific induction training should include:

- Familiarisation with the requirements of the CEMP;
- Vehicles hygiene, handling protocol, footwear wash;
- Emergency response training;

- Familiarisation with site controls; and
- Targeted environmental training for specific personnel.

The need for additional or revised training should be maintained on file and should include:

- Who was trained;
- When the person was trained;
- The name of the trainer; and
- General description of training content.

6.3 Construction hygiene practices

The Amphibian Chytrid Fungus (*Batrachochytrium dendrobatidis*) is widespread globally and it occurs in a range of waterbodies and environmental conditions. It may already occur in frogs (and tadpoles) within the project area and its presence can, however, some parts of the construction area may have frogs not yet infected with the Amphibian Chytrid Fungus and precautions must be taken to minimise further impacts.

The Amphibian Chytrid Fungus occurs within the skin of amphibians (and in the mouthparts of tadpoles) and there is a chance that it survives for short periods in moist environments, in the absence of amphibians. It is dependent on moisture for its survival. Therefore, the greatest risk of a project spreading the fungus will occur when construction activities encounter frogs or tadpoles, or their habitats.

The following relevant points come from Speare et al. (2004), which is an unpublished report documenting the hygiene protocols which are acceptable for and used by, scientific research studies involving amphibians:

- Wild amphibians are naturally at risk of exposure to the Amphibian Chytrid Fungus via contact with the environment such as water, moist substrates and other amphibians;
- Construction activities should be done in a manner that does not significantly increase the risk of exposing frogs or tadpoles to the Amphibian Chytrid Fungus above that normally experienced by frogs and tadpoles in the absence of construction;
- Should frogs need to be handled, they should be handled by experts and using appropriate hygiene methods. Multiple frogs should never be handled together, placed together in contact or in the same container, or placed in previously-exposed containers without disinfection between amphibians. If a container is used for holding frogs or tadpoles, it must be disinfected prior to re-use (using one of the methods given in Table 4) or be a new container; new vinyl gloves each time a frog is handled and footwear used within amphibians' habitat (a waterbody) should be washed to remove mud before being disinfected prior to reuse in another waterbody;
- Water removed from one waterbody, for any purpose, must be used in a way which ensures that runoff will return to the same waterbody. This also includes the movement of mud or moist soils. Machinery, equipment and clothing must be appropriately cleaned prior to leaving a wet area (see *6.3.1 Site Protocol*)

Table 4 Disinfection strategies suitable for killing the Amphibian Chytrid Fungus (*Batrachochytrium dendrobatidis*) on footwear, containers or other equipment used to collect or handle amphibians in the field.

Disinfectant	Concentration	Duration
Complete drying	-	3 hrs or greater
Heat	37°C	4 hrs
Sodium hypochlorite (bleach)	1%	1 min
Didecyl dimethyl ammonium chloride	1 in 1000 dilution	0.5 min
F10 SC	8%	1 min

Note: Each one of these methods will kill the Amphibian Chytrid Fungus. Minimum concentrations and durations shown to be effective are indicated [adapted from Speare et al. (2004) and based on Berger (2001) and Johnson et al. (2003)].

6.3.1 Site Protocol

The Tasmanian Government has produced a set of guidelines titled "*Keeping it Clean – A Tasmanian Field Hygiene Manual to Prevent the Spread of Freshwater Pests and Pathogens*" (Allan & Gartenstein 2010). This document sets a series of hygiene protocols for individual persons and machinery. The following information is a summary of construction disinfection protocols taken from this document.

Machinery

Passenger vehicles and heavy machinery (including trucks, tractors, mowers, slashers, trailers, backhoes, graders, dozers, excavators, skidders and loaders) are major vectors for the spread of soil borne fungal diseases. Vehicles and heavy machinery that stay on formed and sealed roads have a low risk of spreading disease and weeds and on-site cleaning is not essential. However on-site vehicle washdown is particularly important when using vehicles and machinery off (sealed) roads.

Vehicle/heavy machinery washdown is most effective where access can be controlled and entry points, roads or tracks are not open to general use. When selecting a washdown site, consider the following points.

- Where there are large quantities of effluent or there is a risk of extensive run-off (e.g. during road construction), the washdown area should be bunded i.e. an impervious spill area constructed.
- Washdown at the edge of (or near) any areas where pests, weeds or pathogens need to be contained. Ideally choose a site where the land slopes gently away from the washdown area and back into the potentially infected area, or into an adjacent area not susceptible to the problem (e.g. a paddock).
- Select a site where the run-off will not enter a watercourse, waterbody or roadside drain; a buffer of at least 30m is required.
- Select a mud-free site (e.g. well grassed, rocky, gravel, bark or timber corded).
- Avoid sensitive vegetation or wildlife habitat, e.g. remnant native vegetation and areas with threatened species.

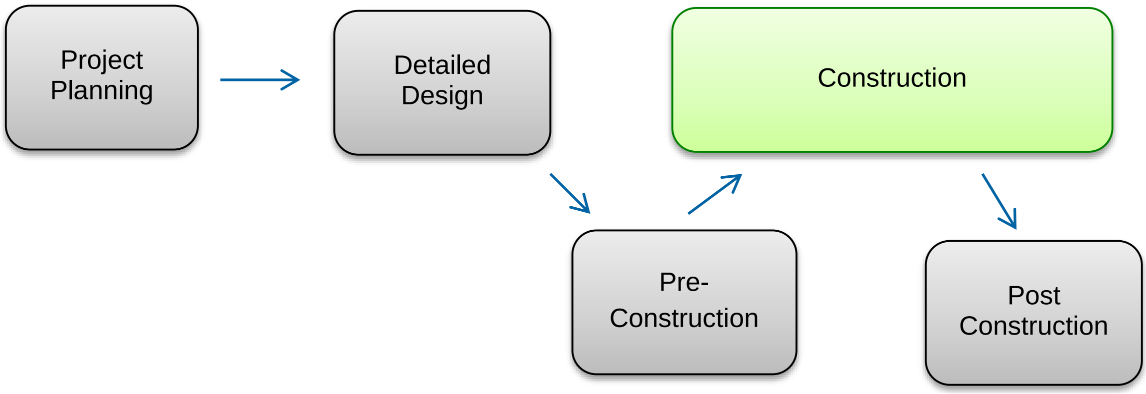
The procedure for cleaning down heavy machinery should include the following.

- Elevate heavy machinery with boom arm to enable underside to be accessed. Tyres can be placed under equipment to allow underside to dry.

- Remove any guards, covers or plates that can quickly and easily be removed and replaced.
- Check the vehicle inside and out for any lodged mud, soil, seeds, algae, plant and other debris or substrate material.
- Knock off large clods of dirt with a crowbar or stiff brush.
- Clean with a high pressure hose and stiff brush or crowbar to further remove clods, starting from the top of the vehicle and working down to the bottom. Remember to clean undersides, tracks, rollers, tyres, wheel arches, guards, blades and buckets, chassis, engine bays, radiator and grill, tray, spare tyres and other attachments.
- When spraying with disinfectant solution be sure to only use the minimum amount of water needed to adequately disinfect all equipment and only add the amount of disinfectant required.
- Allow the disinfectant solution to remain in contact with surfaces for at least 1 minute and wherever possible allow vehicles and equipment to drip dry.
- Avoid driving through any cleaning water/waste.

Vehicular movement through and between waterbodies should be minimised at all times, to minimise degradation to waterbodies and to minimise a project's logistical need for disinfection of equipment. Vehicle movements should be documented and restricted between waterbodies.

7. Construction



The construction phase of the project is where the planning, detailed design and pre-constriction actions come together in the form of on ground works. During this phase, machinery is mobilised, earthworks commence within the designated construction corridor and materials are brought onto site. It is during this phase that existing habitats can be impacted either through direct (destruction of habitat) or indirection (noise and vibration) actions.

7.1 Clearing frogs from construction corridors

As it may not be possible to avoid all frog habitats as part of the construction activities, a clearance survey should be conducted prior to any works occurring in identified green and golden frog habitat.

DIPWE need to be engaged with as a clearance survey may trigger the need for additional threatened species permits.

Once the construction through a waterbody (which includes ephemeral waterbodies in a wet or dry state) has been determined and fenced off appropriately, green and golden frogs that remain within the construction zone will need to be captured and moved out of harm's way using the measures outlined below. This includes both adult frogs and tadpoles.

7.1.1 Adult frogs and terrestrial metamorphs

Within the week prior to commencement of construction activities through a waterbody, concerted efforts should be made by qualified ecologists to detect and capture threatened frogs (and other ground-dwelling fauna within the construction area), using active searching techniques.

If construction is to occur through a waterbody during the breeding season for the green and golden frog, and the environmental conditions at the time are conducive to increased frog activity (i.e., warm and wet nights), then nocturnal searches for the species should also be made prior to construction, to maximise the chances of detecting and clearing frogs from the construction zone.

7.1.2 Tadpoles and aquatic metamorphs - non-linear waterbody (i.e., wetland, pond, dam)

If a non-linear waterbody (i.e., wetland, pond, dam) is intercepted by the construction zone and needs to be drained before construction, then tadpoles and aquatic metamorphs of the green and golden frog will need to be removed from the waterbody and relocated to the nearest available suitable aquatic habitat, according to pre-determined handling protocols and

Amphibian Chytrid Fungus protocols (see Section 6.3). Prior to any relocation, testing of both source and receiving populations for Chytrid Fungus is required.

The optimal method for this would be to commence pumping of the surface water to reduce the size and volume of the waterbody, to concentrate tadpoles and other aquatic fauna into a smaller area/volume. This should be done in the presence of a qualified ecologist, so that the pumping process can be slowed or stopped if it is believed to pose a threat to fauna (particularly the green and golden frog and its tadpoles). The intake for water extraction will need to be within 15 cm of the water surface at all times, and pumping will need to be done using a safe and effective filter system to prevent fauna from being sucked into the pump. The filter could be as simple as a fine mesh fenced enclosure that is installed around the water pump inlet, as long as it effectively excludes fauna.

Once the effective size of the waterbody has been reduced to the satisfaction of the supervising ecologist, pumping should be halted and dipnets and/or seine nets used to extract tadpoles from the water.

When the waterbody has been cleared of fauna to the satisfaction of the ecologist, then the pumping process should continue until the waterbody is de-watered.

If green and golden frog tadpoles (or other hylid tadpoles that could be green and golden frogs – tadpoles can be very difficult to identify in the field) are captured, then they would be moved to a nearby safe location.

Collected tadpoles would be stored temporarily and transported in low densities (no more than 5 large or 20 small tadpoles per litre) in well aerated containers of pond water.

7.1.3 Tadpoles and aquatic metamorphs – linear waterbody (i.e., stream, channel, drainage line)

If a linear waterbody (i.e., stream, channel, drainage line) is intercepted by the construction zone, and upstream water is to be dammed and then pumped around the construction area to the downstream side of the construction zone, then no collection of tadpoles will be required. In that case, the construction process is expected to create a temporary barrier to tadpoles' dispersal, but the likelihood of significant tadpole mortality or injury is considered to be relatively low. The water-pumping process for a linear waterway would still need to be done within 15 cm of the water's surface and using an effective filter system to prevent fauna from being sucked into the pump.

7.1.4 Chytrid management during capture and release of frogs

Measures to avoid the spread of the Amphibian Chytrid Fungus must be implemented during the animal-handling process only.

Chytrid often occurs in a mosaic pattern within the landscape, with infected and uninfected ponds occurring within close proximity of one another. Given this, a risk assessment needs to be completed to ascertain the potential to distribute Amphibian Chytrid Fungus. For example, if the waterway is downstream, within the same catchment, the risk of spreading Amphibian Chytrid Fungus would be small. However if the habitat is located in a separate catchment, the risk would be much higher. Where there is a medium to high risk of spreading Amphibian Chytrid Fungus, testing needs to be completed before translocation can occur.

7.2 Works in waterways

In general, the contractor engaged to construct work should provide a Construction Environmental Management Plan (CEMP). At a minimum this should include:

- All fauna sensitive road designs identified during the planning stage;
- All relevant information regarding the fauna sensitive road design including flora/ fauna assessment reports, targeted surveys and landscape plans (including information that identifies connectivity between habitats);
- Required 'no-go zones' including available habitat for fauna during construction; and
- Requirements for planting and rehabilitation at the end of construction including providing adequate connectivity and in accordance with landscape plans.

To further manage the potential for adverse construction impacts on green and golden frogs, stringent management measures are presented in Section 7.2.1 to 7.2.4.

7.2.1 Scheduling of works

Objectives

For many fauna species, the key management measure to reduce impacts from any project is to restrict construction to a specific time of year.

The green and golden frog and its tadpoles are likely to be resident in suitable waterbodies at any time of the year, but typically the terrestrial form of the species is active from mid-September to March (inclusive).

Controls

It is acknowledged that peak frog activity coincides with the main construction season in Tasmania and as a result, scheduling of works outside of this period is not likely to be possible in many cases. Irrespective of time of year, a range of other measures (as described throughout this chapter) should be implemented to reduce impacts upon possible habitats for the green and golden frog.

Table 5 Controls to be implemented regarding timing of works

Item	Specific Requirement	Responsibility
1.1	Where possible works should be completed between the months of April and August in any "known" habitat locations for the green and golden frog.	Department of State Growth
1.2	If heavy rain is falling, forecasted to fall or has recently fell during the previous 24 hr, measures should be taken to restrict construction works within waterways until water levels have returned to 'normal' background levels.	Contractors Site Engineer
1.3	If construction works involve the temporary installation of a cofferdam, works need to be scheduled to minimise the impact on migrating aquatic animals.	Department of State Growth

7.2.2 Sediment Management

Objectives

- Prevent erosion, contamination and sedimentation of waterways; and
- Minimise the amount of sediment lost due to construction.

Controls

The controls listed in Table 6 are to minimise the risks associated with sediment management and erosion.

Table 6 Controls to be implemented regarding erosion prevention and management

Item	Specific Requirement	Responsibility
2.0	**Prior to Commencement of Construction**	
2.1	Identify existing and proposed site drainage patterns.	Contractors Site Engineer
2.2	Identify the location of permanent and temporary sediment holding ponds to prevent debris escaping into the natural drainage systems and contain sediment to the designated construction areas.	Contractors Site Engineer
2.3	Develop and implement a monitoring system to confirm the effectiveness of erosion management measures during construction.	Contractors Site Engineer
3.0	**During Construction**	
3.1	Avoid stockpiling of sediments along existing and proposed drainage lines.	Contractors Site Engineer
3.2	Cover stockpiles with weighted plastic or tarpaulins when not being actively used, to minimise the mobilisation of sediments during storm events (heavy rain and/or strong wind).	Contractors Site Engineer
3.3	Keep vehicles to well-defined tracks and roads.	Contractors Site Engineer
3.4	Divert stormwater away from disturbed areas to minimise sediment loss.	Contractors Site Engineer
3.5	Divert stormwater away from access tracks and roads using drains and guttering as appropriate.	Contractors Site Engineer
3.6	Minimise the area of exposed ground by utilising appropriate construction measures, to minimise the amount of ground subject to erosion problems.	Contractors Site Engineer
3.7	Ensure compliance with relevant guidelines and apply appropriate techniques to minimise impacts on areas especially sensitive to erosion.	Contractors Site Engineer
3.8	Install temporary erosion control measures appropriate for the site such as sedimentation fences, diversion drains sediment traps and hardstand covers (e.g. hay bale sediment traps, sandbags and geofabric).	Contractors Site Engineer
3.9	Construct temporary sediment holding ponds (refer item 2.2) and divert runoff from disturbed areas to the ponds.	Contractors Site Engineer
3.10	Suspend work during heavy rain to ensure the site is sufficiently stabilised.	Contractors Site Engineer
4.0	**Post Construction**	
4.1	Implement a revegetation program.	Contractor
4.2	Maintain sediment control measures (including cleaning where necessary) until the site is completely stabilised (at least 4 weeks).	Contractors Site Engineer

5.0	**Waterway Crossing**	
5.1	Generally all machinery should be kept out of the waterway and operated on dry and stable areas within the works site.	Contractors Site Engineer
5.2	Existing crossings should be used to move equipment across the waterway. If there is no crossing and the stream must be crossed, machinery should be carefully 'walked' across the stream.	Contractors Site Engineer
5.3	If frequent crossings are required, laying a pad of clean rock at a shallow point of the waterway should make a temporary crossing.	Contractors Site Engineer
5.4	Temporary crossings should be removed when works have finished.	Contractors Site Engineer
6.0	**Instream Works**	
6.1	When excavating the channel, the flow should be diverted and the works site isolated.	Contractors Site Engineer
6.2	Constructing a cofferdam, berm or temporary channel should be used to divert the stream around dry zone.	Contractors Site Engineer
6.3	Any cofferdam should be constructed using sandbags, clean rock, steel sheeting or other non-erodible material.	Contractors Site Engineer
6.4	Temporary diversion channels should be protected by a lining of non-erodible materials to the high water mark.	Contractors Site Engineer
6.5	Silt curtains should be installed downstream of excavation works.	Contractors Site Engineer

7.2.3 Contamination Prevention

Objective

- Prevent contamination of waterways.

Controls

The controls listed in Table 7 are to minimise the risks of contamination associated with construction activities.

Table 7 Controls to be implemented to control contamination

Item	Specific Requirement	Responsibility
7.0	All workers should be trained and equipped to contain equipment spills and leaks.	Contractors Site Engineer
7.1	If a spill occurs, immediate steps should be taken to stop it polluting the water.	Contractors Site Engineer
7.2	The spill should be reported to the appropriate authorities as soon as possible.	Contractors Site Engineer
7.3	Petroleum products and other hazardous substances should be kept out of the waterway.	Contractors Site Engineer
7.4	Petroleum products and other hazardous substances should be kept in a designated, bunded storage facility.	Contractors Site Engineer
7.5	Refuelling, top-ups and oil checks should be done well away from the waterway.	Contractors Site Engineer
7.6	Non-toxic hydraulic fluids, such as vegetable-based fluids, should be used if possible.	Contractors Site Engineer
7.7	All equipment should be inspected and repaired regularly to prevent oil and other fluids leaking into the waterway.	Contractors Site Engineer
7.8	If equipment is to be immersed in the waterway, it should be cleaned beforehand to remove any external grease, oil and other fluids.	Contractors Site Engineer

7.9	Dirt and mud should be removed from all equipment before entering the works site and waterway to avoid transferring weeds and disease.	Contractors Site Engineer
7.10	Wash-down water is not to enter Waterways.	Contractors Site Engineer
7.11	Fresh concrete should be kept out of the waterway. If practical, prefabricated structures and precast components should be transported to the site and assembled on site.	Contractors Site Engineer
7.12	Any cast-in-place concrete should be isolated from the waterway for at least 48 hours to allow the pH to neutralise.	Contractors Site Engineer
7.13	Paints should not be allowed to enter the waterway when constructing, repairing and maintaining in-stream structures.	Contractors Site Engineer
7.14	If using wood treated with preservatives, the chemicals should be given enough time to fix before immersing the wood in the water.	Contractors Site Engineer

7.2.4 Site Rehabilitation

Objective

- Stabilise and rehabilitate banks, streambeds and other area disturbed during construction.

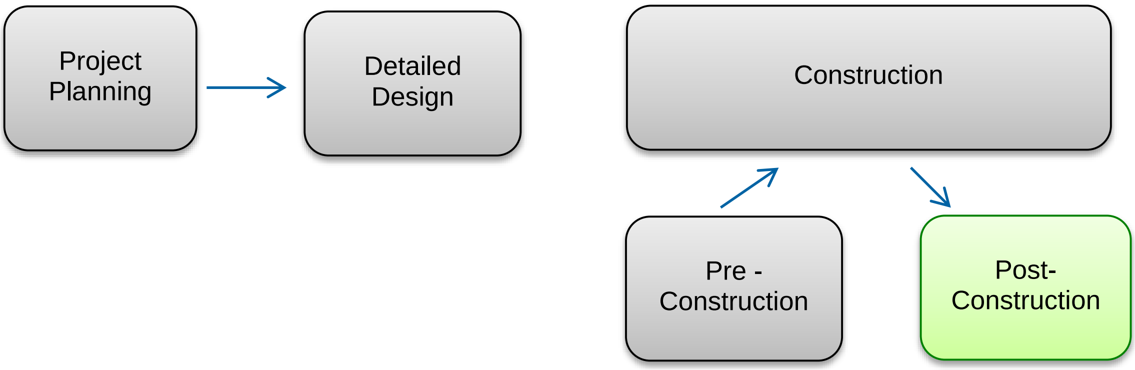
Controls

The controls listed in Table 8 provide guidance with regard to site rehabilitation.

Table 8 Controls to be implemented for site rehabilitation

Item	Specific Requirement	Responsibility
8.0	The site should be rehabilitated when the works have finished. If practical, native vegetation should be established on all exposed soil surfaces, including the head-slopes of bridges and culverts.	Contractor
8.1	Temporary erosion control measures, such as geo-textile silt fences, diversion ditches, sediment traps and temporary seeding with fast growing annuals, should be used to control erosion at the works site.	Contractor
8.2	Temporary erosion controls should remain in place until long-term erosion control methods are established and functioning.	Contractor
8.3	Long-term measures should be used to control erosion at the works site. Suitable measures include slope stabilisation, revegetation, soil coverings, rip-rap and armouring, check dams, sediment traps, brush barriers and vegetation filters.	Contractor
8.4	The measures used should be inspected and maintained regularly to make sure they are effective.	Contractors Site Engineer

8. Post Construction



Following the intense construction phase, the project moves into the post construction phase. The competition of a project does not occur at a single point in time. The post construction phase is an iterative process where the building works should be substantially complete; however some building works may still need completion or resolution, as well as the collection of outstanding documentation such as producer statements, warranties, certificates and so on. It is during this period where activities are handed from the contractor to the maintenance crews. Pertinent to the green and golden frog, on ground rehabilitation works and site controls and maintenance can be implemented.

8.1 Site Rehabilitation

Because of their value to green and golden frogs and other fauna, particular care should be given to restoring the quality of any impacted waterbodies after the completion of construction. This applies particularly to waterbodies that were in a less degraded condition prior to the commencement of construction. The vegetation, topography and habitat features of waterbodies should be returned to a condition at least equivalent to their original condition after the construction phase is complete.

8.2 Weed Control

In areas of known green and golden frog habitation, the physical removal of weeds is the recommended approach to remove declared weeds. There is no herbicide that is totally "safe" for frogs, but weed control using herbicide can be done if done carefully and if hand removal isn't an option.

If the use of herbicide is the only option, then it is important to choose a glyphosate based product. *Roundup bioactive* is likely the best to use for a pond or wetland. It's been advertised by the manufacturer as a "great (froggy) leap forward" in herbicide formulation for sensitive areas. Even so, operators must be careful not to spray directly into the water; if it is strong enough to kill declared weeds, frogs are also likely to be sensitive if the formula is sprayed directly onto the skin. Weed control should be done during the cooler months (April–August) when the frogs are less active. Direct 'spraying' with herbicide should not be undertaken on any frog habitat. Instead, accepted bush regeneration techniques should be used including:

- Hand-pulling small soft plants such as many annual weeds, for example, fleabane (*Conyza* spp.), variegated thistle (*Silybum marianum*), spear thistle (*Cirsium vulgare*), creeping thistle (*Cirsium arvense*) and grasses; and the seedlings of privet (*Ligustrum ovalifolium*);

- Inserting a knife into the ground near the plant and cutting around the root for plants with rhizomes or long tap roots, for example, asparagus fern (*Asparagus aethiopicus*) and some grasses;
- Scraping the stem of vines and scramblers, for example, Japanese honeysuckle (*Lonicera japonica*) and morning glory (*Ipomoea cairica*), and plants with extensive root systems, with a knife and applying herbicide to the length of the scrape;
- Cutting small woody weeds as near to ground level as possible and applying herbicide within 20 seconds to the cut, for plants with stems less than 5 centimetres in diameter, for example, gorse (Ulex europaeus), montpellier broom (*Genista monspessulana*) and English broom (*Cytisus scoparius*); and
- 'Frilling' large woody weeds with stems greater than 5 cm in diameter (e.g. Willow S*alix spp.*) by making a cut with a chisel at the base of the plant and applying herbicide into the gap immediately. Continuing in a circle round the trunk, repeat the 'cut and poison' technique at five centimetre intervals. Alternatively, a drill can be used to bore holes in the trunk and fill them with poison every five centimetres round the base.

The leaves and stems of some plant species can remain on-site in small piles to decompose. Other species such as lantana and many vines can re-sprout if left on the ground. To prevent this happening, create a raft or base of branches, fallen timber or rocks and stack small piles of weeds on top. These piles can then also act as shelter for many animal species.

Plants with thorns such as blackberry (*Rubus fruticosus agg.*) should be removed from the site as they pose a hazard to the frogs and workers. Any fruit or seeds should also be removed from site where possible.

8.3 Fire Management

Fire and fire management can adversely affect frogs by destroying vegetation used for refuge, foraging or shelter. In conducting fire management practices, burning in low lying areas and wetlands dominated by sedge and emergent growth should be restricted. These areas form important shelter and foraging habitat for the frog and generally pose a limited fire risk. The use of chemical fire suppressants may also have negative impacts on the frog, and their use should be avoided on and near known or potential breeding sites.

8.4 Underpass Inspection

Maintenance for underpasses is important and should be considered during the planning stages of project. Waterways in flood or flowing fast can move large bodies of water that can for pick up and move debris such as vegetation, wood, litter and even rock over great distances. This process blocks underpasses and can act as a barrier for effective movement of frogs. At sites where frog underpasses have been integrated into the road design, a regular inspection schedule should be developed and implemented. Inspections can be integrated with any existing culvert maintenance schedule. Maintenance requirements for designated underpass culverts should include:

- Controlling silt build-up and undertaking inspections annually as a minimum.
- Ensuring vegetation and weeds don't become established at entrances to culverts.

8.5 Adaptive Management

At locations where a confirmed green and golden frog population exists and integrated road design has been considered, ongoing monitoring and adaptive management actions should be implemented. Table 9 lists a number of potential monitoring actions that State Growth can employ to assess the success, maintain and improve of structures designed specifically for the management of green and golden frogs.

Table 9 Potential monitoring and adaptive management actions

#		Monitoring and Maintenance Requirement	Specific Task	Timing
1	Monitoring	Habitat Monitoring.	Vegetation, survey, weed inspection and to monitor the level of any public disturbance in and around. habitat	Annually or as determined by State Growth.
2		Population Survey	Targeted Survey.	Annually or as determined by State Growth in consultation with DPIPWE.
3		Wetland Vegetation Survey.	Vegetation Survey.	First two years following completion of pond. Thereafter, as determined by state growth.
4		Water Quality Monitoring.	Water Quality Testing.	As determined by State Growth.
5	Maintenance	Routine maintenance of terrestrial habitat.	Protective fence, exclusion barriers.	As determined by State Growth.
6		Major works maintenance.	Pond clean-out.	Annually or as determined by State Growth in consultation with DPIPWE.
7		Habitat maintenance.	Revegetation; additional planting to ensure pods and terrestrial habitats remain suitable, (i.e. weed removal, mowing).	As determined by State Growth.
8		Manage the level of any public disturbance in and around habitat.	Fence off areas such as movement corridors where impacts are considered a risk to GGF.	As determined by State Growth.
9		Pollution and stormwater maintenance.		As determined by State Growth.

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