UPGRADING THE PACIFIC HIGHWAY

Woolgoolga to Ballina Planning Alliance

UPGRADING THE PACIFIC HIGHWAY

Woolgoolga to Ballina Upgrade

Supplementary Biodiversity Assessment

FINAL

November 2013

NSW GOVERNMENT Transport Roads & Maritime Services

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SINCLAIR KNIGHT MERZ SKM

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PACIFIC HIGHWAY UPGRADE:

HALFWAY CREEK TO GLENUGIE

TARGETED FROG SURVEY

JULY 2013

PREPARED FOR ARUP-PB JOINT VENTURE BY:

LEWIS ECOLOGICAL SURVEYS

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Peter Rand (ARUP) – Project management, design input and output of Figures 4-1a-c and sourcing of GIS data.

Photography - Lewis Ecological Surveys © else stated

Top – Green-thighed Frog (*Litoria brevipalmata*) a common and widespread inhabitant of the Upgrade corridor.
Bottom – Giant Barred Frog (*Mixophyes iteratus*) known from Halfway Creek (ch. 20800).

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ABBREVIATIONS

Abbreviation	Description
PB-ARUP JV	PB-ARUP Joint Venture
RMS	Roads and Maritime Services
LES	Lewis Ecological Surveys
Ch.	Chainage
MCoA	Minister's Condition of Approval

1.0 INTRODUCTION

1.1 Background

The proposed upgrade of the Pacific Highway between Woolgoolga and Glenugie is part of the Pacific Highway Upgrade Program which extends over approximately 31km from the Sapphire and Woolgoolga Pacific Highway Upgrade (S2W – approximately 32km north of Coffs Harbour) to the Glenugie Upgrade Project (approximately 64km north of Coffs Harbour). Section 1 of the overall project extends from the southern tie-in north of Arrawarra Interchange to chainage 16500 within the existing 3.4km Halfway Creek Upgrade. Section 2 extends from chainage 16500 within the Halfway Creek Upgrade to the southern extent of the new northbound carriageway within the Glenugie Upgrade at chainage 31400.

The Arup Parsons Brinckerhoff Joint Venture (APBJV) has been established for the purpose of preparing the detailed design and documentation for the construction of this upgrade. Lewis Ecological Surveys has been engaged by the APBJV to perform targeted surveys for threatened frog species to inform the design and environmental management during the construction of the Upgrade. The target species have been summarised in Table 1-1.

The following is a report that covers section 2 of the W2G Upgrade.

Table 1-1. Summary of target species and their state and commonwealth legislative status.

Species	NSW *Threatened Species Conservation* Act (1995)	Commonwealth Environmental Protection and Biodiversity Conservation Act (1999)
Wallum Froglet (*Crinia tinnula*)	Vulnerable	-
Green-thighed Frog (*Litoria brevipalmata*)	Vulnerable	-
Giant Barred Frog (*Mixophyes iteratus*)	Endangered	Endangered
Southern Barred Frog (*Mixophyes balbus*)	Endangered	Vulnerable
Wallum Sedge Frog (*Litoria olongburensis*)	Vulnerable	Vulnerable
Green and Golden Bell Frog (*Litoria aurea*)	Endangered	Vulnerable

2.0 SURVEY METHODS

Both desktop and field surveys were undertaken as part of this study.

2.1 Desktop Surveys

2.1.1 Database search

Database searches were performed using the Office of Environment and Heritage (OEH) Bionet Wildlife Atlas http://www.bionet.nsw.gov.au/ with search coordinates covering an area of approximately 600 km^2 using the following coordinates:

North -29.83 West 153.03 East 153.21 South -30.09

2.2 Field surveys

All drainage lines and wetland areas that occurred within or close (i.e. 100 m) to the Upgrade corridor were subject to a field inspection during daylight hours to assess their suitability for the target frog fauna. At this time, a number of low lying areas that were likely to become flooded depressions during substantial rainfall events were also identified. This approach identified 15 survey sites that were surveyed over 5 nights between the 5th December 2012 and the 7th February 2013 (Figure 2-1). Surveys undertaken around the 26-28th January were in response to rainfall events which delivered in excess of 200 mm in 48 hours and was considered ideal for detecting the Green-thighed Frog (Figure 2-2). All the remaining surveys were performed within 7 days of a notable rainfall event (i.e. >10 mm in 24 hours).

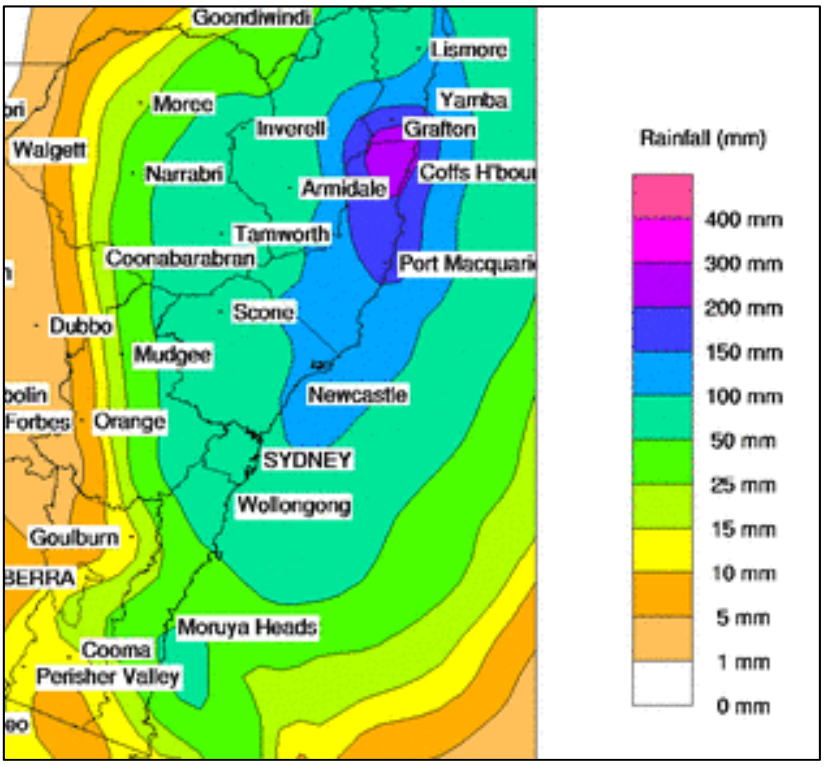

Figure 2-2. Rainfall pattern at the time of the Green-thighed Frog surveys on the 28th January 2013. **Source** – Bureau of Meteorology

Ephemeral sites were surveyed for 15 minutes to target Green-thighed Frog and occasionally Wallum Froglet whilst dams and streams were surveyed for a standardised 1 hour period. In some instances, sites were established in close proximity to one another in order to capture a range of habitats present. For example, a dam sites located near a stream was considered as two separate habitats.

2.3 Likelihood of the target species

The likelihood of each target species have been assigned to one of five groups ranging from 'known' to a 'very low'. A description for each of the ratings is provided below.

1. **Very Low**: The site does not support critical habitat attributes associated with the target species. For example, the occurrence of Giant barred Frog at an ephemeral wetland site when this species requires semi permanent to permanent water bodies most often associated with streams.

2. **Low:** The habitat attributes at this site are generally not present or heavily degraded to an extent to which they are unlikely to recover. For example, the suitability of the Arrawarra Creek tributary at ch. 300 for the Giant Barred Frog. At this location, the creek and a lot of its riparian vegetation is heavily degraded following the removal of its understorey and transformation into lawn areas and extensions of the creek into dams. Whilst the water itself may be suitable for the larval stage of this frog the riparian habitats offer very few refuge sites and foraging habitat for adults.
3. **Moderate**: The survey site provides suitable habitat for the species but there is usually a factor which has detracted from the site being given a higher ranking. For example, the habitat has been disturbed in some way at Boneys Creek for the Giant Barred Frog dues to past clearing of the riparian habitat, periodic grazing of cattle and horses and modification of the water course.
4. **High**: The species is known to utilise habitats similar to those found at the survey site and this is substantiated by nearby records (< 5km) and/or is the expert opinion from the author. There are numerous examples of this for the Green-thighed Frog including the Red Bank Creek area (ch. 5500-6200).
5. **Known**: The species was recorded during the course of the field surveys for this report.

These terms are used throughout the remainder of this report including figures and tables used to describe the distribution and likelihood of the target species.

Table 2-1. Summary of the surveys and likelihood of each target species using the Upgrade corridor.

Site No	Easting	Northing	Broad Location Details	Survey Dates
7	506309	6692153	Wells Crossing either side of highway	7.12.2012 27.1.2013
15	504697	6697793	Southern end of the Glenugie Deviation incorporating Glenugie Creek	27.1.2013 28.1.2013
16	505004	6697393	Franklins Road bordering the Pacific Highway	27.1.2013 28.1.2013
17	505146	6696122	Halfway Creek southbound Heavy Vehicle Checking Station	27.1.2013 28.1.2013
18	505150	6695791	0.5 km south of south bound heavy vehicle checking station	27.1.2013 28.1.2013
19	505247	6695381	Northern side of north bound heavy vehicle checking station on western side of highway	27.1.2013 28.1.2013
20	505573	6694902	Start of Bald Knob Road on edge of highway	27.1.2013 28.1.2013
21	505947	6694676	Around 0.7 km along Bald Knob Road in Wells Crossing Flora Reserve	27.1.2013 28.1.2013
22	505948	6692708	0.8 km north of Wells Crossing on edge of highway	27.1.2013 28.1.2013
23	506309	6692153	Flooded areas adjacent Wells Crossing	27.1.2013 28.1.2013
24	506434	6691762	0.5 km south of Wells Crossing	27.1.2013 28.1.2013
25	506627	6690629	Northern side of Halfway Creek in riparian vegetation	27.1.2013 28.1.2013
26a	507370	6689596	Around 0.5 km south of Kungala Road on Pacific Highway	27.1.2013 28.1.2013
26b	507636	6689300	Southern end of clearway safety fencing around 1 km south of Kungala Road where Halfway Creek flows close to pacific Highway	27.1.2013 28.1.2013
12	506370	6690572	Halfway Creek	27.1.2013 and 7.2.2013

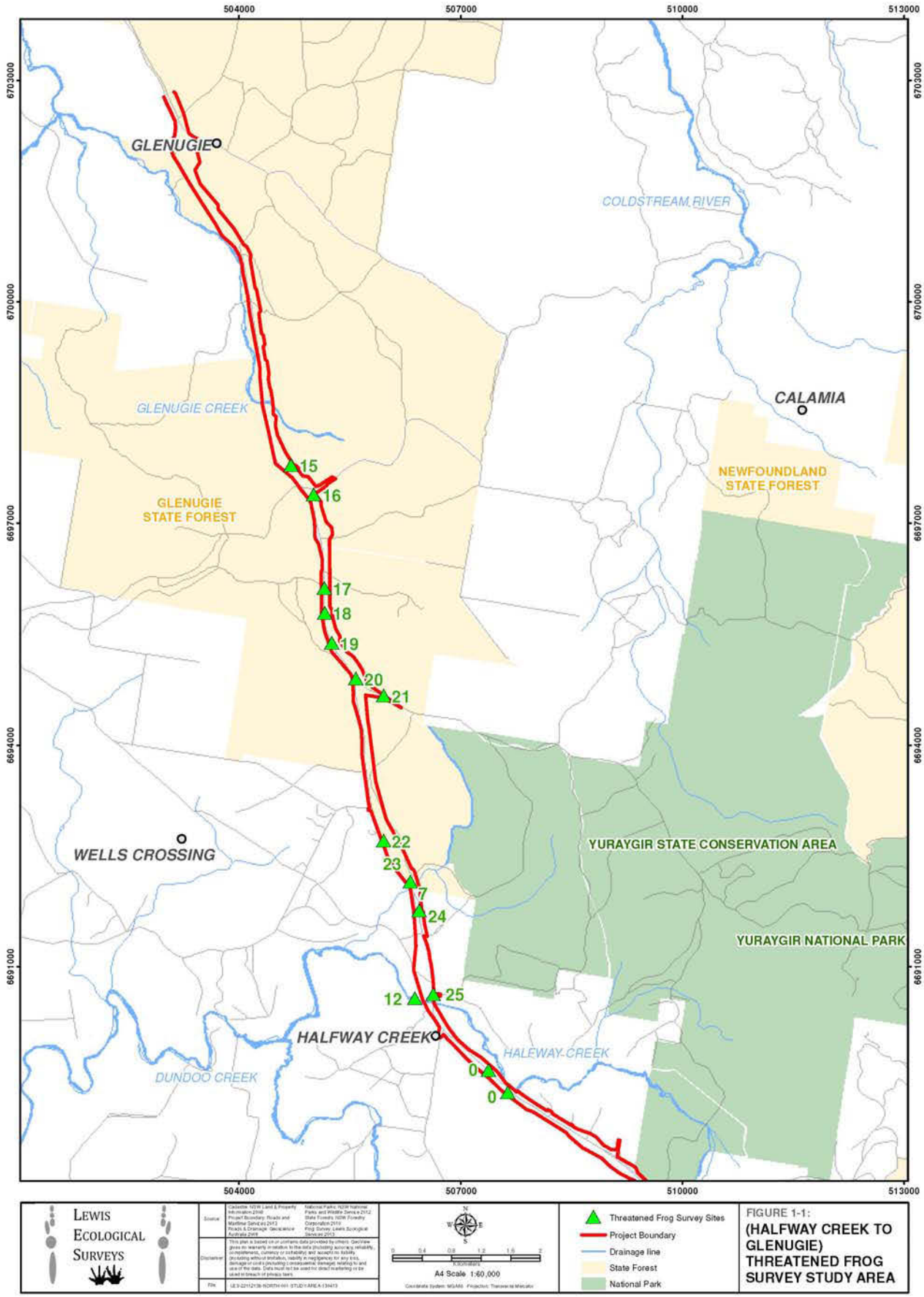

Figure 2-1. Distribution of survey sites between Halfway Creek and Glenugie (ch. 31400).

3.0 RESULTS & DISCUSSION

3.1 Giant Barred Frog

Giant Barred Frog was recorded at Halfway Creek where 1 male frog was observed around 250 m downstream of the existing highway (Figure 3-1a-d; Table 3-1). This site contains high quality habitat and is likely to contain a population of Giant Barred Frog which extends for several kilometres in either direction. In this context, where the proposed Upgrade footprint borders riparian habitat of this creek it should be considered Giant Barred Frog habitat (i.e. east of site 26b or ch.19000).

Habitat at both Wells Crossing (ch.22400) and Glenugie Creek (ch. 29380) was assessed as containing a low likelihood of supporting Giant Barred Frog (Table 3-2). Factors that have detracted from the overall suitability of these sites include the ephemeral nature of Glenugie Creek makes it unsuitable for a frog with long larval stages (i.e. tadpoles often taking 12 months; *see* Anstis 2002) and its riparian habitat is essentially dry sclerophyll forest leaving adult frogs relatively exposed. At Wells Crossing the riparian habitat is dominated by tall sedges (i.e. *Lepironia articulata*) and lack the obvious stream bank structure which is important as oviposition sites (i.e. steep sided banks for the tadpoles to hatch and drop directly into the water).

The known occurrence of the Giant Barred Frog within Halfway Creek warrants a number of frog specific recommendations which have been outlined in section 4.

Table 3-1. Summary of Giant Barred Frog data.

Site	No. Frogs Recorded	Comments
Halfway Creek (ch.20700; Site 12)	1	• Adult male recorded at edge of stream 250 m downstream of existing highway bridge. • High quality habitat though low number of frogs recorded. • Halfway Creek likely to contain extensive population extending upstream for several kilometres including the riparian habitat adjacent Site 26 a/b.

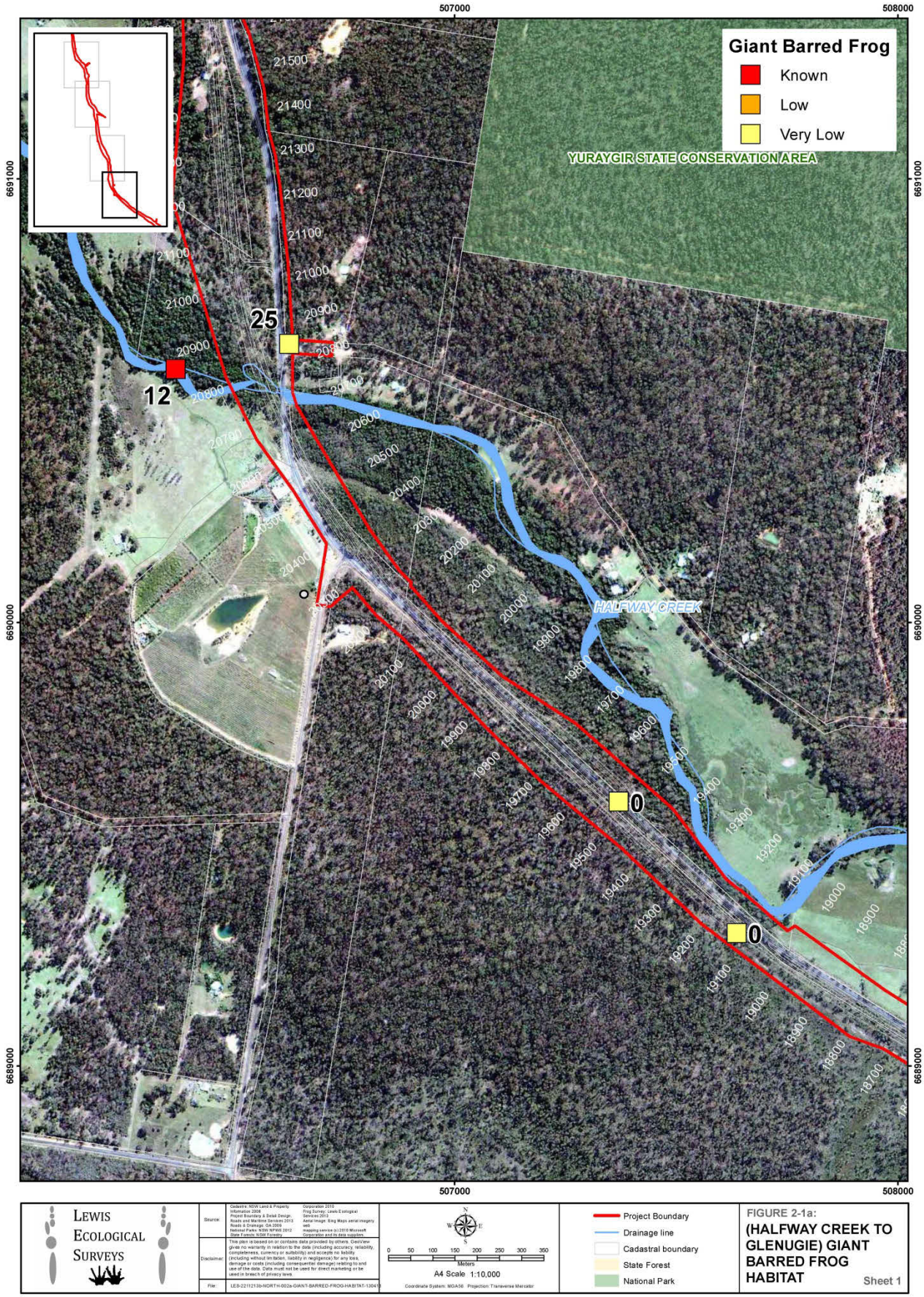

Figure 3-1 a. Survey sites and the likelihood of the Giant Barred Frog between ch. 18500-21600.

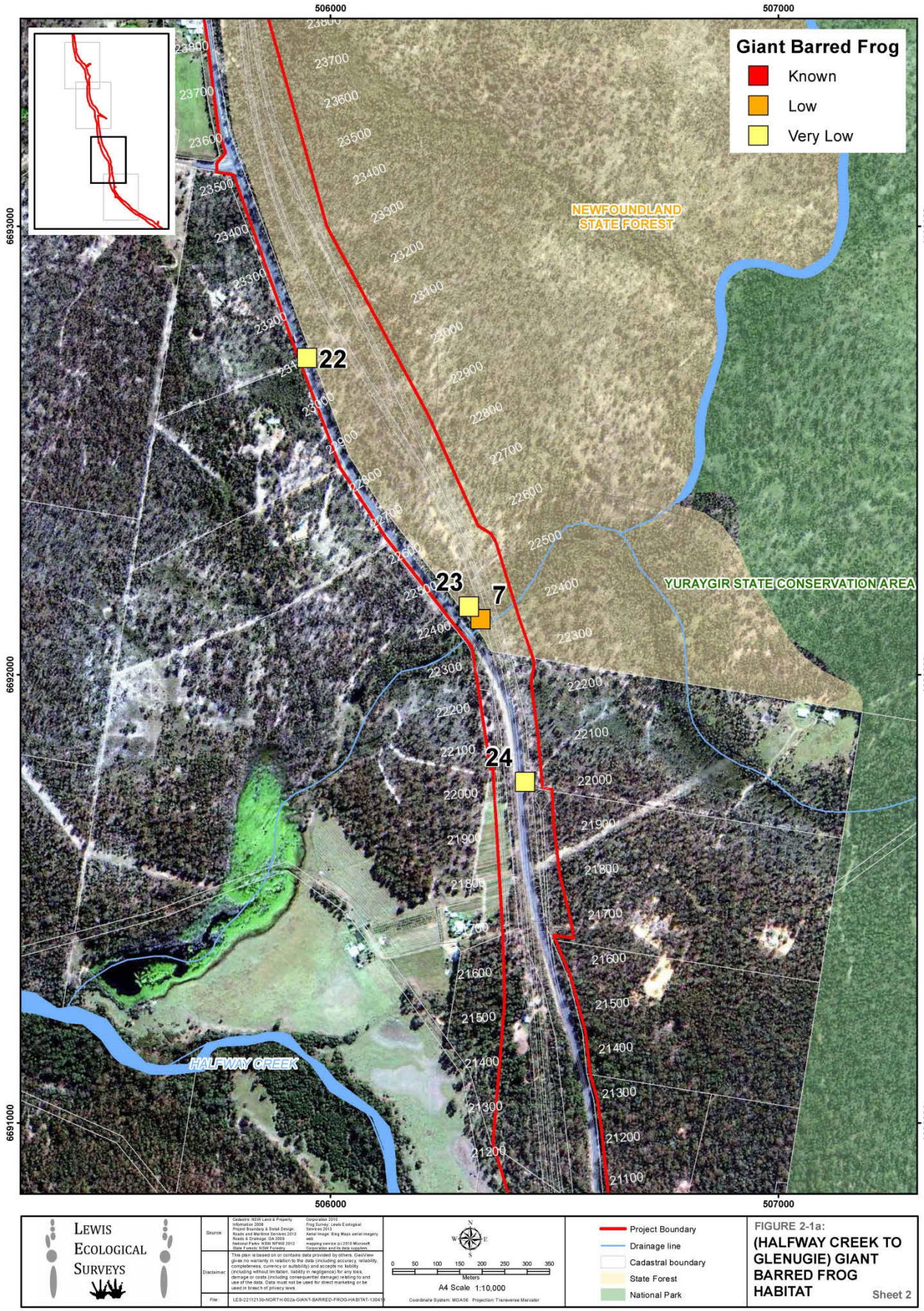

Figure 3-1 b. Survey sites and the likelihood of the Giant Barred Frog between ch.21100-23800.

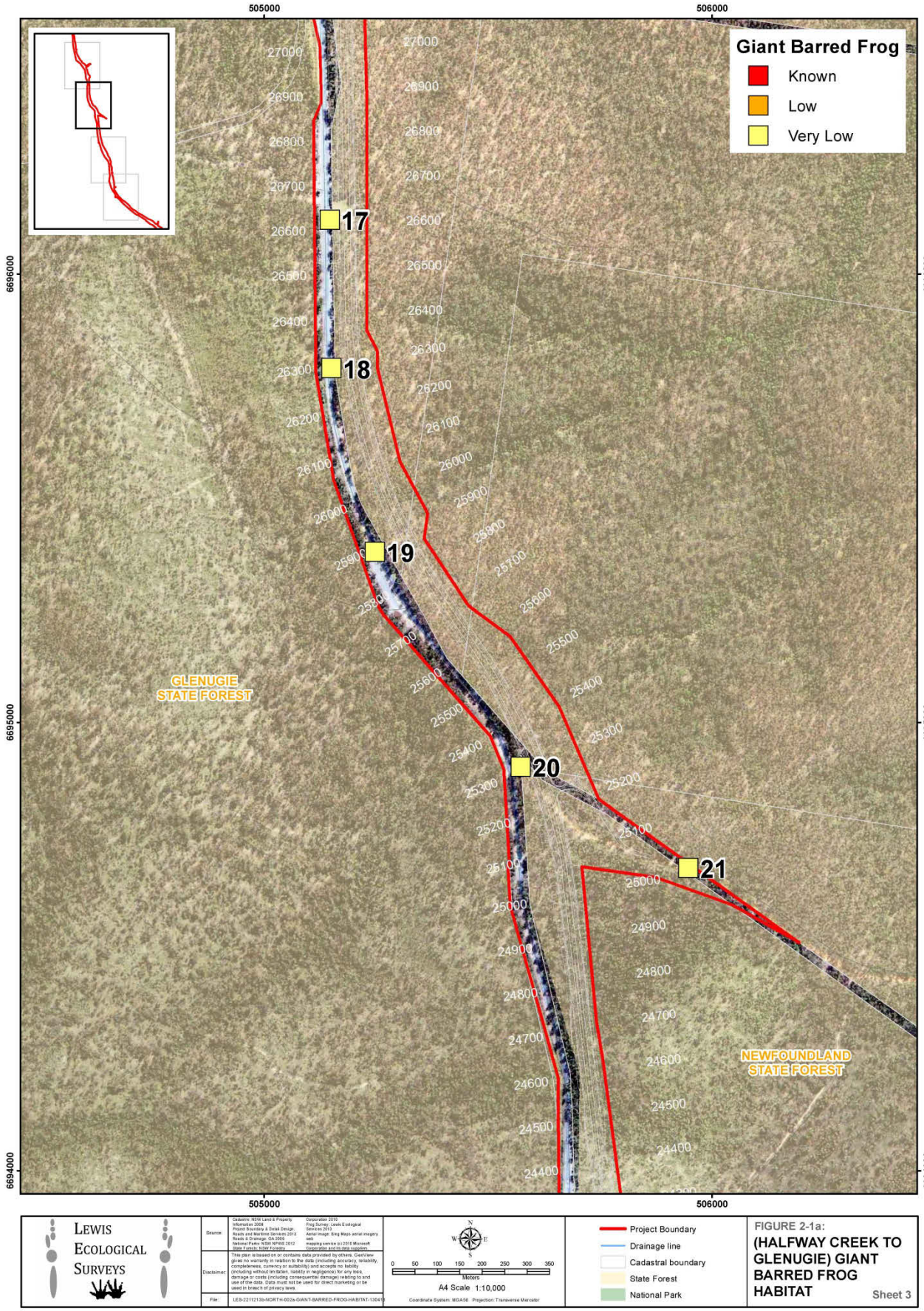

Figure 3-1 c. Survey sites and the likelihood of the Giant Barred Frog between ch. 24400-27000.

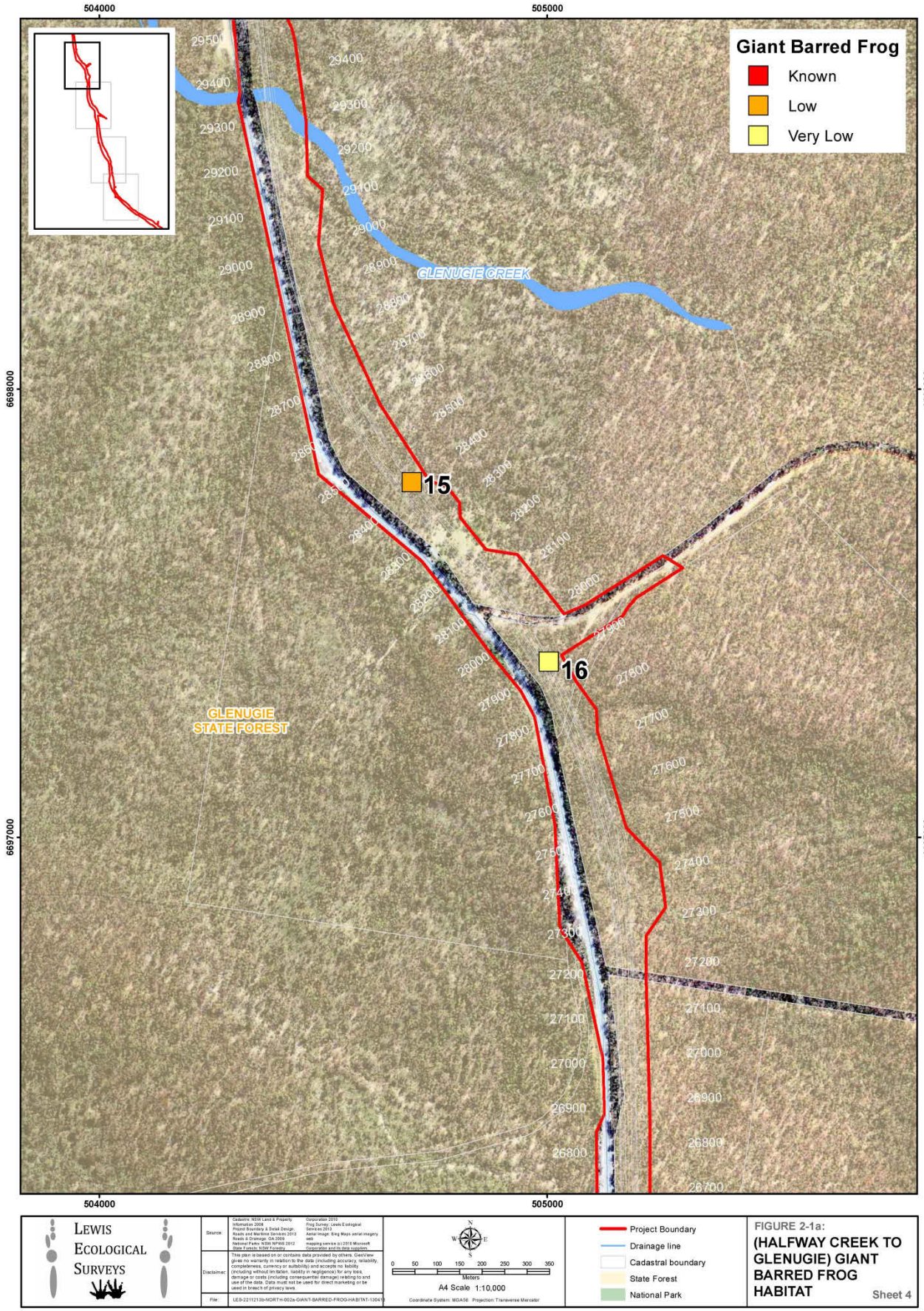

Figure 3-1 d. Survey sites and the likelihood of the Giant Barred Frog between ch. 26800-29500.

3.2 Green-thighed Frog

The Green-thighed Frog was recorded at eight locations north from Halfway Creek (ch. 19100) to Franklins Road, Glenugie (ch. 28000) on the 27th-28th January (Figure 3-2a-e; Table 3-3). The remaining seven locations were assigned as having either a moderate or high likelihood given the existing habitat in that general vicinity (<200 m) was suitable. Overall, this species is considered locally common in the dry forests around Halfway Creek and Glenugie where it occurred in larger tracts of forests that supported a less disturbed shrub and ground cover layer in close proximity to flooded depressions. These sites occur across the existing landscape gradient from drainages lines to mid slopes and low ridges.

The calling intensity of male frogs at the recorded sites ranged between 1-50 males with individuals calling from perched positions on fallen branches or vegetation (i.e. Frogsmouth, *Philydrum lanuginosum*) growing around the flooded pond. The Halfway Creek area (site 26a/b marked 0 and 0 on Figure 3-2 a), Franklins Road (site 16) and Bald Knob Tick Gate Road (Site 20) appear to be important sites within the Upgrade corridor with at least 15 males calling from each of these sites. Although no post breeding surveys were performed as part of this survey water is likely to have remained long enough for tadpoles to reach metamorphosis (i.e. >28 days).

A number of mitigation options should be adopted to reduce impacts on this species, namely strategic frog fencing and creating some breeding ponds where large areas of suitable breeding habitat would be removed by the Upgrade (*see* Section 4).

Table 3-2. Summary of Green-thighed Frog data.

Site	No. Frogs Recorded	Comments
Halfway Creek (ch. 19100; Site 26b but 0 in Figure 3-2 a)	40-50	• At least 40-50 males chorusing in this general area including the flooded roadside drains on western side of existing highway.
Halfway Creek (ch. 19500; Site 26a but 0 in Figure 3-2 a)	4-5	• Small chorus of frogs on western side of the existing highway.
Bald Knob Tick Gate Road (ch.25000; Site 21)	1	• Occasional call from one frog adjacent to flooded roadside within Wells Crossing Flora Reserve.
Bald Knob Tick Gate Road (ch.25300; Site 20)	15	• Frogs concentrated around a shallow borrow pit adjacent to cattle grid and existing highway. • Site likely to be a successful breeding site given the tenure of specific aquatic plants (i.e. Frogsmouth, *Philydrum lanuginosum*).
Pacific Highway Northbound Heavy Vehicle Inspection Station (ch. 25900; Site 19)	3	• Frogs calling from western side of road intermittently.
Area between heavy vehicle inspection stations (ch. 26300; Site 18)	5-8	• Frog chorusing from flooded roadside drain on western side of existing highway.
Pacific Highway Southbound Heavy Vehicle Inspection Station (ch. 25900; Site 19)	3	• Frogs calling from western side of road. • Calling confined to roadside drain.
Franklins Road (Ch. 27900; Site 16)	15	• Frogs calling from flooded drains immediately south of cattle creek and turn around bay. • Site likely to be successful breeding as it contains some deeper sections capable of holding water for at least 30 days.

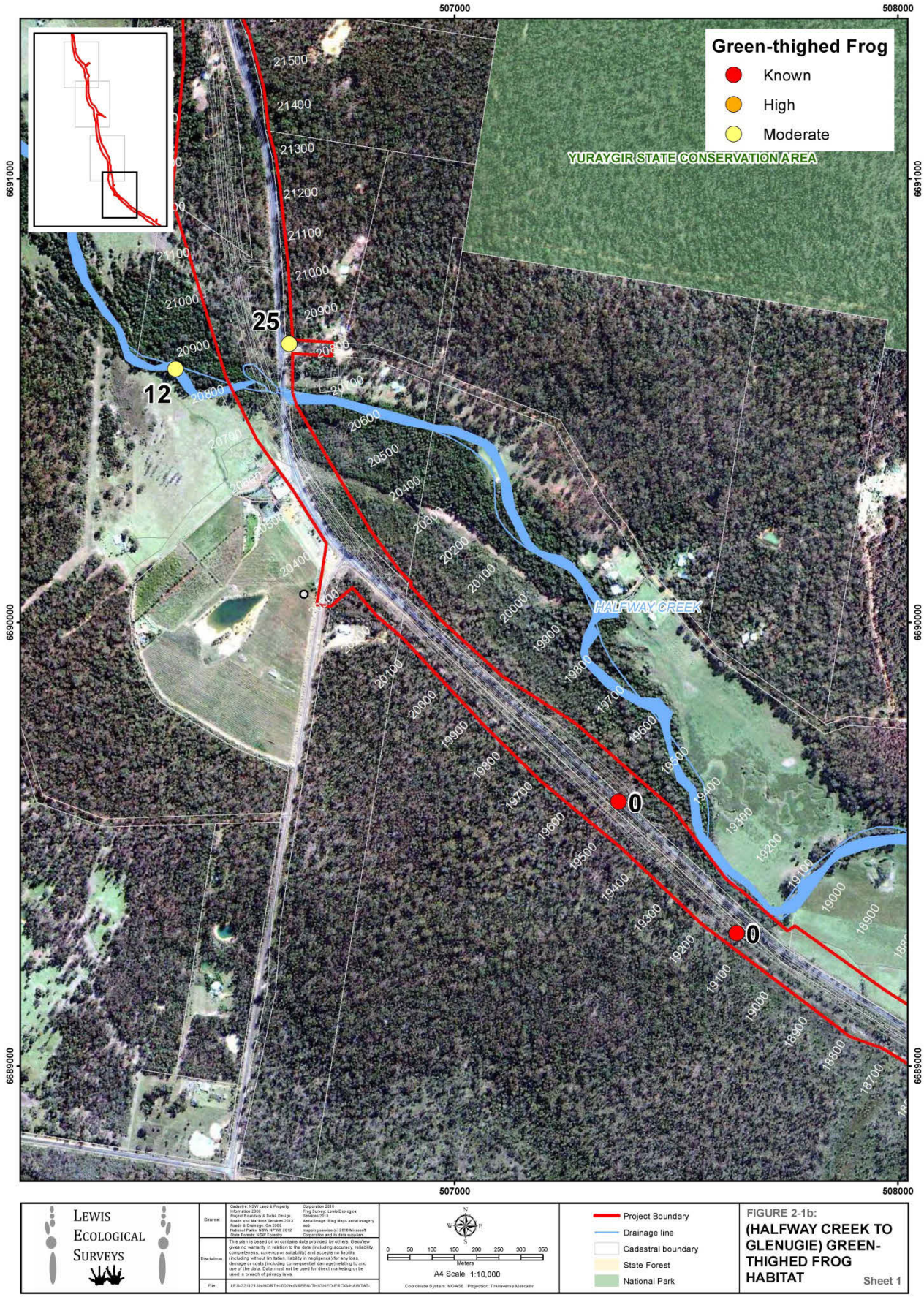

Figure 3-2 a. Survey sites and the likelihood of Green-thighed Frog between ch. 18600-21600.

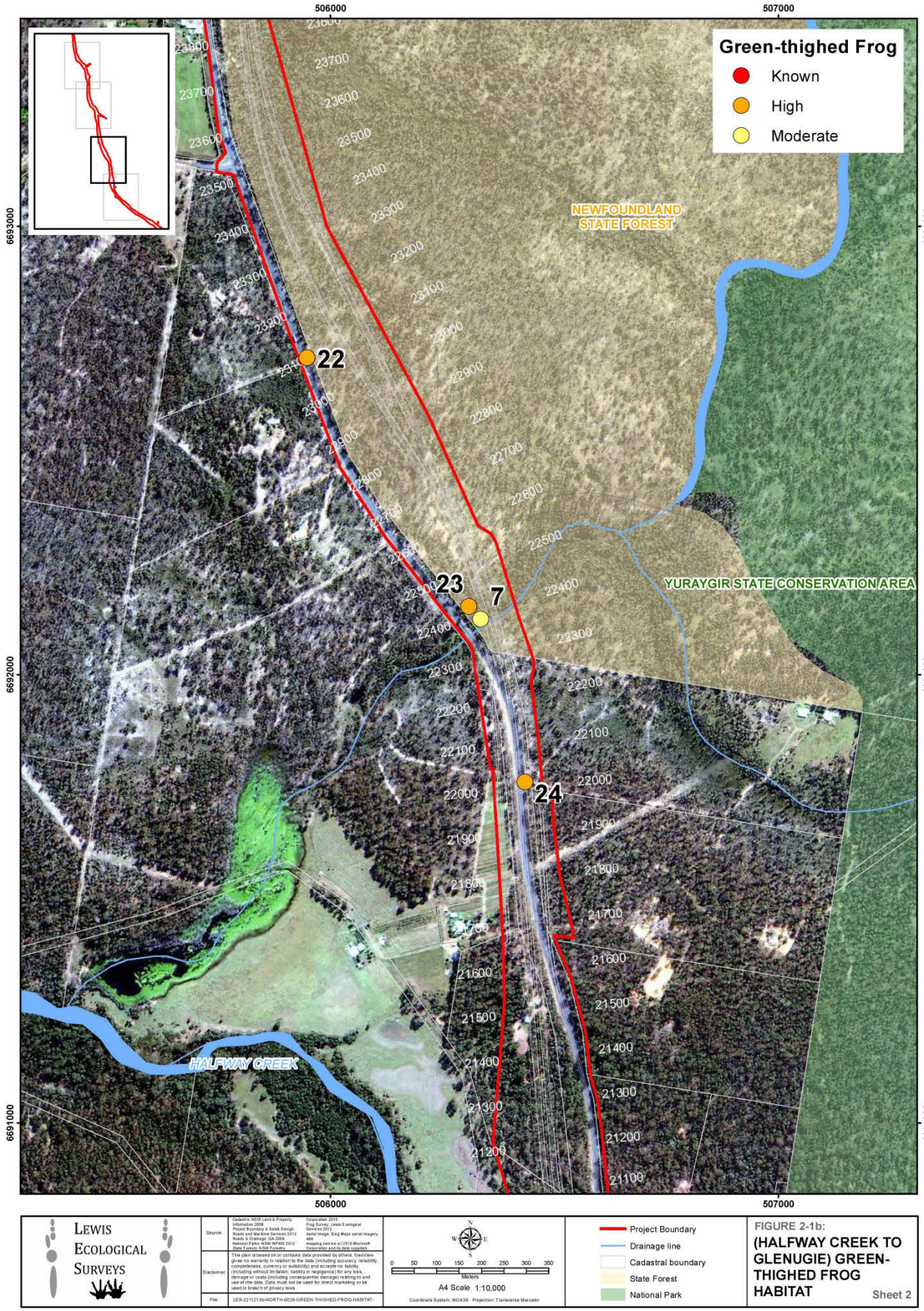

Figure 3-2 b. Survey sites and the likelihood of the Green-thighed Frog between ch. 21100-23800.

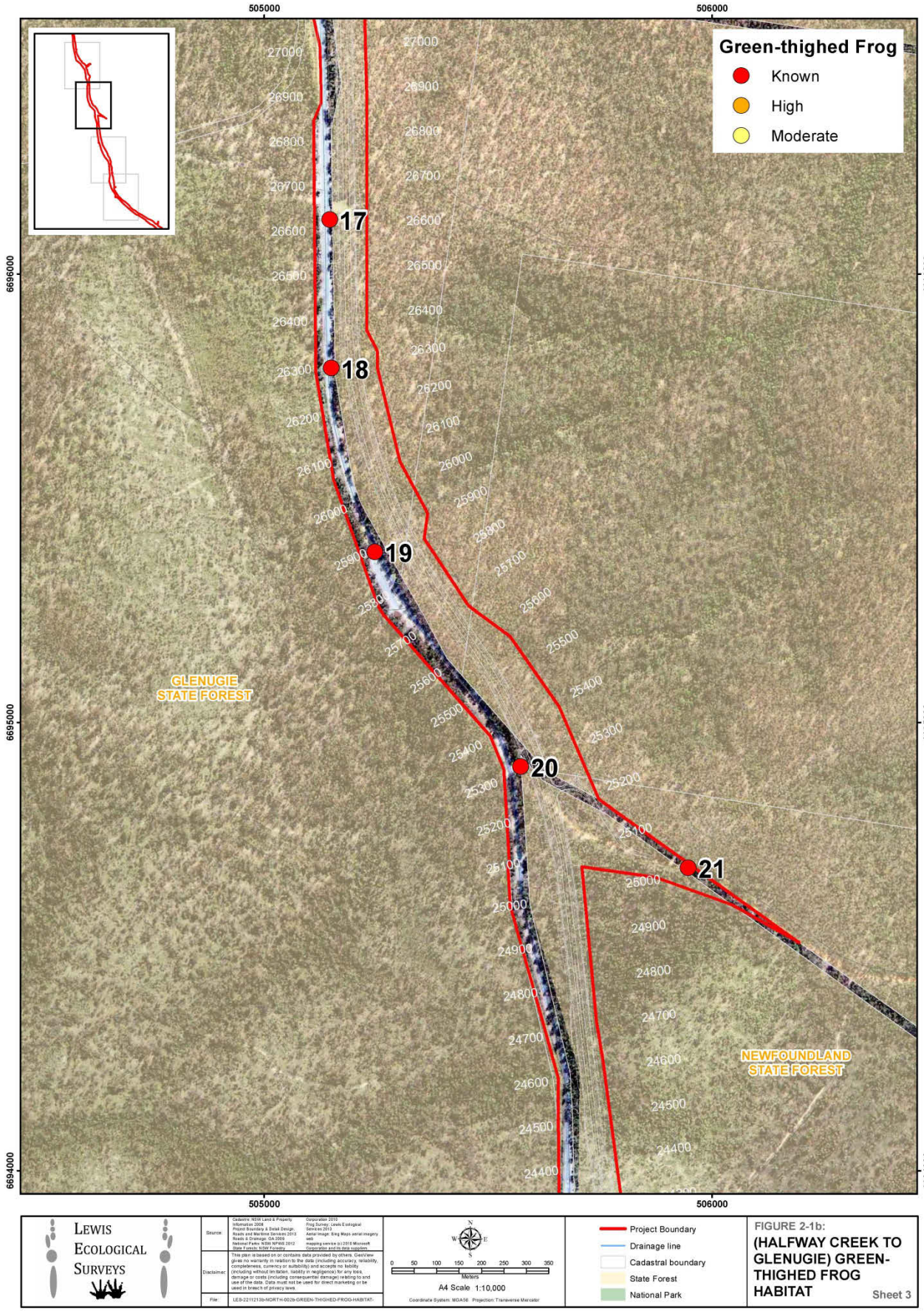

Figure 3-2 c. Survey sites and the likelihood of the Green-thighed Frog between ch. 24400-27100.

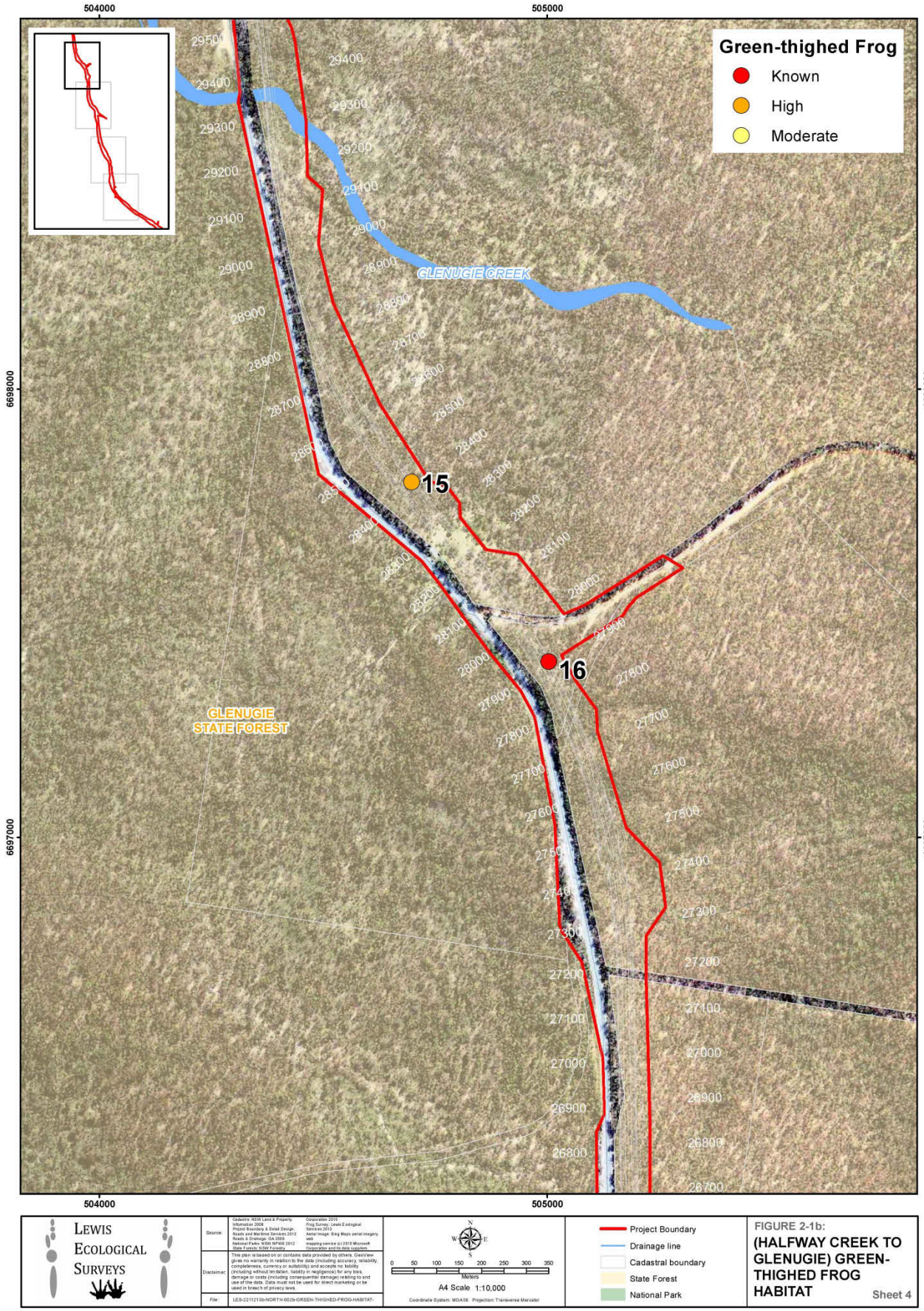

Figure 3-2 d. Survey sites and the likelihood of the Green-thighed Frog between ch.26700-29500.

3.3 Wallum Froglet

The Wallum Froglet was not recorded during the survey (Table 3-2). There is however, one historic record (OEH Scientific Licences dataset: SDMPI0258179) of this species along Bald Knob Tick Gate Road which corresponds to Site 21 in this study (i.e. Wells Crossing Flora Reserve). The habitat at this location was principally Ironbark/Spotted Gum ± Grey Box dry sclerophyll forest which does not normally align with this species (*see* Meyer *et al.* 2006) but rather the common and widespread Eastern Sign-bearing Froglet (*Crinia parinsignifera*). This later species is common and widespread between Corindi and Grafton (OEH 2013). Habitat around 2 km further to the south at Wells Crossing (ch. 22400) presents as being more suitable for the Wallum Froglet given the sedges (i.e. *Leperonia articulata*; *Baumea sp*) and somewhat tannin stained waters closely resemble known Wallum Froglet habitat bordering coastal sand plains further to the east in Yuraygir National Park. Frogs recorded at Wells Crossing were either species associated with ephemeral situations (i.e. *Pseudophyrne*) or common pond dwelling species such as Tyler's Tree Frog (*Litoria tyleri*), Striped Marsh Frog (*Limnodynastes peroni*) and Eastern Dwarf Frog (*Litoria fallax*) which don't normally co-occur with Wallum Froglet. Given this, the site was assessed as having a low likelihood of supporting Wallum Froglet which is indicative of the Upgrade corridor and therefore no specific Wallum Froglet mitigation has been recommended.

3.4 Green and Golden Bell Frog

The Green and Golden Bell Frog was not recorded during the field survey (Table 3-2). The nearest known populations exist in Yuraygir National Park with one at Blue Lake around 25 km to the south east of Halfway Creek and another at Diggers Camp around 25 km east of Glenugie (*see* Lewis and Goldingay 1999).

Surveys identified Wells Crossing as providing the most suitable of the surveyed locations and whilst habitat at this site is consistent with the broad habitat requirements of this species with emergent aquatic vegetation, slow or still water body there are no obvious habitat links in which a meta population structure could be linked with these known populations. Given their low overall likelihood of occurrence no specific bell frog mitigation is warranted.

3.5 Wallum Sedge Frog

The Wallum Sedge Frog was not recorded during the field survey (Table 3-2). This species is not known from the study area although it is known from a number of locations closer to the coast where it reaches its southern distributional limit around Woolgoolga (Lewis and Goldingay 2005; Meyer *et al.* 2006; OEH 2013).

Field surveys conducted throughout the study area identified this species as having a 'very low' likelihood of occurrence. This is due to its specialised habitat requirements which are not present within or in close proximity to the study area. For example, Wallum Sedge Frogs are restricted to coastal fore dune swamps and lagoon systems that are frequently inundated with low pH waters (Barker *et al.* 1995; Cogger 1995; Robinson 1995; Ehmann 1997; Hines *et al.* 1999; Lewis and Goldingay 2005; Meyer *et al.* 2006). This species is more sensitive to habitat disturbance than the Wallum Froglet and require more permanent naturally fluctuating wallum wetlands. Given their low likelihood of occurrence no specific sedge frog mitigation measures are warranted.

3.6 Southern Barred Frog

The Southern Barred Frog was not recorded during the field survey (Table 3-2). This species is not known from the study area although it is known from a number of locations further to the west in the Dorrigo and Nymboida areas (OEH 2013). These populations are around 30-40 km further to the west.

Field surveys conducted throughout the study area identified this species as having a 'very low' likelihood of occurrence. This is due to its association with more montane areas above 500 m elevation on the NSW north coast. No specific mitigation measures are warranted for this species.

3.7 Discussion of Key Findings

The area between Halfway Creek (ch. 18000) and Glenugie (ch. 31400) supports a population of the endangered Giant Barred Frog at Halfway Creek and multiple populations of the vulnerable Green-thighed Frog which extend over most of the Upgrade corridor. There is an aberrant historic record of the Wallum Froglet close to ch. 25000 which is an outlier from more coastal locations that warrants further investigation. For the remaining three species considered in this survey the Upgrade corridor either provides no habitat for the Southern Barred Frog and Wallum Sedge Frog which have both been assigned a 'very low' likelihood of occurrence. In the case of the Green and Golden Bell Frog the still to slow moving waters of Wells Crossing supporting emergent aquatic vegetation that is broadly similar to known bell frog habitat in Yuraygir National Park, however, the tenuous habitat linkages for a wetland frog such as this indicate there is a low likelihood of this species occurring in the Upgrade corridor.

Although surveys performed as part of this study were cursory in their nature (1-2 visits) the results are considered adequate for the purposes of providing useful information to progress the design and environmental management requirements for this section of the Upgrade. In this context, it is considered necessary to adopt some species specific management strategies to reduce impacts on threatened frogs as the Upgrade is constructed in the vicinity of ch. 19000-19500, Halfway Creek, Bald Knob Tick Gate Road and Franklins Road where known populations of Green-thighed Frog and Giant Barred Frog occur. These management strategies relating to design and environmental management during constructed have been presented in Section 4.0.

Table 3-3. Summary of the surveys and likelihood of each target species using the Upgrade corridor.

Site No	Easting	Northing	Broad Location Details	Survey Dates	Giant Barred Frog	Green-thighed Frog	Wallum Froglet	Southern Barred Frog	Wallum Sedge Frog	Green and Golden Bell Frog
7	506309	6692153	Wells Crossing either side of highway	7.12.2012 27.1.2013	Low	**Moderate**	Low	Very Low	Very low	Low
15	504697	6697793	Southern end of the Glenugie Deviation incorporating Glenugie Creek	27.1.2013 28.1.2013	Low	**High**	Very low	Very Low	Very low	Very Low
16	505004	6697393	Franklins Road bordering the Pacific Highway	27.1.2013 28.1.2013	Very Low	**Known**	Very low	Very Low	Very low	Very Low
17	505146	6696122	Halfway Creek southbound Heavy Vehicle Checking Station	27.1.2013 28.1.2013	Very Low	**Known**	Very low	Very Low	Very low	Very Low
18	505150	6695791	0.5 km south of south bound heavy vehicle checking station	27.1.2013 28.1.2013	Very Low	**Known**	Very low	Very Low	Very low	Very Low
19	505247	6695381	Northern side of north bound heavy vehicle checking station on western side of highway	27.1.2013 28.1.2013	Very Low	**Known**	Very low	Very Low	Very low	Very Low
20	505573	6694902	Start of Bald Knob Road on edge of highway	27.1.2013 28.1.2013	Very Low	**Known**	Very low	Very Low	Very low	Very Low
21	505947	6694676	Around 0.7 km along Bald Knob Road in Wells Crossing Flora Reserve	27.1.2013 28.1.2013	Very Low	**Known**	Very low	Very Low	Very low	Very Low
22	505948	6692708	0.8 km north of Wells Crossing on edge of highway	27.1.2013 28.1.2013	Very Low	**High**	Very low	Very Low	Very low	Very Low
23	506309	6692153	Flooded areas adjacent Wells Crossing	27.1.2013 28.1.2013	Very Low	**High**	Very low	Very Low	Very low	Very Low
24	506434	6691762	0.5 km south of Wells Crossing	27.1.2013 28.1.2013	Very Low	**High**	Very low	Very Low	Very low	Very Low
25	506627	6690629	Northern side of Halfway Creek in riparian vegetation	27.1.2013 28.1.2013	Very Low	**Moderate**	Very low	Very Low	Very low	Very Low
26a	507370	6689596	Around 0.5 km south of Kungala Road on Pacific Highway	27.1.2013 28.1.2013	Very Low	**Known**	Very low	Very Low	Very low	Very Low
26b	507636	6689300	Southern end of clearway safety fencing around 1 km south of Kungala Road where Halfway Creek flows close to pacific Highway	27.1.2013 28.1.2013	Very Low	**Known**	Very low	Very Low	Very low	Very Low
12	506370	6690572	Halfway Creek	27.1.2013 and 7.2.2013	**Known**	**Moderate**	Very low	Very Low	Very low	Very Low

4.0 RECOMMENDED ACTIONS

Five broad management actions have been recommended as a means to avoid, minimise and mitigate impacts to threatened frog fauna for the Upgrade during both the design and construction phases of the project. These could be captured in the later development of a threatened frog management strategy that considers at least Giant Barred Frog, Green-thighed Frog and Wallum Froglet with the objective to guide construction and environmental management of threatened frog populations during the construction of the Upgrade.

As part of these early works design package the recommended actions include:

1. **Frog fencing in areas of Giant Barred Frog and Green-thighed Frog habitat considered in the context of:**
    a. **Temporary frog fencing; and**
    b. **Permanent frog fencing.**

2. **Creation of frog breeding ponds for Green-thighed Frog.**

3. **Identification and protection of known habitat and areas considered to have a 'moderate' or 'high' likelihood of supporting threatened frog fauna;**

4. **Frog survey and collection to be implemented in four stages of:**
    a. **Early works when establishing site controls (i.e. clearing limits for clearing and grubbing);**
    b. **Pre-clearing survey within 5 days of commencing the clearing and grubbing program;**
    c. **Supervision during the clearing and grubbing program; and**
    d. **De-watering procedures within areas identified as Giant Barred Frog habitat (i.e. creek diversions) and as deemed necessary by the project Ecologist for identified Green-thighed Frog breeding locations[1].**

5. **An unexpected finds procedure to address instances where threatened frogs are detected during routine pre-clearing surveys or at other times during the project.**

4.1 Development of Frog Fencing

The development of frog fencing can be divided into two categories of temporary frog fencing leading up to and during the construction of the Upgrade followed by the installation of permanent frog fencing. Both are discussed below.

4.1.1. Temporary Frog Fencing (Early Works – Establishing Site Controls)

a) Temporary frog fencing should be installed for up to 200 m either side of the stream or breeding site (minimum 500 mm for Green-thighed Frog and 900 mm for Giant Barred Frog high above ground and buried to a depth of 50-100 mm)[2]. Where the terrestrial habitat bordering the stream is cleared land (i.e. southern side of Halfway Creek) this could be reduced to 100 m. In the vicinity of ch. 19000-19500 the frog fencing on the

[1] Often these would be expected to be dry leading up to a clearing event.
[2] It is acknowledged that installation of the fence itself will represent ground/vegetation disturbance and as such it should be subject to a pre clearing active search survey and the works supervised by the Project Ecologist.

eastern side of the Upgrade should be the larger fence for the Giant barred Frog. Whenever the frog fence has been installed, a return wing (5 m in length) should be used to reduce frogs breaching the fence.

c) Fencing should be installed and inspected/signed off by the Project Ecologist involved with the Upgrade. This procedure should form part of the pre clearing/ground disturbance checklist/permit.

d) Fencing should be installed at least 5 days prior to the scheduled clearing date so that active searches for frogs can be performed within the clearing footprint (see below).

e) The works area for the temporary fencing should be inspected/searched by the Project Ecologist immediately prior to installing the temporary fencing. The search should use active techniques such as raking the leaf litter, call broadcast (this species will readily call during the day) and inspections around tussocks (i.e. *Lomandra* clumps in particular) and logs. A nocturnal survey may be required the night before depending on the season and prevailing weather conditions.

4.1.2 Permanent Frog Fencing

a) Frog fencing should be installed as a minimum at the following locations:
   - ch. 19000-19500 where ponds are being proposed for the Green-thighed Frog. The eastern side must be designed using the Giant Barred Frog design given the proximity to Halfway Creek;
   - Upwards of 200 m either side of ch. 20800 (Halfway Creek) to reduce impacts on Giant Barred Frog. This could be amended depending on the final design of the bridge over Halfway Creek and the batter profile of the abutments within 200 m of the stream;
   - Ch. 24800-25200 (Bald Knob Tick Gate Road) where ponds are being used on the eastern side of the road; and
   - Ch. 27800-28200 (Franklins Road) where ponds are being recommended in the event of any disturbance to the existing breeding site.

b) A fence return of 5 m should be installed if the frog fencing does not extend for at least 50 m into unsuitable habitat (i.e. cleared land or non-riparian habitat) at the above mentioned sites.

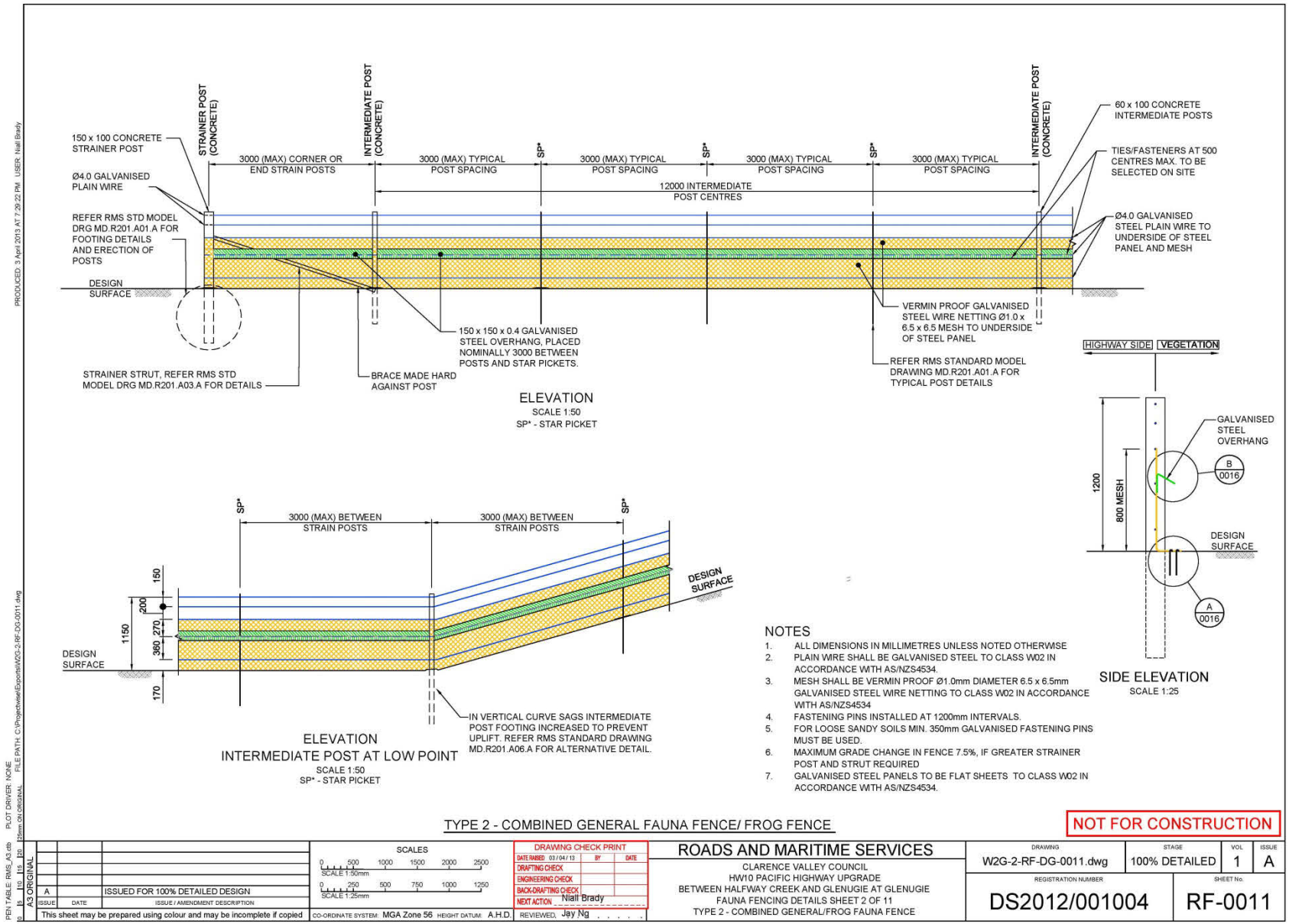

Figure 4-1a. – Type 2 General fauna/frog fence design.

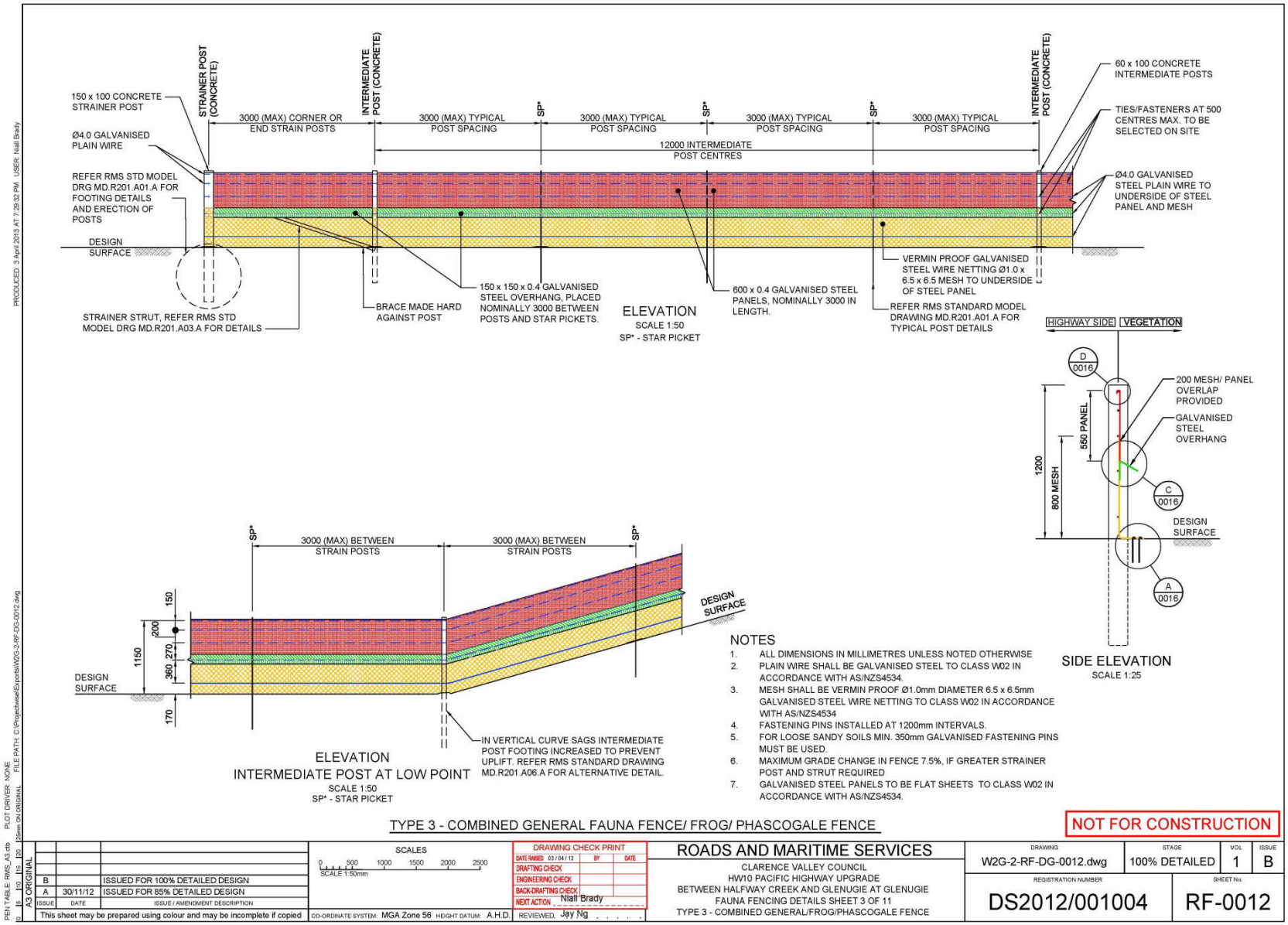

Figure 4-1b. – Type 3 General fauna/frog fence design.

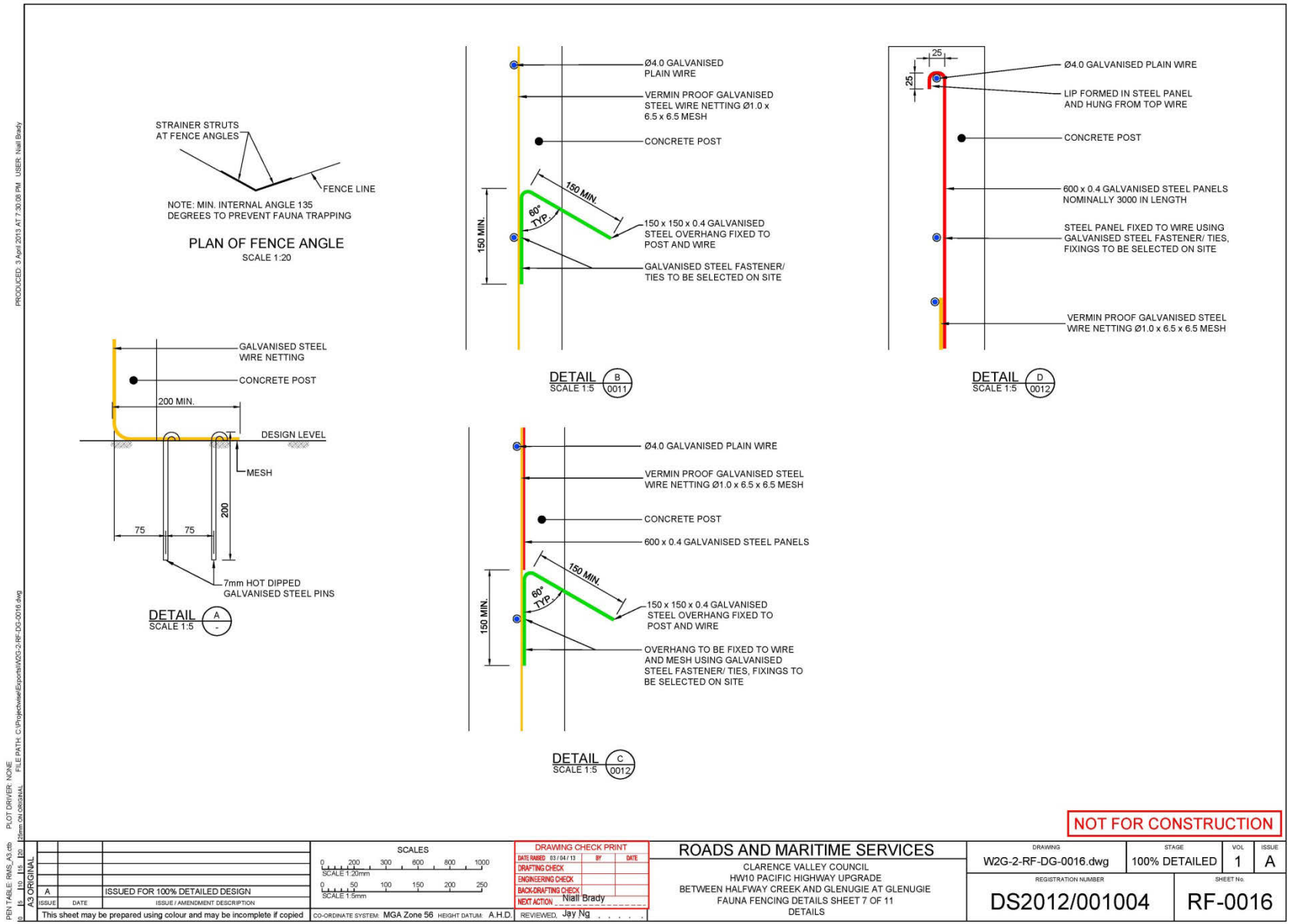

Figure 4-1c. – Cross section profile of Type 2 and Type 3 general fauna/frog fence design.

Design wise, the frog fencing should be incorporated into the fauna fencing design or alternatively the boundary fence. From a design perspective, two types of frog fencing have been proposed to address the differing sizes of the threatened frog's encountered (Figure 4-1a-c). Any amendments to these designs should ensure the gauze size is no greater than 30-40 mm at sites with Giant Barred Frogs and <20 mm at sites with Green-thighed Frog to ensure they remain effective. This should still prevent frogs from moving through the fence whilst still allowing for overland water flows/drainage. The fence would need to stand at least 900 mm in height with the residual 150 mm use as an on ground return (i.e. product 1050 mm in width/height).

The success of this design during any subsequent ecological monitoring should be based on the absence of Giant Barred Frog or Green-thighed Frog fence breaches[3]. As part of the monitoring procedures for measuring the effectiveness of the frog fencing, some monitoring of fence breaches should be undertaken by a suitable qualified zoologist at certain times of the year (i.e. when population monitoring occurs) and involve surveys for frogs on both sides of the fence.

4.2 Green-thighed Frog Breeding Ponds

The construction of Green-thighed Frog breeding ponds should be undertaken at locations where there is potential for the loss of breeding sites within the Upgrade corridor and the changed hydrological patterns have the potential to affect the suitability of residual areas adjacent to the corridor. After considering this, three locations have been identified:

a) Halfway Creek (ch. 19000-19500) providing ponds on both sides of the Upgrade;
b) Bald Knob Tick Gate Road area (ch. 25000) providing ponds on the eastern side of the Upgrade; and
c) Franklins Road (ch. 28000) providing ponds on the eastern side of the Upgrade if this area is impacted by means of ground disturbance or changed hydrological regimes.

At the remaining locations where Green-thighed Frog was recorded or is expected to occur (i.e. moderate or high likelihood) the construction of breeding ponds is not warranted. This is due to the newly constructed carriageway inevitably creating new areas of breeding habitat as a result of changed drainage patterns and the positioning of fill and embankments that will create the required ephemeral pools of water. For example, Green-thighed Frogs have recently used an area on the Kempsey Bypass Project which was formerly a seasonally inundated grazing paddock adjacent to swamp forest (Lewis in prep).

The key element with designing a breeding site for Green-thighed Frog is to ensure the water body periodically dries out. This provides two important advantages for this species, firstly, it reduces competitive interactions with pond dwelling frogs (i.e. Tyler's Tree Frog, *Litoria tyleri*) which are common in the study area, and secondly, it reduces predatory interactions associated with the exotic Mosquito Fish (*Gambusia holbrooki*). Based on site specific data and surveys of breeding sites on the mid north coast including monitoring of constructed Green-thighed Frog ponds at Kempsey, a temporary water body should hold surface water for between 40-50 days at sunny exposed sites and for between 60-70 days at more shaded locations following a suitable summer rainfall event of 100-150 mm in 24-36 hours.

With the above in mind, the shallow excavated ponds should be similar to those illustrated in Plate 4-1 and have the following attributes:

- Each pond should cover and area of around 12 m^2;
- Maximum deep of 400 mm;
- Batters no steeper than 1:4;

[3] This will also be detailed in the EMS required for the project.

- Construct 3-5 with each one staggered out from a drainage line thus ensuring they will be flooded at differing rainfall events; and
- Vegetated via assisted planting techniques with low naturally occurring ground covers obtained from the site (i.e. *Carex sp.*, *Fimbristylis sp.*).

Another key message in the design of the breeding ponds is to not over design the pond and replicate features from other known breeding locations on the mid north coast and thus provide the best opportunity for a successful breeding event. Essentially, a simple shallow excavation that will hold water for the required period is all that is needed as this species has been regularly encountered breeding in inundated motor vehicle wheel ruts, disused logging dumps, roadside culverts and eroded gully lines (B. Lewis unpublished data). Where possible, a number of options should be proposed and can include *in situ* habitat if it is deemed suitable. The design and construction of breeding ponds should be supervised by the Project Ecologist and this should occur within 12 months of the clearing and grubbing operations.

a. September 2011 b. September 2011 c. March 2012

Plate 4-1. Green-thighed Frog ponds at Fill 6 Kempsey Bypass project (September 2011-March 2012).

4.3 Identification of Known and Potential Threatened Frog Habitat

Environmental management during the construction of the Upgrade should as a minimum consider the following sites outlined in Table 4-1. The areas should be protected from construction related works other than what is considered essential. The locating of access tracks, utilities redistribution, car parking facilities and other ancillary works including topsoil stock piles, lay down areas, wash down bays, site shedding and compound sites should not be located in these areas. This approach is likely to be consistent with the MCoA issued as part of the approval to construct the Project. The protection of the identified areas should include the demarcation of clearing limits and signage identifying these areas as 'threatened species habitat' and/or 'no go' zones.

Table 4-1. Summary of target species and their distribution in the halfway Creek to Glenugie Upgrade corridor. (numbers in parentheses represent survey site numbers)

Species	Known Locations	Suspected/Potential
Wallum Froglet (*Crinia tinnula*)	Nil	• Aberrant record in Wells Crossing Flora Reserve (ch. 25000)
Green-thighed Frog (*Litoria brevipalmata*)	• Halfway Creek (26a, 26b) • Northbound heavy vehicle inspection point (19) • Southbound heavy vehicle inspection point (17) • Between heavy vehicle inspection points (18) • Bald Knob Tick Gate Road (20,21) • Franklins Road (16)	• Halfway Creek (12,25) • Glenugie (15) • Wells Crossing North (22,23) • Wells Crossing (7) • Wells Crossing South (24)
Giant Barred Frog (*Mixophyes iteratus*)	• Halfway Creek (12)	
Southern Barred Frog (*Mixophyes balbus*)	Nil	Nil
Wallum Sedge Frog (*Litoria olongburensis*)	Nil	Nil
Green and Golden Bell Frog (*Litoria aurea*)	Nil	Nil

4.4 Additional Construction Related Recommendation - Pre-clearing Surveys

Additional construction related management including the use of pre-clearing surveys should be undertaken as an additional safeguard to reduce direct mortality to individual frogs during the clearing and grubbing phase of the project. At all of the sites identified in Table 4-1 and any others (i.e. unexpected finds) the following pre-clearing survey procedure is recommended.

4.4.1 Pre-clearing Survey for Frogs

a) Within 5 days of scheduled clearing/ground disturbance operations, the Project Ecologist or environmental manager of the Upgrade should ensure that temporary frog fencing has been installed (*see* 4.2.1) so that a qualified and suitably experienced ecologist can perform pre-clearing surveys over a minimum of two non-consecutive nights (i.e. before clearing commences).

b) Surveys should last 1 person hour per hectare of habitat to be disturbed/removed and involve the use of call broadcast, spotlighting and active searches of litter, debris and logs.

c) All threatened frogs[4] captured should be relocated to the nearest side of the clearing limit with information collected on sex, breeding condition and snout-vent length. Alternative relocation sites should also be considered provided they occur within the same drainage line. As a general rule, frogs should not be relocated further than 200-300 m from the capture site which should theoretically remain within an individual's home range[5].

[4] Non threatened frogs will be relocated in accordance with fauna handling procedure to be developed for the Upgrade.
[5] Based on current knowledge of mark recapture data and radio tracking (B. Lewis unpublished data).

d) Consideration should be given to marking the larger Giant Barred Frogs (i.e. >40 mm will be PIT[6] tagged) to document the performance measure of this as a suitable relocation strategy. Smaller frogs may need to be marked using another method in accordance with the animal care and ethics licence of the Project Ecologist. Toe-clipping is one possible method, however, not all animal care and ethics committees support this approach.

e) A frog hygiene protocol would need to be adopted at sites with threatened frogs. This protocol will be in accordance with Department of Environment and Climate Change DECC (now EPA) Hygiene protocol for the control of disease in frogs Information Circular Number 6 (DECC 2008).

4.4.2 Clearing Supervision

a) At all sites with threatened frogs, the clearing and grubbing activities should be supervised by the Project Ecologist until such a time they are confident no individual frogs remain within the work site.

b) Captured frogs should be treated as per 4.5.1 c) and 4.5.1 d).

c) The need to perform additional night time surveys should be considered and ultimately at the discretion of the Project Ecologist. For example, only part of the site may have been cleared or more suitable weather conditions present an increased opportunity to detect frogs.

4.4.3 Dewatering Procedures

a) The dewatering process should be conducted in accordance with an Environmental Work Method Statement (EWMS) and the DECC (2008) hygiene protocol for the control of disease in frogs. All waterbodies identified as threatened frog habitat should be subject to this dewatering process.

b) Where the water body is to be pumped dry, the intake pipe should be positioned in the deepest section. This would avoid further disturbance of the aquatic habitat prior to capture and relocation of aquatic fauna.

c) Screening of the pump intake (5mm mesh size) should be installed to prevent tadpole entrainment.

d) Dip netting should be undertaken to remove as many aquatic fauna as practical once the water body is shallow enough to be effectively waded through by field personnel.

e) All tadpoles should be identified and sorted by species and/or genus and placed into separate holding containers. The size of these containers should ultimately be left to the discretion of the Project Ecologist.

f) All tadpoles should be released into adjacent habitats that support the same microhabitat attributes. Tadpoles should be acclimatised to the recipient sites water temperature by

[6] Passive Integrated Transponder (i.e. microchip as used to mark and identify domestic animals).

immersing bags or aquaria in the release pools to allow a gradual equilibrium of water temperature prior to release.

g) In instances where there are numerous tadpoles from a wide range of species, preferential treatment should be given to the tadpoles of threatened frogs. The release of predatory species (i.e. eels) should not occur in areas where the tadpoles of threatened frogs are being released. This will reduce the risk of additional predation and/or competition.

4.5 Unexpected Finds Process

An unexpected finds process should be developed as part of the environmental management during the construction of the Upgrade. This is in response to field surveys not being exhaustive and the ability of some frogs to move relatively large distances in short time periods. For example, Giant Barred Frog has the capacity to move hundreds of metres over a time period of 1-2 nights whilst the clearing footprint will rarely extend beyond 120 m. This equates to frogs moving into and out of the clearing footprint.

In an unexpected finds instance, the management strategies and any other deemed necessary by the Project Ecologist should be adopted. Some examples include:

1. Protection of threatened frog habitat including provisions for its protection from ancillary areas and their associated impacts;
2. Temporary and if required permanent frog fencing;
3. Additional pre-clearing surveys as deemed appropriate by the Project Ecologist or frog specialist; and
4. Consideration for the implementation of new findings into any current monitoring program.

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